

**Writing in crooked lines:**  
**A dynamic analysis of writing development in**  
**neo-literate Bambara women**

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May, 2014

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## **Abstract**

Learning to write is not a linear process by which a student, whether child or adult, moves from strength to strength, first acquiring one skill then moving on to the next. It is rather a “crooked” path where different interacting factors move forward and backward, creating a pattern of development as writing skills emerge. This study investigates the developmental patterns involved in emergent writing skills of 20 previously illiterate Bambara women in Bamako, Mali. It examines the preliminary process of skills development in basic letter production as a precursor which may hinder or enhance the practice of writing as self-expression. Three developmental contexts unite to make this study on writing both informative and unique: adult basic literacy skills, an African language and early writing processes.

Dynamic Systems Theory is employed as a means of analyzing a variable of interest consisting of letter formation, alignment, size and spacing as they reflect periods of stability and change over time in a non-linear, self-organizing, open system. The analysis leads to a proposed model of writing development in Bambara adults and the implications that such a model could have for understanding the process of writing acquisition by the adult learner.

The study addresses questions regarding the presence of distinct patterns in writing skills development, whether such patterns are the same intra-individually and between adult and child learners, and the implications of patterning, in particular regression in patterning, for teaching and evaluation.

Findings of the research indicate not one overall pattern for the study, but separate and distinct patterns in each learner. The patterns in the data of each individual are unique in respect to the range and percentage of output, the order of development of different sub-skills, and the progression and regression of each sub-skill. From the data, it is not possible to predict for a particular individual or to generalize for the population as a whole which factors will act in concert or in competition. The patterns evident in the data are not the same intra-individually.

However, given the flexibility of patterns of development among individual learners, it may be said that the data in this study support the proposition that neo-literate adults in a non-literate context pass through the same stages of

development in the writing process as do children. The concepts foundational to writing skills, including basic directionality and linearity of text, word spacing and letter formation, must still be given a chance to develop in each new adult writer.

In a proposed model of emergent writing development, the elements which varied intra-individually were separated from the generalities that were consistent across the data. This consistency was evident in the types of patterns formed by the roles or functions expressed by each of the elements in the variable of interest. So while the data cannot indicate a particular order of development or interaction among the elements, they do indicate specific roles and functions that will be evident within the variable of interest at any given point.

Study findings reinforce the following concepts:

- regression in performance in one area may be a positive indicator of learning in another;
- scaffolding and revision may lessen the cognitive load and enhance learning;
- a balance between whole class and individualized instruction will respond to the needs of different learning patterns;
- continuous, or at least frequent, assessment will create a more accurate learning profile;
- the scope of assessment should include awareness of the various interacting elements in skills development.

Key Terms: adult literacy, Bambara, Dynamic Systems, instruction, language development, learning patterns, learning process, literacy, women's literacy, writing



# **Skryf in skewe lyne: 'n Dinamiese analise van skryfontwikkeling by nuutgeletterde Bambara-vroue**

## **Opsomming**

Die proses om te leer skryf is nie lineêr nie; 'n leerder, hetsy kind of volwassene, gaan dus nie van krag tot krag deur aanvanklik een vaardigheid te verwerf en dan aan te beweeg na die volgende nie. Dit is eerder 'n “skewe” paadjie waar verskillende faktore in wisselwerking met mekaar vooruit en agteruit beweeg, wat 'n ontwikkelingspatroon skep namate skryfvaardighede ontluik. Hierdie studie ondersoek die ontwikkelingspatrone by die ontluikende skryfvaardighede van 20 voorheen ongeletterde Bambara-vroue in Bamako, Mali. Dit ondersoek die voorafgaande proses van vaardigheidsontwikkeling in basiese letterproduksie as 'n voorloper wat die beoefening van skryf as selfuitdrukking mag belemmer of vergemaklik. Drie ontwikkelingskontekste kom in hierdie studie oor skryfontwikkeling bymekaar wat dit beide informatief en uniek maak: basiese geletterdheidsvaardighede by volwassenes, 'n Afrika-taal en vroeë skryfprosesse.

Dinamiese Sisteemteorie word gebruik as metode om belangwekkende veranderlikes te ontleed: lettervorming, belyning, grootte en spasiëring. Al hierdie vertoon oor tyd heen periodes van stabiliteit en verandering in 'n nielineêre, selforganiserende, oop stelsel. Die analise lei tot 'n voorgestelde model van skryfontwikkeling by Bambara-volwassenes en die implikasies wat so 'n model mag hê om die proses van die verwerwing van skryfvaardigheid by die volwasse leerder te verstaan.

Die studie spreek vrae aan betreffende die teenwoordigheid van kenmerkende patrone tydens die ontwikkeling van skryfvaardighede, of sodanige patrone dieselfde intra-individueel of tussen volwasse en jong leerders is, asook die implikasies van patroonvorming, veral regressie in patroonvorming, vir onderrig en evaluering.

Bevindings van die ondersoek dui nie een algemene patroon aan nie, maar afsonderlike en kenmerkende patrone by elke leerder. Die patrone in die data van elke individu is uniek wat betref die omvang en grootte van die uitset, asook die volgorde van ontwikkeling van verskillende subvaardighede en die progressie en regressie van elke subvaardigheid. Dit is nie moontlik om uit die data 'n

voorspelling betreffende 'n spesifieke individu, of algemeen vir die populasie as 'n geheel te maak oor watter faktore in harmonie of in kompetisie met mekaar gaan optree nie. Die patrone wat duidelik in die data voorkom, is nie intra-individueel dieselfde nie.

Gegewe die buigzaamheid van ontwikkelingspatrone by individuele leerders kan dit egter gekonstateer word dat die data in hierdie studie die stelling ondersteun dat nuutgeletterde volwassenes in 'n nie-geletterde konteks deur dieselfde ontwikkelingsfasies in die skryfproses as kinders gaan. Die konsepte wat ten grondslag van skryfvaardigheid lê, insluitende die basiese rigting en die liniariteit van teks, woordspasiëring en lettervorming, moet nog 'n kans gegun word om by elke nuwe volwasse skrywer te ontwikkel.

In 'n voorgestelde model van ontlukende skryfontwikkeling is die elemente wat intra-individueel gevarieer het, geskei van die algemeenhede wat deurlopend in die data voorgekom het. Hierdie reëlmatigheid het duidelik geblyk in die soort patrone wat gevorm is deur die rolle of funksies wat elk van die elemente in die betrokke veranderlike vervul het. Alhoewel die data dus nie 'n spesifieke volgorde van ontwikkeling of interaksie tussen die elemente kan aandui nie, dui dit wel spesifieke rolle en funksies aan wat op enige gegewe punt in die betrokke veranderlike sal blyk.

Bevindings versterk die volgende konsepte:

- regressie in prestasie op een gebied mag 'n positiewe aanduider van leer op 'n ander terrein wees;
- ondersteuningsmeganismes en hersiening kan die kognitiewe lading verminder en leer bevorder;
- 'n balans tussen individuele en klasonderrig sal die behoefte aan verskille in leerpatrone kan bevredig;
- deurlopende, of ten minste gereelde assessering sal 'n meer akkurate leerprofiel oplewer; en
- 'n bewustheid van die onderskeie elemente wat op mekaar inwerk in vaardigheidsontwikkeling behoort neerslag te vind in die omvang van die assessering.

# **Chapter 1.**

## **Introduction**

Writing has been called “the neglected half of literacy” (McLane & McNamee, 1990:23), with less research available on it than on reading and less known about its relationships with later success in learning. Torrance (2008) bemoans the poorly understood nature of writing development in contrast to the studies available on reading and calls for a more complete model of writing expertise (Torrance, 2008:4). Writing is often treated as the acquisition of a collection of skills, rather than as an ever-evolving, recursive process (Gillespie, 2001:63-64), with the result that as the many and varied strands of awareness and capacities which feed into the writing process are described, discussions of the development of writing appear either scattered or self-contradicting. Moats (2005) refers to writing as “a mental juggling act,” citing the necessity for basic skills in handwriting, spelling, grammar and punctuation to support higher-level compositional issues such as topic, organization, word choice and audience (Moats, 2005:12).

This study employs the term “writing” in a specific and limited context, referring to the formation of letters and spatial and directional orientation of symbols reproduced manually on a page by previously illiterate adults. It will examine this preliminary process of skills development in basic letter production as a precursor which may hinder or enhance the practice of writing as self-expression.

Three developmental contexts unite to make this study on writing both informative and unique: adult basic literacy skills, an African language and early writing processes. Each of these areas has been researched to a greater or lesser degree, but the intersection of the three narrows the focus of this study to provide a heretofore unexplored area of investigation. The three contexts and their importance may be introduced as follows:

### ***1.1 Early writing***

“Beginning writers are not beginning thinkers” (Basic Skills Agency, 2001:105), but the process of acquisition itself and the continuing development of basic writing skills may inhibit new writers’ ability to express their thoughts fluently and accurately in a written form. Both children and adults may use simpler forms of expression in writing than they would use in spoken form while they master the technical skills of putting words onto paper (ibid.:105; Christie, 2003:2). This restriction on compositional skill points to the importance of mastery of handwriting as foundational to the use of writing as a form of self-expression if it is not to be hindered by the need to concentrate on either retrieval of cognitive information on sound-symbol correspondence or the physical skills of letter formation on the page. In both children and adults, this need to focus on more basic skills interrupts the thought process and distracts writers from concentrating on the thoughts they wish to express (McCutchen, 2006:126; Kellogg, 2006:7-8). Yet the study of how such fundamental writing skills are acquired is often quickly passed over in favor of the study of higher level composition processes. In prioritizing the development of composition skills, foundational writing skills which themselves contribute to composition are neglected (Medwell & Wray, 2007:15).

“[A]lthough there is quite an extensive literature exploring what works in writing instruction, little is known about the mechanisms by which these interventions have an effect” (Torrance, 2008:4). These mechanisms, or skills, need an elaborated base, an explanation of how the foundations of lower-level writing skills emerge in adult learners, in order to better inform instructional and interventional practice.

### ***1.2 Language development***

Language development as a term may be applied to the process by which an individual gains increasing capacity to communicate, whether orally or in written form. School children’s language development is the focus of what is often referred to as the Language Arts strand of the curriculum, the reading, writing, speaking and listening skills, involving such domains as spelling, grammar, vocabulary and self-expression, either written or oral. The development of a

child's language skills and communication capability is relevant to a child's academic success. Cummins' Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP) describe two levels of language development of the child and explain, particularly in reference to second language acquisition, the need for a different level of language development for the individual to succeed in an academic endeavor as opposed to functioning adequately in a language in a social setting (Cummins, 1999). Other theorists and researchers address these issues in terms of academic discourse and differential communicative ability (Patterson & Weideman, 2013). Language development in this sense is studied and encouraged in the individual child, but would not be a significant factor in the developing capacities of the adult learner, if the learning is being conducted in the learner's first language: in normal circumstances, adults will have attained a fully functional ability in the first language.

The term language development may equally be applied to the processes by which languages themselves gain capacity to be incorporated into a formal educational system, to be codified into a standardized written form, to have reference materials such as dictionaries and orthography guides to aid in the standardization of a written form of the language, to have a corpus of printed literature, to be used in text messaging, on Internet websites and for other activities which will enable the language to continue to serve as a viable means of communication for a given population in an ever-growing range of domains. SIL International, a faith-based non-governmental organization, serves language communities through partnering for sustainable language development. This organization defines community-based language development as "a series of ongoing planned actions that a language community takes to ensure that its language continues to serve its changing social, cultural, political, economic and spiritual needs and goals" (SIL, 2013:online).

While every vital language exhibits an ever-growing capacity to adapt and change according to the demands of communication in society, when it comes to language development, some languages are more equal than others. Those languages which have yet to create or which are in the process of creating a corpus of materials and the capacity to interact in a variety of communication modes may be referred to as developing languages. The Bambara language of Mali, an African language of the

Mande family which has only had a formal written form since the time of French colonization, is an example of a developing language. Because of the strong influence of French as the official language in the country, little is available in print or recording of the rich Bambara oral literature. Use of a standardized Bambara orthography is often ignored by those who are literate in French in favor of an adaptation of the French writing conventions to represent the local language. While Bambara is more highly developed as a written language than many other African languages, creating a print-rich Bambara environment for new readers and writers remains a challenge.

The question may be raised as to why there would be interest in or relevance to becoming literate in Bambara, given the rich resources already available in French, the official language of the country. The stark reality of the situation is that the women in these basic literacy classes do not speak the official language of their country, or if they do, it is only to a very basic level. The language that they use in every aspect of their lives is Bambara. The women who participated in this study have not been through the formal education system, yet they are fully functioning adult members of society. Their level of language development, in the first sense of the term given above, is that of an adult, capable of expressing whatever they wish to communicate orally and of comprehending what is spoken to them in the language. It is only the written form of the language that is inaccessible to them. Yet the inaccessibility of this one form of the language has a profound impact on these women.

### ***1.3 The impact of literacy on women***

Literacy is a bridge from misery to hope. It is a tool for daily life in modern society. It is a bulwark against poverty, and a building block of development, an essential complement to investments in roads, dams, clinics and factories. Literacy is a platform for democratization, and a vehicle for the promotion of cultural and national identity. Especially for girls and women, it is an agent of family health and nutrition. For everyone, everywhere, literacy is, along with education in general, a basic human right.... Literacy is, finally, the road to human progress and the means through which every man, woman and child can realize his or her full potential (Annan, 1997:online).

The above statement, made by Kofi Annan on the 1997 International Literacy Day at the beginning of his term as the Secretary General of the United Nations, makes several claims pertaining to the impact of literacy. More recent studies continue to deepen and broaden those claims, as will be seen in the following paragraphs.

More than 40% of the adult and young adult population in West Africa is illiterate. Of these 65 million people, 40 million are women. The inability of over half of the West African women aged 15 and over to read or write is “both a sign and a cause of women’s continuing marginalization and poverty” (Pearce, 2009:4). Recent studies on women’s use of technology in Africa have found that, while mobile phones are popular and used extensively for work, security and social contact, illiterate women were reliant on others to text message or even to compose the numbers for a call (Macueve, Mandlate, Ginger, Gaster & Macome, 2009:26-27). A Congolese colleague working in Brazzaville related that his mother was unable to contact him by phone because she was illiterate and could not recognize the numbers on the touchpad or match them to a written phone number to make contact (Beapamé, 2011). These cases give very practical, even startling, examples of the extent to which illiteracy impacts modern daily life.

In traditional societies, women are less exposed to outside cultures and languages through schooling, work and mobility and thus have a greater tendency to be monolingual (UNESCO, 2003:15). This lack of exposure to an official language of the country further decreases their capacity to interact in matters of democracy and development or to have access to basic literacy programs, unless there is one in their own language. The capacity to read, even in primarily oral societies, gives greater access to information, particularly information originating outside of the traditional culture, such as in the realms of politics, economy, health, and development. A recent UNESCO report states that “171 million people could be lifted out of poverty if all students in low-income countries left school with basic reading skills” (UNESCO, 2010:1).

In matters of health, women’s literacy is important not only to them as individuals but also in their confidence and ability to care for their families. Not only are literate women able to read health and nutritional information and follow directions for medicines and prescriptions, but they also are further empowered to interact with health officials and to request treatment (Pearce, 2009:11). This is

seen practically in that a child born to a mother who is literate has a 50% greater chance of surviving past the age of 5 (UNESCO, 2010:5). Heugh (2011) reinforces this position, pointing out that higher education rates for women and girls are linked to lower rates for HIV/AIDS and other health-related issues. The significance of this benefit is further reflected in the economy, through lower health-care expense, potentially higher wage earnings, and increased maternal support for children, not only in the home but in the education of the next generation (Heugh, 2011:269).

Wagner (2000, 2011) summarizes the benefits of literacy into the following categories: economic benefits, as higher skills lead to better wages, social development resulting from the empowerment of women, the growth of democracy and national identity as national campaigns and governments are seen to promote the rights and needs of the disenfranchised among the population, educational benefits of literate parents to the achievement of their children's academic performance, endogenous motivations for community cohesion and identity and exogenous benefits of international standing in development in relation to other countries (Wagner, 2000:online; 2011:121-123).

The women in this study have yet to experience the full impact of the benefits of literacy mentioned above. In fact, their motivations may be entirely other than those factors mentioned. For some, literacy may be a goal in itself, a benchmark of personal achievement. Being able to vote without using their thumbprint, or as was seen at the beginning of data collection for this study, to sign their names giving permission for their data to be included in this study, was a personal accomplishment which gave them pride and dignity. For others, the class itself may be the draw of a social activity, a communal event. Again, in the course of this study, the social atmosphere and the personal relationships among the class members were strong and caring. It was a privilege to be included in these circles of endeavor, even as an outsider. Still others may simply thirst for knowledge, for learning of any kind. Women with this motivation will likely continue to develop their skills and join other classes on the strength of their new-found literacy abilities. These three motivations, task-oriented, socially-oriented, and learning-oriented, will in turn have their own impact on each individual's success in



learning to read and write and in continuing a life-long learning process (Houle, 1961).

### ***1.4 Adult basic literacy skills***

That person is literate who, in a language that he speaks, can read and understand anything he would have understood if it had been spoken to him; and who can write, so that it can be read, anything that he can say (Gudschinsky, 1973:2).

The process of becoming literate goes beyond signing one's name, as impactful and significant as that can be in itself. For the women in this study to be truly literate, their reading and writing skills must extend to using words on paper for communication. Adult learners face some challenges that differ from those of younger learners. On the positive side, the adult learner brings life experience and specific motivations for learning to the literacy task. Yet for some older adult learners, there are the potential challenges of arthritic joints and failing eyesight. Adult learners' individual language development levels, their oral and aural language capacity, would not be a factor in the learning process for native-language literacy as it is in younger learners. But in this developing language context, the effect of a lack of a print-rich environment may be evidenced in the level of meta-linguistic awareness of adult literacy learners. Basic directionality and linearity of text, word spacing, and even letter form and orientation are new concepts to the majority of these debutant literacy learners. The significance of these factors is heightened in the context of a developing language, where not only is the writer developing an awareness of grammatical forms, written style and technical capacity for reproducing language in written form, but the language itself is evolving a standardized written form with conventions and manners of expression reflective of the language and culture. In such a context, the new writers are not accustomed to a written environment, to reading and writing as a part of daily life, or even to an awareness of the letters of the alphabet or writing conventions as they begin their studies.

Even though adult literacy learners have fully developed oral communication skills and function in society with adult cognitive capacity, the demands of the multiple tasks required to communicate effectively in a written mode will reduce the adult learner's ability to a level similar to that of a child for the basic skills of

letter formation, alignment, spacing and size. Fine motor coordination that is just beginning to develop in the primary school child may never have been given an opportunity to develop in the illiterate adult. An analysis and description of the development of each of these strands of writing skill will inform the teaching process for adult literacy classes and give insight into the nature of the development of language in a written form at an individual level.

To reach this analysis of writing skills, this study will first look at a number of areas that have received attention in the literature, such as what is known about writing as a developmental process, the influence of a literate environment, what has been studied about the development of handwriting in adult learners, and available options for assessing the writing process itself. With this foundation, we will then present the context in which the study is set, both politically and linguistically, to establish the learning environment and the tools to be acquired, i.e., the writing system of the Bambara language. Because this study focuses on the output rather than the teaching/learning process, further description of the literacy methodology, teaching training and materials will not enter into consideration. All learners will have experienced the same teaching methodology, so its influence on the writing output will be the same for all of the data.

After this contextualization in the literature, the country and the language, the study will present dynamic systems theory as the methodology for analyzing the data. The methods of data collection from the women's literacy center and the data coding will be delineated, before presenting the analysis of the data grouped according to 3-month, 4-month and 5-to-6-month samples. Each individual's data will be coded and analyzed for the development of letter formation, letter size, spacing and alignment, and compared inter- and intra-individually. These data will then be used to investigate the possibility of a model of writing development in Bambara adults and the implications that such a model could have on the understanding of the process of learning to read and write for the adult learner.

The purpose of this study is to apply a dynamic systems analysis to describe the progression and interplay of four aspects of handwriting capacity shown in the output of beginning writers in order to discover the pattern of development of the writing process in newly literate Bambara women in a developing language context. To accomplish this goal in this three-fold developmental context, writing

samples collected at monthly intervals from Bambara women attending basic literacy classes were assessed to ascertain the emergence of developmental patterns according to the parameters of letter formation, alignment, size and spacing.

The study will address the following questions:

- Are there distinct patterns in the learning of writing skills in this language? Stated differently, are there interactions of various influencing factors in writing skills development that come together at thresholds of learning that could inform researchers as to the nature of the process of learning to write in the Bambara language?
- Do illiterate adults in this language develop handwriting skills according to the same developmental steps as has been documented in children?
- If patterns are evident, are they the same intra-individual, or is each adult learning sequence unique?
- What can be learned from the seeming regression, or “dips in developmental progress”, for teaching and evaluation?

## **Chapter 2.**

### **Review of the literature**

As stated in the introduction, this study is limited in scope by focusing specifically on handwriting skills development in adult literacy learners in the context of an African language using an alphabetic writing system. While the preponderance of writing development studies focus on the emergence of compositional skills, writing research does show that early writers continue to struggle with the mental and physical effort required to form letters and words (McCutchen, 2000; Medwell & Wray, 2007). As a result, fewer cognitive resources are available to the beginning writer for higher-order processes required for tasks of self-expression such as sentence and text composition (Verheyden, Van den Branden, Rijlaarsdam, Van den Bergh & De Maeyer, 2012:184). For this reason, this study addresses handwriting development as a foundation to be established before issues of composition, pedagogical or therapeutic intervention for handwriting difficulties can be addressed. The review of the literature will therefore be limited to three areas: the development of the basic writing capacities being investigated in the study, differences between adult and child development, and means of assessment of handwriting as it relates to skills development.

#### ***2.1 Writing as a developmental process***

“Writing” is a word with many meanings. From the tracing of a letter on a page to the abstract set of symbols used for communicating a language in written form, the term may as easily refer to making a list or creating a novel. Writing may refer to a notational system, a mode of production or a collection of discourse styles. Any of these uses of the term may be approached from a developmental perspective. Such an approach implies two basic assumptions: that the learner is aware of the use of writing in the environment and that the ideas that the learner develops about writing and the stages by which the learner attains writing skills are not in direct one-to-one relationship with the ways in which they are taught (Tolchinsky, 2006:83). Kellogg (2006) describes writing as a developmental

process which encompasses other processes and capacities, including orthographic and phonologic encoding, memory and cognitive and language capacities (Kellogg 2006:1).

Children in a literate environment develop their own ideas about writing and how it functions before they are taught to write in school. Before the age of 3, the child may produce graphic patterns on a page, but the meaning assigned to those patterns is determined by the child as author, not discernible by an observer. Understanding of writing continues to develop through this initial stage, as a greater awareness develops as to what forms are acceptable as “writing.” Further writing parameters develop to show a growing correspondence between the length of a word and the number of symbols used to represent that word. This correspondence slowly becomes more refined, as segments of speech and written symbols become more stable in sound-symbol relationship. Finally the child discovers the alphabetic principle, by which each consonant and vowel is represented by a letter. This developmental progression is driven primarily through writing and the acts of writing to which the child is exposed (Tolchinsky, 2006:94).

#### *Writing development*

Writing development builds on children’s ability to communicate through speech. However, written communication differs from speech in several important ways, each of which is associated with new skills that the developing writer must acquire. Writing requires graphic representation (i.e., the ability to form letters on the page) and grapheme-phoneme conversion (i.e., letter-to-sound conversion) in order to form words. ... Learning to write therefore requires development of new skills both at the level for language representation (i.e., moving from aural to visual expression) and message communication (i.e., moving from reliance on interaction with an interlocutor to informational self-sufficiency) (Torrance, 2008:1-2).

The developments of the capacities which lead to the ability to write begin very early in life. Long before formal reading and writing behaviors are exhibited, an underlying comprehension of the functions of literacy begins to dawn in the incipient awareness and abilities of the child. Fine motor skills, eye-hand coordination, language skills, symbolic representation, distinction between drawing and writing, objective and constant meaning held by symbols, sound-

symbol correspondence, all these and more lay an ever-developing and expanding base for the emergence of writing skills (Lancaster, 2003; National Association for the Education of Young Children, 1998).

While it is beyond the scope of this study to delve into the parameters of cognitive development necessary for writing skills development, an awareness of children's developmental stages as they relate to writing readiness may inform the analysis of writing skills development in adults. Foundational to any such discussion is Piaget's model of cognitive development. His model classifies human development into four basic stages, each of which is further elaborated into more specific subdivisions:

1. Sensorimotor stage (ages 0-2 years)
2. Preoperational stage (2-7 years)
3. Concrete operational stage (7-11 years)
4. Formal operational stage (12 years and on) (Davis, 1991:13-14)..

Most useful to this discussion of writing development in children are the preoperational stage and the concrete operational stage. During the first of these, symbolic functions and early reasoning skills begin to emerge and the child develops the capacity to focus on one element at a time. During the concrete operational stage, symbolic capacity continues to develop in the concepts of conservation of space, numbers, seriation and classification (ibid.).

In later work, Piaget allowed for more flexibility in the rate of movement through the developmental stages, particularly in respect to different cultures and socialization processes (ibid.:19-20).

Ferreiro (1990) makes specific reference to the development of literacy skills within Piaget's model, elaborating three developmentally-ordered levels of acquisition of literacy competencies in children. During the first, the child is learning to distinguish between writing and drawing. In this Piagetian preoperational stage, the child is beginning to grasp the concept of the use of symbols, and learns primarily through experimentation. In literacy skills, s/he is beginning to associate symbols with sounds in lieu of associating the written signs with a visual representation, as in a drawing. Linearity of symbols begins to be

copied. According to Ferreiro, in literacy-rich environments, children will begin to exhibit these behaviors in the third year. This first level of literacy acquisition continues with the development of internal principles of minimum quantity, i.e. that a word needs to have a certain number of letters, and of internal qualitative variation, i.e. that these letters need to be different. By the end of this first developmental level, meaning is not yet associated with writing. In the second level, these areas of awareness continue to develop, with the child searching for the identifying factors which distinguish meaning, e.g., does the name of a bigger object use more letters, or does an older person have more letters in their name? As the concept of numbers is developing at the beginning of Piaget's concrete operations stage, this link also emerges through experimentation into how many letters are needed as a minimum and a maximum to represent words. Further hypotheses develop as to how many letters need to change before the word means something else. At the third developmental level proposed by Ferreiro, experimentation extends to a syllabic hypothesis, as series of similar letters are used to represent similar "pieces of sound." This hypothesis is expanded to a syllabic-alphabetic hypothesis, in which some letters may represent syllables while others represent phonemes. Development continues, reflecting the development of logical reasoning based on experience, to an alphabetic hypothesis whereby the similarity of sound indicates a similarity of letters, and inversely, dissimilarity implies a different letter. At this stage, children seek to regularize the writing system in much the same way that they would regularize irregular verb tenses in spoken communication (Ferreiro, 1990:12-25).

The tendency in the literature is to continue to describe the process of learning to write as a progression along a continuum, but the multiple physical and mental sub-skills and processes requisite to the writing task develop at differing rates, rendering this a complex task (WGBH Educational Foundation, 2002:online). The rate of maturity of motor skills and cognitive and linguistic capacities varies within each individual. Also, as one new capacity is being acquired, other skills formerly learned may show a brief regression in ability, causing a seeming disruption in a progressive scale of development. In addition, language, culture, and quality of interaction with adults and older siblings may influence the order and rate of development of each of the sub-skills (Deford, 1980:162; Steffler &

Critten, 2006:online). Given these caveats, and with allowance for some flexibility, it is still possible to discuss some general patterns of development of writing skills.



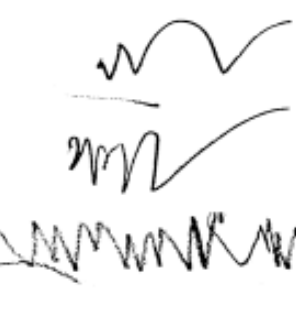
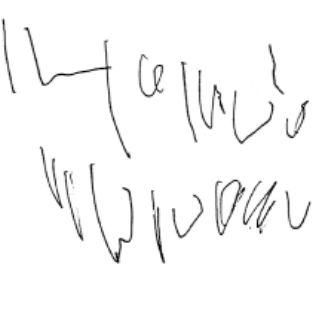





Clay first used the term “emergent literacy” in 1966 to refer to the early behaviors of children engaging in reading and writing-like activities, whether they were actually capable of reading and writing yet or not. The term has since been expanded to include the concepts of:

- The development of skills leading to literacy before school-age instruction;
- The interrelated nature of the development of reading, writing, listening and speaking skills;
- Meta-linguistic awareness (e.g., letters spelling words and words conveying meaning) being as important as learning letter-sound correspondence;
- Engaging with adults, exploring for themselves, and observing others in reading and writing activities designed to teach them about written language and how to use it;
- Stages of literacy development in children at differing ages and in differing ways (Teale & Sulzby, 1986).

The concept of emerging writing skills has been further defined in practice, as demonstrated by the handout developed for parents by the Parents as Teachers National Center, Inc., and Missouri Department of Elementary and Secondary Education (1997), reproduced in table 1:



**Table 1. Developmental stages of writing**

 <p><b>Scribble Stage</b> Scribbles are lines and circles starting any place on the page.</p>	 <p><b>Separated Scribbles</b> Scribbles separate as child moves pencil to many starting points</p>	 <p><b>Left to Right Scribbles</b> Child moves pencil across the page from left to right.</p>
 <p><b>Scribble / Mock Writing</b> Scribbles resemble writing with no identifiable letters.</p>	 <p><b>First Letters</b> Some scribbles resemble actual letters.</p>	 <p><b>Transition Stage</b> First attempts to make specific letters.</p>
 <p><b>Strings of Letters</b> Child writes letters without forming words.</p>	 <p><b>Copies Print</b> Child interested in writing real words and attempts copying.</p>	 <p><b>Conventional Writing</b> Child writes real words and is interested in spelling.</p>

Steffler and Critten (2006) outline the development of writing skills in English-speaking children between the ages of 0 to 60 months, thus before formal school instruction, as summarized below:

- Between 1 and 2 years of age, children begin playing with books, imitating parents and older siblings. Fine motor skill development, in particular the coordinated use of the thumb for grasping at around 13 months and eye-hand coordination at around 18 to 24 months, enables the manipulation of crayon and paper. An awareness of physical consequences of actions, such as a visible trace of a writing implement on a surface, leads toward awareness of symbolic representation. At this stage, toddlers are developing an implicit understanding of print through exposure to books and environmental print such as traffic signs, which prepares a foundation for a subsequent and more explicit knowledge of writing.
- Between 2 and 3 years old, children continue to imitate the writing practices they observe, differentiating between writing and drawing. This is evidenced in the motions used by children: in drawings, the motions tend to be large and circular, while writing motions are shorter and less fluid. At 2 ½, children begin to use more conventions of writing, such as linear form, left-to-right directionality, use of spacing between units and blocks of writing, and may begin to copy some individual letters, or even recognize their own names by the first letter. By 3 years old, children draw and write with distinctively different results. At this pre-phonemic or emergent spelling stage, one letter may represent an entire word, or wavy lines separated by spaces may represent words.
- Between 3 and 4 years of age, children distinguish between writing and other markings. They use directionality in their writing and begin to represent words as strings or groups of letters. While letter formation is the centralized focus of learning, linearity skills may seem to regress. Letters may vary in size, but tend to be separated by spaces and grouped into at least three letters to represent a word. Longer strings of letters are used to represent longer words. At this semi-

phonetic or early phonemic stage, children seldom repeat the same letter twice in a row, indicating an awareness of variety in sounds or symbols used to write. They may have favorite letters that are used more frequently, often the first letters in the names of family members.

- When children are between 4 and 5 years of age, they exhibit consistent use of letter-sound correspondence as opposed to assigning their own meaning to markings. This corresponds to a less ego-centered awareness in the child and a semi-phonetic or early phonemic stage of development. In English, children often use one letter to present a word, then the first and last letters or consonant sounds, then a string of letters as a precursor to the use of actual spelling skills. At this stage, letters that have the same point of articulation in the mouth, e.g., p/b, k/g, t/d, can easily be confused in writing (Steffler & Critten, 2006:online).

Lancaster (2003) noted discernible emergent writing practices among children before the age of three. Children growing up in literate cultures are surrounded from birth by what Lancaster refers to as a “complex array of literacy practices,” including print not only in books but on clothing, bedcovers, toys, eating and drinking utensils and other manner of merchandise. Children’s engagement with all manner of graphic meaning as symbolized by logos, pictures, numbers and letters enables them to distinguish among writing, drawing and numbers before the age of three. This graphic environment is designed to attract and engage, creating a desire to find out more. This interest in symbols encourages children at a very young age to interact at an abstract level, which is a pre-cursor necessary to developing writing skills. Even before the age of three, children are confronted with spatial organization, varied marking systems, different genres and ways of displaying and representing meaning. Through general awareness and more active responsiveness, children develop an awareness of “how literacy works.” Early “scribbling”, while not being discernible as communication by an outside observer, is deemed by the young writer to have connection to intended meaning and letter form. Thus, to represent the development of writing as a simple procedure of learning to form letters and linking letters to sounds does not

accurately reflect the nature of writing nor the process developing in the child's capacities (Lancaster, 2003:online).

Deford (1980), in a study to discover an overall structure for the development of writing in two- to seven-year old children, found that progression in writing skills did not develop either linearly or sequentially, reflecting rather a constant shift between global and more detail-oriented aspects of print. Attention to letter formation or words as separate segments of speech grew out of the budding writers' desire to communicate whole messages. Thus, while finding a linear description of writing progression "impossible" (Deford, 1980:162), she did propose a flexible framework of stages which may develop concurrently or in a variety of orders to aid in understanding the process of writing development in English-speaking children:

1. Scribbling
2. Differentiation between drawing and writing
3. Concepts of linearity, uniformity, inner complexity, symmetry, placement, left-to-right motion, and top to bottom directionality
4. Development of letters and letter-like shapes
5. Combination of letters, possibly with spaces, indicating understanding of units (letters, words, sentences), but may not show letter/sound correspondence
6. Writing known isolated words - developing sound/letter correspondence
7. Writing simple sentences with use of invented spellings
8. Combining two or more sentences to express complete thoughts
9. Control of punctuation - periods, capitalization, use of upper and lower case letters
10. Form of discourse - stories, information material, letters, etc.

(Deford, 1980:162)

Thus, while there is a tendency to view the process of learning to write as a sequential progression during which one set of skills builds on the previous (WGBH Educational Foundation, 2002:online), or as a developmental continuum (NAEYC, 1998:3), a more helpful model might be a compendium of several interacting continua drawing from physical, psychological and linguistic

developmental processes. As children develop the physical capacities to manipulate pencil and paper and the eye-hand coordination to form letters and words, they also form attachments to adults and seek to communicate with them and to imitate their actions, while developing a sense of identity that can differentiate between personal will and objective meaning. At the same time, and perhaps driven by the psychological need to be in relationship with those about them, children develop language abilities. None of these, singly, can adequately address the nature of the development of writing, but if taken together, they can potentially provide a more integrated understanding of the process. The social and contextual nature of literacy development (Street, 1995)<sup>1</sup> becomes pertinent to even the earliest stages of scribbling. Moreover, the physical capacity to write or type a written form without hesitation or difficulty disrupting the communication of the intended message is also relevant to the most advanced adult writer.

In summary, research into writing development is still in the beginning stages (Harrison, 2007:online). Many models have been used to describe the processes that affect the development of writing, in general including these major elements: spelling and handwriting, planning and self-monitoring, compositional skills. Many describe the process as a developmental hierarchy, in which new writers are limited by their ability to form written letters as well as by their memory and the developmental levels of their language skills (ibid.). But the development of writing awareness and writing skills is highly influenced by the child's environment, language and culture (Deford, 1980; Ferreiro, 1990; Lancaster, 2003). The following section will review studies on the impact of the context of the learner on literacy skills acquisition.

## ***2.2 The significance of a literate context***

Studies investigating the writing process have been undertaken in a number of countries and in a variety of languages (Ferreiro & Teberosky, 1982; Rosenblum, Weiss, & Parush., 2004; Stellakis & Kondyli, 2004), yet similar results have been found for writing development in schoolchildren. It should be borne in mind that the research and theories are developed from the context and perspective of

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<sup>1</sup> Street rejected the idea of literacy as a discrete set of skills which develop without regard to the cultural and social institutions of which they are a part.

literate societies and in the first language of children of literate parents. As Lancaster (2003) pointed out, the environment surrounding the child from birth is attractive and engaging, replete with literate stimuli. Deford (1980) declared that the most important elements for the development of writing in children are “a rich, meaningful print environment, varied opportunities for individual exploration, and a willing, supportive audience” (Deford, 1980:162). The National Association for the Education of Young Children further states that the lack of a firm grounding in such literacy experiences before children begin formal schooling can “severely limit the reading and writing levels they ultimately attain” (NAEYC, 1998: 1-2).

This statement was exemplified in a seminal study by Heath (1982) on home literacy practice and its effects on school performance. The study tracked children in three communities, referred to as Maintown, Roadville and Tracton. Maintown was a US suburban middle-class community of mixed race. Parents in Maintown were in general well-educated and read to their children as a natural part of the home culture. Roadville was a white, working-class community, in which the parents’ attitude reflected a separation between education and home life. Their perceived responsibility was to send their children to school, but education was the teacher’s role. Tracton was an African American working-class community in transition from farm work to factory work. In this community, responsibility for raising children was shared by the community as a whole.

The interactions with reading, what Heath referred to as “ways of taking from books,” varied significantly. In the community where parents read to their children, asked questions about what was read, encouraged the child to think about the text, and where books were readily available and used at home, children did well in reading instruction throughout their school years. In the community where parents made books available to their children in the home and even read to them, but did not interact significantly with them about their reading, the children performed well in the first few years of school, but good performance did not continue into the later elementary grades. In the community where parents thought of education as important as a means to employment but did not model reading and where books were not readily available in the home, children tended to perform poorly in school. Heath concluded that the impact of transition from

home to school culture was significant. She further offered suggestions for transitioning into a different mode of learning.

The logical extension of these findings for children who not only do not grow up with literate parents in a literate environment but whose language also does not yet have story books and age-level literature at all speaks to the literacy and education context for much of Sub-Saharan Africa.

The same questions can be applied to illiterate adults in a developing language context. Much of the research on writing development has been related to the acquisition and development of writing skills in children. Little is known about how adults develop basic writing skills. Research relating to the process of writing development in adult learners is limited and generally focused on the development of compositional skills, not on the more basic processes of learning to form letters or to develop phonological awareness of sounds in words. Most of the studies are set in developed countries, and thus investigate a study population of adults who have an awareness of reading and writing, but who are considered to be in the minority or learning disadvantaged. These studies on adult literacy address the stresses and life concerns of the participants and their motivations for learning (Gillespie, 2001:12-15).

### ***2.3 Handwriting in adults***

To date, we know little about the relationship of adult basic literacy skills acquisition and how it corresponds to the same processes in children. Adult learners' expectations of their own performance may be different to that of children, and adults may be more unwilling to make mistakes or unaware of a need for re-writing and editing (ibid.:25).

A small number of studies have examined the correspondence between the development of adult and children's literacy in spelling skills (Viise, 1996; Worthy & Viise, 1996). In a study comparing spelling development in 195 children and 124 adults, it was found that adult literacy learners progressed in a manner very similar to that of children in the acquisition of English spelling rules. More difficult spelling features were rarely attained before simpler features were mastered. Although adults did seem to have a more highly developed level of language, understanding prefixes, suffixes and syllable junctures, in two-thirds of

the features studied, adults and children scored within 10% of one another (Viise, 1996:574-577). Research is needed to see how, within the context of adult expectations for compositional skills, more basic skills of writing can be acquired, for example, learning letters and words to the point of automaticity in order to free the mind of the writer to concentrate on the content.

A study on the impact of transcription skills on writing quality found that in students from grades one to six, a need to focus on handwriting fluency and spelling caused a variation in the quality and length of their compositions (Graham, Berninger, Abbott, Abbott & Whitaker, 1997:170, 179-180). A study on working memory and writing found that before letter formation and spelling become fairly automatic, young writers use a lot of their focus, or cognitive resources, on transcription skills to the detriment of the composition process (McCutchen, 2000:22).

A series of studies by Bourdin and Fayol (1994, 2000 & 2002) investigated differing levels of difficulty in oral and written communication. The primary objective of the study was the investigation of cognitive memory span, but the method of testing used low-level processes of written language, defined as formulation: activities included cognitively accessing words and forming phrases, graphic transcription and motor activity of writing production. Examining oral and written recall of dictated lists of words in second graders, fourth graders and in university students, the initial study found that written language recall tasks were more difficult than oral language recall tasks for second and fourth graders, but not in the adult test-population. The finding was attributed to the cognitive demands of spelling and writing skills which were not yet mastered to the point of automaticity in the study participants. The relative speed of reproduction in oral recall was discounted as a factor in the ease of memory-reproduction by including a transcriber of the students' recall, thus alleviating the demand for subjects' engagement in spelling and writing tasks. There was a linear progression in cognitive memory skills between the second and fourth grade groups, but the gap between oral response and written response remained constant. For the university students, the results were reversed, with a slight increase in recall of the list dictated in a written as opposed to an oral reproduction. The degree of automaticity of low-level writing skills is shown to have an effect on the higher-



level writing composition capacity, and this is expressed in terms of the cognitive cost of those lower-level skills (Bourdin & Fayol, 1994).

The second study (idem, 2000) investigated the importance of the orthographic factor of the cognitive cost of writing by eliminating the spelling element and requesting simple drawing reproductions in the recall tasks. The cognitive load decreased significantly between the group of second graders and the group of fourth graders, but the grapho-motoric skills continued to be a factor.

In their 2002 study, Bourdin and Fayol explored the cognitive costs of oral and written communication in adults, but in more complex text tasks. While the research continued to demonstrate the interference of lower-level writing process skills, and this time in adults instead of children, the level of literacy composition tasks investigated makes this research less directly relevant to the current study.

A further pertinent aspect to this research was that it was carried out in French, the official language of the context of the current study. One of the tenets of Bourdin and Fayol was that the findings should be applicable in other languages, as they related to cognitive processes, not to linguistic form (Grabowski, 2005:3). This tenet was tested by Grabowski (2005), who replicated the study in a German setting. The relative transparency of a German orthography as compared to a French orthography added another layer of verification that the aspect being tested was cognitive processing and not the language itself as medium of instruction.

The Grabowski research reinforced Bourdin and Fayol's findings, with the similar results for children but not adult university students, who showed poorer memory span in written as opposed to oral responses. There continued to be a linear progression in cognitive memory skills between the second and fourth grade groups with the gap between oral response and written response remaining constant.

The studies of Grabowski and Bourdin and Fayol are of particular interest to the present study because the nature of their investigations involved the development of cognitive principles which should apply cross-linguistically. In addition, the finding of the importance of automaticity of lower-level writing processes highlights the need for a study on the process of acquiring writing skills in previously illiterate adults. Grabowski specified that "children, but not (literate)

adults, lack to some degree automation of low-level processes in writing (particularly spelling and the motor activity of handwriting) which should impair the performance of higher-level activities” (Grabowski, 2005:1). This statement begs the question, “What about illiterate (or newly literate) adults?”

The literature on writing as a developmental process, on the significance of a literate or non-literate context of the learner and on studies on the development of handwriting in adults has been presented, but we have yet to look into the ways in which the development of writing is assessed. The next section will review the methods and motivations for the assessment of writing from the early 1900’s to the present.

## ***2.4 Writing assessment***

Handwriting assessment tools can be generally categorized into two basic methodologies: global assessment of legibility or analytic assessment based on predetermined criteria. Global assessments are based on an overall judgment of a writing sample in comparison to standard writing samples of various predetermined levels of quality, as defined by legibility. Analytic assessments are based on the premise that general readability of a writing sample can be determined by certain specific criteria that relate to writing appearance, such as the formation of letters and spacing between letters and words (Rosenblum *et al.*, 2003:47-49).

Thorndike (1910) was the first to propose a way of measuring the quality of handwriting. He posited three approaches to such a study: through the “physiology and psychology of movement,” the role handwriting might play in student achievement, and the quality and speed of handwriting (Thorndike, 1910:83). He proposed a scale for merit of the handwriting of children in grades 5 to 8 whereby handwriting samples were rated for quality by a panel of judges on a scale from 4 to 18, 4 being an artificially produced poor writing sample and 18 being a copy book model of writing. Handwriting samples to be evaluated were placed alongside the samples in the scale to find the closest match in quality. He also presented a scale for adult women’s handwriting, consisting of 6 points, developed in much the same manner.

Two years later, Ayres proposed a 16-point scale based on legibility of writing samples as measured by timed readings. Again, the scale consisted of ranked writing samples to which the evaluator matched subjects' writing as closely as possible. The measure of legibility emphasized the function of writing to be read by another person over the evaluation of appearance, and the measurability of timed readings of the writing samples gave a more objective method of evaluation (Ayres, 1912:5). Legibility was then analyzed into component parts of slant (vertical, measured as 90°-80° being the most legible, then medium, measured as 79°-55°), crowding of words on a line and crowding between lines, word breaks occurring over lines, and incomplete letter formation (e.g., i's not dotted and t's not crossed) (ibid.: 14-15).

Since these beginnings, myriad scales and assessments of handwriting have been developed in attempts to measure handwriting quality more accurately, but many of the criteria remain fundamentally unchanged. The Freeman Handwriting Measuring Scale, published in 1959, employed the factors of slant, letter alignment, letter form, spacing and quality of line (Freeman, 1959:219). In the 1970's, a variety of scales focused on correct and incorrect letter formation using omission, substitution, letter reversal, slant, size and relative spacing of letters (Hofmeister, 1992:8). All of these tools sought to measure quality, not to describe the development of mastery of skills.

Of particular interest to this study was a tool developed by the Basic Skills Agency for assessing adult literacy and listening, speaking, reading and writing skills in adult ESOL (English Speakers of Other Languages). It had been developed for "a range of adults, including total beginners in terms of literacy" with specific application to evaluation of free writing assignments (Sewell, 2004:3). The adult literacy core curriculum developed for the UK, on which the ESOL curriculum draws, has 5 levels, corresponding to the national educational curriculum and to the UK national qualifications framework. It is designed with attainment targets identifying particular grammatical or linguistic features of each level.

The instrument provides a structure for recording writing skills at word, sentence and text level. The word level addresses the handwriting, structure and spelling of individual words; the sentence level addresses grammar, structure and

punctuation, and text level addresses the overall meaning. Skills at each of these levels are assessed as Emerging (eM) where there is little or no evidence of the skill, Consolidating (C) where some aspect of the skill is seen, whether partial or inconsistently applied, and Established (E) where both consistent and secure understanding is shown (ibid.:10).

Unfortunately, the level assumed of the learner in the literacy curriculum in the UK is already too ambitious at the entry 1 level, expecting at this first level that learners will know the whole alphabet and be able to write a simple sentence (Basic Skills Agency, 2001:online). This level of basic mastery of the alphabet and the emerging capacity to produce words and sentences in written form are in focus in the current study. It cannot be taken for granted, in the context of this study, that adult learners will have even the most basic of skills or print awareness. The disparity of the situation of illiterate adults in emerging language development contexts requires a more basic starting point.

There is some disagreement in the literature regarding the relative importance of global legibility and that of individual letter formation. In a study of proficient and dysgraphic writers, Rosenblum *et al.* (2004) found that global legibility, as measured by erased or over-written letters, unrecognizable letters and spatial arrangement of words, was effective in discriminating between writing samples of previously determined dysgraphic and proficient writers. She further found that letter legibility, as indicated by the size, direction, spacing and alignment of letters and the irregularity or absence of joins, could significantly inform the determination of text legibility (Rosenblum *et al.*, 2004:18-20). In their *Handwriting Assessment Protocol*, Pollock *et al.* (2009) state that global legibility is a valid assessment parameter, while retaining the functional handwriting components of slant, letter formation, spacing, alignment and size. They further note the need to consider the distinction between handwriting in copied text and handwriting in a creative writing sample, with copied texts consistently being of a higher quality of legibility (Pollock *et al.*, 2009:14-15).

While there is general agreement among different analytical assessment tools on the basic elements to be assessed (letter formation, size, slant, spacing and alignment), the methods and criteria by which they are evaluated have varied (Rosenblum *et al.*, 2003:9-20). In addition, the motivations for assessment have

swung from predicting academic achievement (Thorndike, 1910), to legibility based on the reader's perception (Ayers, 1912), through a variety of measures of quality or correctness of form (Freeman, 1959; Hofmeister, 1992), to a diagnostic tool to identify dysgraphia or other developmental needs (Rosenblum *et al.*, 2004; Pollock *et al.*, 2009). There is a distinct gap in the literature on studies describing the process of the *development* of writing skills, which could contribute to the definition and practice of all other writing-related studies.

Much more could be said on the parameters of evaluation of existing handwriting assessment tools, but it is beyond the scope of this study to assess those tools themselves. This study, set within an emerging literate context in which the use of literacy skills are not the norm, focuses on describing the interplay of the acquisition of the various skills which lead to handwriting development in previously illiterate adults. It is nonetheless informed by the literature in the choice of letter formation, size, spacing and alignment as parameters.

The following chapter addresses the specific geopolitical, social and linguistic contexts of this study and describes briefly the orthography and grammatical structure of the language used in the study.

## **Chapter 3.**

### **Context of the study**

#### ***3.1 Geopolitical***

The geopolitical context of the research, while not unique in Africa, is distinct from studies carried out in Northern-context countries. Political instability affected the duration of the program from which data was gathered. Funding is often not available for non-formal adult education. Key factors of access to education, language of communication, and level of language development influence adult literacy rates. The women of the study are to be commended for their determination to learn to read and write in Bambara and are sincerely thanked for their participation in the study.

Mali is a landlocked country in the interior of western Africa, surrounded clockwise by Algeria, Niger, Burkina Faso, Côte d'Ivoire, Guinea, Senegal and Mauritania. Almost 10% of its 14,533,511 inhabitants live in the capital city of Bamako. Consistently ranked among the 25 poorest nations in the world, Mali is dependent on foreign aid, with about 80% of its workforce engaged in farming or fishing. Roughly 65% of the 1,240,192 square kilometer land-mass is desert or semi-desert, thus economic activity centers largely around the area irrigated by the Niger River (U. S. Government, 2012:online).

The United Nations Development Program (UNDP) produces an annual report on the development progress of countries around the world. The report includes a Human Development Index (HDI) which ranks countries according to three basic dimensions of health, education and income. The 2011 UNDP Human Development Report ranked Mali as 175<sup>th</sup> out of 187 countries with comparable data available (UNDP, 2011:online).

On 22 March 2012, there was a *coup d'état* in Mali, one lesser result of which was the closing of all government-sponsored programs, including the women's literacy program used for this study.

### **3.1.1 Literacy rates**

Mali defines as literate “any person aged 15 or above who can read and write in any language.” Data on literacy rates is gathered by labor force survey and measured by household declaration (UNESCO, 2009a:online). From this basis, the adult literacy rate in Mali was estimated in 2009 to be 26% overall, with 35% of adult males being literate in some language, and 18% of adult females being able to read and write in some language (UNESCO, 2009b:online). With 52.7% of the population of Mali aged 15 years or older (U. S. Government, 2012:online), this indicates that almost 5 million adults are illiterate in Mali, or 57% of the population. This figure is expected to grow with increasing adult population figures (UNESCO, 2009b:online).

### **3.1.2 Literacy centers**

*La Coordination des Associations et ONG Féminines du Mali (CAFO)*, created in 1991, has around 2,385 associations and non-governmental organization (NGO) members, of which 604 are in the capital city of Bamako. The goal of this organization is to contribute to the valorization of the status of women by uniting organizations and coordinating activities and through political action. Through CAFO’s agency for education, CEDUPAC (*Coalition, Education, Paix et Culture: the Coalition for Education, Peace and Culture*), women’s basic literacy and numeracy classes in Bambara are offered from September through February (Touré, 2012, personal communication). It is from two such classes that data on the writing development at one-month intervals from 20 emerging-literate women has been gathered.

## **3.2 Language**

### **3.2.1 The linguistic context**

The official language of Mali is French, but there are 66 individual languages identified as used in Mali; of these, 13 are recognized as official languages, formally accepted by the government for use in institutions outside of the local home and community (Lewis, 2009:online). Bambara is recognized as an official national language, with an estimated 80% of the population speaking it to varying degrees of fluency as a language of wider communication (U. S. Government,

2012:online). In the Bambara language, speakers refer to themselves ethnically as “bamanan” and to their language as “bamanankan,” but “Bambara” remains the term of wider use and will be used throughout this study.

There are over 2,700,000 mother-tongue speakers of Bambara in Mali, with cross-border dialect variations also spoken in Burkina Faso, Côte d’Ivoire, Gambia, Guinea, Mauritania and Senegal (Lewis, 2009:online).

### **3.2.2 Writing in the Bambara language**

Before beginning to look at the data gathered for this study, it will be useful to discuss briefly the conventions for writing Bambara and the basic phrase structure used in the language. The symbols used in the alphabet will have a direct impact on the letter formation skills acquired by new literates. These are the tools, i.e., the letters and combinations of letters, which the women in the study are trying to learn. A summary description of the written form of the language will serve to give yet another context – that of the world of reading and writing into which these women seek entry.

The Bambara orthography is relatively transparent, with a basic one-to-one correspondence between sounds and letters, as is shown in the orthography summary description in this section. This is a boon to writers of the language, but since this study is exclusively concerned with one language, not yet with comparing development among different languages or writing systems, it is mentioned here as an indication of the relatively short time period required to master the basic alphabet.

Though this study does not extend to the development of composition and free writing in Bambara by the new literates, the recursive nature of the developmental process of writing may be influenced by the grammatical level of the content being employed. As this study will include the letter formation, alignment, size and spacing skills as shown in simple sentences, at least a cursory understanding of what constitutes a phrase in Bambara is necessary to the analysis. For example, counting the number of appropriately placed word breaks in a phrase is not possible without first comprehending the basic phrase itself. In exploring the progression from single letter formation to writing of dictated phrases, and in one



case, of a free-writing exercise, a basic comprehension of grammatical elements does come into play, and thus is outlined here to inform the analysis.

While researchers do not agree on every aspect of linguistic analysis of Bambara, it is possible to outline broadly the basic phrase structures of the language in order to investigate the grammatical structures used by beginning writers. The following descriptions and examples are synthesized from Calvet (1971), Dumestre (1994) and Bailleul (2000, 2007). Glosses and terminology in English are provided by this author.

### 3.2.3 The Bambara orthography

The Bambara alphabet is made up of 20 consonants and 7 vowels. They are represented below in upper and lower cases:

**A a, B b, C c, D d, E e, Ɛ ɛ, F f, G g, H h, I i, J j, K k, L l, M m, N n, Ŋ ŋ, Ɗ ɗ, O o, Ɔ ɔ, P p, R r, S s, T t, U u, W w, Y y, Z z.**

#### *Consonants*

The consonant phonemes, their allophones and graphemes are presented in the table below with their use in various positions in the word. The syllable structure is open, allowing for CV, V, N. The only consonant symbols appearing in syllable-final position are ‘-n’ to mark nasalized vowels and ‘-w’, as the plural suffix marker.

**Table 2. Bambara consonants**

Grapheme	Phoneme	Allophone	Example
<b>P p</b>	/p/	[p]	<b>pan</b> <i>to jump</i>

Grapheme	Phoneme	Allophone	Example
<b>T t</b>	/t/	[t]	<b>tiga</b> <i>peanut</i>
<b>K k</b>	/k/	[k]	<b>kaba</b> <i>corn/maize</i>
<b>B b</b>	/b/	[b]	<b>bama</b> <i>crocodile</i>
<b>D d</b>	/d/	[d]	<b>da</b> <i>mouth</i>
<b>G g</b>	/g/	[g]	<b>gaŋ</b> <i>book</i>
		[ɣ] <sup>2</sup>	<b>məŋ</b> <i>person</i>
<b>C c</b>	/tʃ/	[tʃ]	<b>cɛ</b> <i>man</i>
<b>F f</b>	/f/	[f]	<b>fura</b> <i>leaf</i>
<b>S s</b>	/s/	[s]	<b>soso</b> <i>mosquito</i>
		[z] <sup>3</sup>	<b>sonsən</b> <i>hare</i>
<b>Z z</b> <sup>4</sup>	/z/	[z]	<b>zanwuyɛ</b> <i>January</i>
<b>J j</b>	/dʒ/	[dʒ]	<b>jara</b> <i>lion</i>
<b>H h</b>	/h/	[h]	<b>haŋ</b> <i>fault</i>
<b>M m</b>	/m/	[m]	<b>mali</b> <i>hippopotamus</i>
<b>N n</b>	/n/	[n]	<b>naŋ</b> <i>garden</i>
<b>ŋ ɲ</b>	/ɲ/	[ɲ]	<b>ɲunu</b> <i>beehive</i>
<b>L l</b>	/l/	[l]	<b>laada</b> <i>custom</i>
<b>R r</b>	/r/	[r]	<b>rɔŋ</b> <i>to gather</i>

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<sup>2</sup> g is realized as [ɣ] intervocalically between low vowels

<sup>3</sup> s is realized as [z] after a nasal consonant

<sup>4</sup> z is only used in loan words

Grapheme	Phoneme	Allophone	Example
<b>W w</b>	/w/	[w]	<b>wari</b> <i>money</i>
		[u] <sup>5</sup>	<b>daw</b> <i>mouths (pl)</i>
<b>Y y</b>	/j/	[j]	<b>yeelen</b> <i>light</i>

### *Prenasalized Consonants*

Certain consonants in Bambara may be prenasalized in word-initial position. These are written with an ‘n’ before the consonant. This only symbolizes prenasalization, not a syllabic nasal. There is some tendency for using the voiceless consonants: nk, np, nt, ns, nc, in preference to the voiced consonants: ng, nb, nd, nz, nj, but that usage is not completely standardized, as can be seen in these examples:

**nkuna**, *Sclerocarya birrea* (marula tree)

**ngaba**, *Ficus platyphylla* (broad-leaf fig)

### *Labialized Consonants*

The ‘g’ is often pronounced as a labialized ‘gw’ in traditionally Bambara-speaking regions of Mali, but it is written as ‘g’. A common example is the phrase, [a ka g<sup>w</sup>ã], it is hot, which is transcribed: **A ka gan**.

### *Palatalization*

The long vowels ‘ee’ and ‘εε’ sometimes produce a palatalized pronunciation in the preceding consonant: **feere**, *to sell*, [f<sup>ɛ</sup>ε:re]. This palatalization is not reflected in the official orthography (Bailleul, 2000:37).

The palatalized ‘s’ [ʃ] is represented in the writing system as a combination of ‘s’ and ‘y’, as found in **syɔ**, *beans* [ʃɔ], and **syε**, *chicken* [ʃε] (Bailleul, 2007:400-401).

### *Vowels*

The Bambara language has 7 vowel phonemes, presented with their allophones and proposed graphemes in the table below.

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<sup>5</sup> When w is used at the end of words as a plural marker, it is realized as [u].

**Table 3. Bambara vowels**

Grapheme	Phoneme	Allophone	Example
<b>I i</b>	/i/	[i]	<b>misɪ</b> <i>cow</i>
<b>E e</b>	/e/	[e]	<b>bere</b> <i>stick</i>
<b>Ɛ ɛ</b>	/ɛ/	[ɛ]	<b>jɛɛ</b> <i>fish</i>
<b>A a</b>	/a/	[a]	<b>saga</b> <i>sheep</i>
<b>U u</b>	/u/	[u]	<b>kulu</b> <i>hill</i>
<b>O o</b>	/o/	[o]	<b>bolo</b> <i>hand</i>
<b>Ɔ ɔ</b>	/ɔ/	[ɔ]	<b>kɔɔ</b> <i>bird</i>

***Vowel length***

Bambara has both short and long vowels, written as a sequence of two vowels.

Examples of these vowels and the contrasting short vowels are given below:

<b>miiri</b>	<i>to think</i>	<b>miri</b>	<i>sprat (kind of fish)</i>
<b>feere</b>	<i>to sell</i>	<b>fereke</b>	<i>to tangle</i>
<b>fɛɛɛ</b>	<i>trick, ruse</i>	<b>fɛɛ</b>	<i>to be at ease</i>
<b>baara</b>	<i>work</i>	<b>bara</b>	<i>favorite, preferred</i>
<b>duuru</b>	<i>five</i>	<b>durusi</b>	<i>to memorize</i>
<b>foolo</b>	<i>goiter</i>	<b>foro</b>	<i>field</i>
<b>fɔɔɔ</b>	<i>to inflate</i>	<b>fɔɔ</b>	<i>to begin</i>

***Nasalized Vowels***

All long and short vowels in Bambara may be nasalised, and this is written by adding an ‘n’ after the vowel, as in the following examples:

<b>npereketeniin</b>	<i>miniscule</i>	<b>min</b>	<i>which</i>
<b>koteenten na</b>	<i>maybe</i>	<b>ten</b>	<i>forehead</i>
<b>bɛɛnɛ</b>	<i>maternal uncle</i>	<b>bɛn</b>	<i>to meet</i>
<b>faantan</b>	<i>poor person</i>	<b>fantan</b>	<i>orphan</i>
<b>binduun</b>	<i>hairy</i>	<b>dun</b>	<i>deep</i>
<b>boonsi</b>	<i>beard</i>	<b>jonjon</b>	<i>to gambol</i>
<b>nɔɔnsi</b>	<i>chameleon</i>	<b>dɔn</b>	<i>dance</i>

### *Vowel orthography rules*

In contexts in which the initial consonant of the second syllable of a word is ‘l’, ‘n’, or ‘r’, the vowel in the first syllable may elide. The official Bambara orthography retains the open syllable (CV) structure in written form (Bailleul, 2000:51).

**fila**, *two* [fla]    **biri**, *to place face-down* [bri]    **dalan**, *bed* [dlã]    **tɛnɛ**, *tabou*  
[tnɛ]

***Tone***

Tone is contrastive but is not marked as part of the writing system.

### *Elision*

When a pronoun represented by a vowel follows another word which ends in a vowel, the ending vowel of the first word is elided in favour of the pronominal vowel. The elision is marked by an apostrophe (').

**U ye o di a ma.** [u jo da ma] **U y'o d'a ma.**

3PL PAST 3SG.DEM give 3SG POST

*They gave that to him.*

A    ma                    o                    fɔ    u                    ye.                    [a mo fu je]    A m'o f'u ye.  
3SG PAST.NEG 3SG.DEM say 3PL POST

*He didn't tell them that.*

(Bailleul, 2000:7)

### *Punctuation and capitalization*

The punctuation marks and the rules that govern the Bambara language are the same as those for French. The punctuation marks used for Bambara are therefore as follows:

1. Full stop (.)
2. Question mark (?)
3. Exclamation mark (!)
4. Comma (,)
5. Colon (:)
6. Semicolon (;)
7. Quotation marks (« ... »)
8. Parentheses (brackets)

### ***Full stop***

The full stop (.) in Bambara marks the end of a declarative sentence.

**An    bε    taa    dugu    kɔnɔ.**

1PL    PRED    go    town    POST

*We are going to town.*

### ***Question mark***

The question mark (?) marks the end of an interrogative sentence.

**I        bε        taa        min?**

2SG    PRED    go        where

*Where are you going?*

### ***Exclamation mark***

The exclamation mark is written at the end of a command, or it is placed following exclamatory words or phrases. It functions to express interjections, surprises, excitement, and forceful comments as well as simple commands, as follows.

**Na            yan!**

come.IMP    here

*Come here!*

### ***Comma***

Commas are used to separate clauses or parallel words within a clause, as below:

**Su        kora        dɔrɔn,        n        jε        tɛ            foyi        ye.**

night    fall-PST    as.soon.as    1SG    eye        NEG.PRED    nothing    see

*As soon as night falls, I can't see anything.*

### ***Quotation marks***

Quotation marks (« ... ») occur at the beginning and end of direct speech and are preceded by a colon, as below:

**A        ko:    « O            diyar'            an    ye. »**

3SG    say        3SG.DEM    be.good-PST    1PL    POST

*He said, "That pleased us."*

Note: In Bambara, as in French, other punctuation marks always precede closing quotation marks when they occur next to each other.

### ***Capitalization***

Capital letters are used at the beginning of sentences and for proper nouns.

First word in a sentence:

**A taara Gao.**

3SG go-PST Gao

*He went to Gao.*

Proper nouns:

**Musa ni Fanta sigilen bε Bamako.**

Moussa CONJ Fanta sit-PTCP PRED Bamako

*Moussa and Fanta live in Bamako.*

Note: In Bambara, as in French, the names of people groups are capitalized, but the names of languages are not.

**Bamananw bε bamanankan fɔ.**

Bambara-PL PRED Bambara-language speak

*The Bambara people speak the Bambara language.*

### **3.2.4 A simplified description of Bambara phrase-level grammar**

A simple phrase structure in Bambara consists of a noun plus predicate, which in itself may be comprised of simply

1. a predicator.<sup>6</sup>

**Donso don.**

/hunter PRED/

*He is a hunter.*

**Donso tε.**

/hunter NEG.PRED/<sup>7</sup>

*He is not a hunter.*

**Ji bε.**

/water PRED/

*There is water.*

These predicators may be completed by

<sup>6</sup> Bailleul (2000:59) analyses this same construction as a subject + predicate, without a predicator, translating ‘bε’ as a verb meaning ‘to exist’ and ‘don’ as the verb ‘to be’: Here bε. peace + exists = *There is peace*. Kɔnɔ don. bird + to be = *it is a bird*.

<sup>7</sup> Dumestre (1994:109) analyzed ‘tε’ as ‘mode’, while Calvet refers to ‘tε’ as a ‘prédicatif à la forme négative’, or a ‘negative predicator’ (Calvet, 1971:22).

2. a verb:  
**Donso bε taga.** *The hunter is going.*
3. an adjectival verb:  
**Donso ka farin.** *The hunter is fierce.*
4. a noun or a noun plus a postposition:
  - a. **Donso ye ne ye.** *I am a hunter.*
  - b. **Donso bε dugu kɔnɔ.**  
 /hunter PRED town POST.LOC/ *The hunter is in town.*
5. a noun between the predicator and the verb:  
**Donso ye wara faga.**  
 /hunter PRED wild.animal kill/  
*The hunter killed the wild animal.*
6. a combination of a noun between the predicative and the verb and a noun plus a postposition following the verb:  
**Donso ye wara faga kungo kɔnɔ.**  
 /hunter PRED wild.animal kill bush.country POST.LOC/  
*The hunter killed the wild animal in the bush.*

Dumestre (1994) proposed analyzing these as the six basic types of simple sentences in Bambara: 1. presentative phrase, 2. processive phrase of two terms, 3. descriptive phrase, 4a. equative phrase, 4b. situative phrase, 5. processive phrase of 3 terms and 6. processive phrase followed by a noun and postposition. His study highlights the fixed word order demonstrated by the phrases and the ability to substitute the mode markers, which could never occur phrase-initially (Dumestre, 1994:131). He did not give an example of a situative –processive phrase of three terms, such as Calvet posited for phrase 6 above, but the two agree that all of these cases exemplify simple phrase structure with only one predicator (Calvet, 1971:2-11; Dumestre, 1994:107-131).

Interrogative phrases are formed by adding ‘**wa**’ to the end of the phrase:

7. **Donso don wa?**  
 /hunter PRED Q/  
*Is he a hunter?*



Negative phrases are formed by replacing the predicator ‘**bɛ**’ with ‘**tɛ**’ as seen in example 1 above, or by replacing the predicator ‘**ka**’ with ‘**man**’ to indicate a negative attributive or adjectival phrase.

8.        **Donso ka jugu.**                      **Donso man jugu.**  
               *The hunter is mean.*                      *The hunter is not mean.*

(Dumestre, 1994:109 & 114; Calvet, 1971:21-30)

Complex phrases in Bambara are composed of more than one predicator.

Dumestre (1994:330) presents a typology of 6 complex phrase-types based on the relationship between or among the propositions and the presence or absence of a relator element, as shown in the following table:

**Table 4. Typology of Bambara phrases**

relation \ relator element	-	+
independence	succession	coordination
interdependence	juxtaposition	junction
dependence	implication	rection

Calvet (1971:31-42) posits four propositional relationships: juxtaposition, coordination, using the element ‘**ka**’, using the element ‘**min**’. For the purposes of this study, the two analyses will be accepted as non-contradictory, with Dumestre’s typology defining more precisely the juxtaposition category proposed by Calvet according to the independence, interdependence or dependence of the component propositions and with Calvet’s examples of the elements ‘**ka**’ and ‘**min**’ serving as examples of Dumestre’s categories of junction and rection respectively.

The difference between a juxtaposed complex phrase and two simple phrases lies in the possibility of replacing a second reference to a noun in the second proposition by a pronoun, as in the example:

9.        a. **Mame tɛ                      so                      kɔnɔ.**  
               /Mame NEG.PRED house POST.LOC/  
               *Mame is not in the house.*

b. **Mame bε bulukuli la.**

/Mame PRED cook-place POST.LOC/

*Mame is in the cooking-place.*

c. **Mame tε so kənɔ, a bε bulukuli la.**

*Mame is not in the house, she is in the cooking-place.*

(Calvet, 1971:32)

Coordinated propositions in a complex phrase are marked by the addition of elements of coordination (EC), which may precede the phrase, as in such cases as ‘**ni**’, or may follow the proposition, as with ‘**wo**’ (Calvet, 1971:33):

1. **Ni dugutigi bε kuma, mɔgɔw bεε bε mɛn.**

/EC village-chief PRED speak people-PL all PRED listen/

*When the village chief speaks, everyone listens.*

2. **A bε na wo, a tε na wo, o bεεka kan.**

/3SG PRED come EC 3SG NEG.PRED come EC PN all PRED equal/

*If he comes or if he doesn’t come, it is all the same.*

(Bailleul, 2007:432)

Bailleul (2000:196-197) refers to this construction as a relative proposition, while Dumestre (1994:330) refers to it as rection within a proposed system of typology based on the relationships of the propositions and the presence or absence of a functional marker or ‘relator’.

The third type of complex phrase in Bambara is formed by replacing the predicator ‘**bε**’ or ‘**ye**’ in one of the propositions with ‘**ka**’ (Calvet, 1971:36).

Bailleul refers to this as a predicator indicating a positive infinitive form or to indicate a coordination of successive actions:

1. **An tɛna se ka na sini.**

/1PL NEG.PRED.FUT be.able.to PRED come tomorrow/

*We will not be able to come tomorrow.*

2. **Muso soli ka ji goniya ka taa a sigi**

/woman rise.early PRED water heat PRED go 3SG set

*The woman rises early to heat the water [and] place it in the*

**pɛgɛn na ka dunan wele ko : ji sigilen.**

shower POST.LOC PRED foreigner call say water sit-PTCP/

*shower [then] calls the foreigner/visitor to say the water is ready.*

(Bailleul, 2007:181)

The fourth type of complex phrase is formed by adding the element ‘**min**’ as a relator element (RE) after one of the nouns in the proposition:

3. **Donso ye jara min faga, a tun ka bon.**

/hunter PRED lion RE kill 3SG IMP PRED big/

*The lion which the hunter killed was big.*

4. **Donso min ye jara faga, a tun ka bon.**

/hunter RE PRED lion kill 3SG IMP PRED big/

*The hunter who killed the lion was big.* (Calvet, 1971:37)

### 3.2.5 Orthography and learning to write

Both the orthography and the grammar of the Bambara language are analyzed and documented well enough to allow for clarity and consistency in teaching presentation and in writing practice. While the body of material printed in the language is certainly not as extensive as would be found in French or English, there are newspapers published in the language and several dictionaries: monolingual in Bambara (Kone, 1994) and others in French and Bambara (*Direction nationale de l'alphabétisation fonctionnelle et de la linguistique appliquée*, 1980; Bailleul, 2007), English and Bambara (Bird & Kanté, 1977), and tri-lingual Bambara-French-English (Margetts, 2010). The existence of these resources, as well as school materials in the language, bodes well for the future readers and writers of Bambara, but the present situation remains a challenge, with the literacy rate, as mentioned earlier, at an estimated 18% of adult females in Mali for any language (UNESCO, 2009b:online). A study of the development of writing in an adult population with such low levels of reading and writing competence could give insights into the needs of these new literacy learners.

The following chapter will outline the methodology used to analyze the development of writing skills in 20 Bambara women through the duration of a basic literacy class. It will introduce Dynamic Systems Theory (DST) and explain the data collection and coding methods used before returning to a more specific discussion of the use of DST as it relates to the development of writing skills.

## Chapter 4.

### Methodology

[I]t is not easy or unproblematic for an applied linguist to make an informed choice of a theoretical starting point (Weideman, 2009b:229).

A review of the literature has shown the nature of writing development to be emergent, recursive and drawing from a variety of skills in a synergistic nature. These properties have been shown in studies with children from a variety of languages and cultures. The literature further highlighted the significance of the initial context, whether highly literate or minimally literate, of the learner in the development of writing skills. Finally, the review revealed a lack of data available on the very fundamental levels of handwriting skills development in adults. Into this setting, the Bambara language is introduced, with a relatively transparent, easy to learn writing system of one symbol to one sound and a straightforward grammar, both well-defined in a consistent manner. Given this baseline context, what can be learned from early writing samples from previously illiterate women about the development of handwriting skills? Analysis of the data to be attempted here must find a form that can describe a process of development in skills at several different levels concurrently without standardized norms, neither for adults nor for writers of this language, to which to compare it.

#### *4.1 The rationale for the analysis of data*

The data taken from a fundamental level of writing development in 20 Bambara women must be considered as a growth process, changing over time. A theory for examining the data needs to be able to consider an individual's learning over the course of the instruction as well as being able to relate patterns that emerge at this foundational level to higher levels of writing development (Larsen-Freeman & Cameron, 2008:245). In addition, the analysis must be able to respond to seeming regressions or nonlinear development in the data, those examples which seem to reflect that the learner is failing to learn, or even unlearning, the task at hand

(Weideman, 2009a:232). This study seeks to respond to the questions of patterns of writing development in adult Bambara speakers, their relation, if any, to patterns in children's writing development, and the significance of seeming regressions in the learning process. Dynamic Systems Theory provides a design that is sensitive to each of these analytical demands.

#### ***4.1.1 Dynamic Systems and Complex Systems***

Before looking at the data and the application of the theory, it is necessary to discuss some differences in the use of terminology. The literature provides examples of complex systems which are dynamic (Larsen-Freeman, 1997; Larsen-Freeman & Cameron, 2008) and dynamic systems which are complex (Thelen, 2005; Thelen & Smith, 2006). In addition, one finds diversity in the use of dynamic systems and dynamical systems, complexity theory and connectionism, even extending to "complex dynamical systems theory" (Juarrero, 2010) and references to "the complexity/dynamic approach" (De Bot, Lowie & Verspoor, 2011:1). So, to talk about Dynamic Systems Theory, it is necessary to address various influences and developmental backgrounds and the ways in which they influence terminology.

Chaos Theory came to prominence in the 1980's to investigate physical systems that follow natural laws in unexpected ways, for example, a dripping water tap or a weather pattern. According to the theory, the phenomenon is unexpected due to the lack of attention paid to the influencing factors present at its initial state.

Complexity theory developed from the basis of Chaos Theory, to address systems with a variety of components whose interactions, based on relatively simple rules, produce a larger effect than may be expected from the simple sum of each of the elements (Tesson, 2006:47-48).

Connectionism, an approach to cognitive modeling, also investigates the interactions of simple units that produce complex behavior, but from the discipline of cognitive development (Eliasmith, 2013a:online). Connectionism is linked with Dynamical Systems Theory (DST), which grew out of the fields of computational mathematics, to apply the use of mathematical equations and General Systems Theory to describe complex systems. In recent years, DST has been proposed as a way to describe human cognition and development (idem,

2013b:online; Richardson, 2004a:75). The use of the term “dynamical” refers to the study of dynamics, but in later literature, as the theory has been applied to cognitive and developmental sciences, usage is shifting to “dynamic,” as referring to the dynamic system of complexity and change over time. This term is found most notably in Larsen-Freeman (1997), who specified the use of “dynamic” as referring to the capacity for change in a dynamic system, while recognizing the origin of the term “dynamical” in the computational sense (Larsen-Freeman, 1997:147-148).

This shift in terminology can also signal a shift in focus of the theory as it continues to develop and be applied to different fields of study. For this reason, clarity in the use of terminology and an awareness of the roots from which the theory springs are important in the sharing of research, particularly across different academic disciplines, to avoid tension and misperception of shared research findings. Richardson responded to the purported tension in the development of complexity and dynamic systems away from their computational roots in a series of articles (2004a, 2004b, 2005; Richardson & Midgley, 2007) discussing the similarities in the underlying principles of complexity theory and systems theory. While acknowledging the philosophical and methodological differences at the roots of these theories, theorists and practitioners are increasingly looking more to the common ground among them, with some observing that connectionism and dynamic systems are “the same theory, approached with somewhat different methodologies and goals” (Thelen & Bates, 2003:379), and Spencer and Schöner positing that the distinctions among them would “largely disappear in the next 20 years” (Spencer & Schöner, 2003:392).

By whatever name and springing from whatever academic discipline, all of the theories attempt to represent systems with multiple interacting variables which are sensitive to the initial context and exhibit change over time. Each of them seeks to define a model of the interactions that reflects a synergistic effect. Given this background and with the assumption that a variety of terms referring to similar phenomena will continue to be found in the literature, this study will employ the term Dynamic Systems Theory (DST) to refer to “a flexible framework for analyzing how many factors act together” (Rose & Fischer, 2009:1).

#### ***4.1.2 Some drawbacks to the theory***

One potential drawback to the use of DST is found at the very heart of dynamic systems themselves: their open, interactive nature. The act of selecting and plotting interactions among a set of variables creates, from the dynamic system that is the subject of the study, a sub-system that is closed in nature. If all dynamic systems are open and sensitive to initial context, the sub-system, and any ensuing model based on the sub-system under study, will never reflect all the potential reactions of the system as a whole. “[W]e simply cannot model the world, the Universe and everything.” (Richardson, 2004a:77).

Within this constraint, DST will still afford the possibility to study different stable phases of development and the interaction of variables that lead up to a change in state. It is this ability to address both stability and change that recommends the theory to this area of study (Rose & Fischer, 2009:5). DST is still relatively new to the field of applied linguistics and will not address issues in the same manner as other more traditional approaches. Drawing from previous research to inform current research in a new theory is fraught with potential misunderstanding and misapplication. But while a DST view may not directly inform, for example, how to teach a second language, it can attempt to give a new perspective on how to look at language itself (Weideman, 2009a:61,70).

Before delving further into DST and how it relates to language as a complex system and writing as a sub-system of language, the collection and coding of data to be used in a dynamic analysis will be considered to see more clearly the nature of the information to which the analysis is applied. Subsequent to this discussion of the way that data were collected and coded, to a more detailed articulation of DST and how it was selected as appropriate to the data is presented.

#### ***4.2 Data collection***

DST opts for longitudinal studies of real-life messy facts (Verheyden, 2010:116).

Writing samples were collected from women’s basic literacy classes held in Diallobougou and at the Netaa Centre, both located in Bamako, Mali, under the auspices of CAFO (the national Centre for Women’s Associations and NGOs in Mali). The women ranged between 16 to 59 years of age, and all spoke Bambara

fluently. All began the course self-reportedly unable to read or write in any language. Samples were taken at one-month intervals from their notebooks with their permission. Owing to the voluntary and social nature of the adult literacy classes, samples were recorded from all notebooks with a camera, quickly, before the beginning of class, and the notebooks returned to the learners. If at least three months of writing samples from the same individual could not be gathered, those data were omitted from the study. Of the 24 learners in the Diallobougou class, 14 were included in the study. Of the 15 learners in the Netaa Centre class, six were included in the study. A total of 103 separate writing samples were collected from these 20 learners, or an average of 5.15 samples per learner. Actual writing sample numbers ranged from three months' representative samples from ten women, four months' writing samples from five women, five months' writing samples from four women, to six months' representative samples from one woman. Some additional writing samples were gathered from those learners who were able to write connected text by the end of the course.

### ***4.3 Data coding***

Each writing sample was analyzed according to the collective variable of interest as identified in the literature on writing development and assessment: letter formation, letter size conformity, letter and word spacing, and alignment. A number of other factors, although considered in other research into handwriting assessment in other contexts, were omitted from consideration as part of the collective variable of interest.

#### ***4.3.1 Variables omitted from the study***

- Slant and joining between letters: The women in this study were learning manuscript form, not cursive, so slant and joining between letters was omitted from the factors to be considered in assessing and describing the writing samples.
- Speed: rate of production is a common factor in many handwriting assessment tasks. Speed of writing may have an effect on a student's ability to perform in an established time frame such as academic testing, and so is important when assessing a student for potential educational



remediation, but a description of the developmental progression of writing skills in an individual is not dependent upon the rate of production. In addition, speed is likely to be influenced by the orthography of the language. Given that there are no standards for developmental levels of letters per minute for this language, rate of production was not considered in this study.

- Pencil-grip: Development of fine motor skills can be a factor in both children's and adults' writing in the context of an emerging-literate society. Fine motor skills may not have developed to the point of pencil-manipulation in adults who have never held a pencil, but all of the women in this study, as complete illiterates at the beginning of this literacy training, would have similar experience or lack thereof, resulting in a homogeneous corpus for analysis. Although a hierarchical ranking of pencil grasp is available in the literature (Schneck & Henderson, 1990), normal handwriting may be learned with a variety of grasps (Schneck, 1991), and so writing grasp was not included as a measure in this study.

Visual evaluation of the writing sample, with a percentage within the individual sample of acceptable production, was calculated for each parameter. Results for all four factors were then plotted over time for each individual writing sample, and individual results compared to each other for pattern and discrepancy, with special attention being paid to regression errors and concomitance of factors. Collective results from all samples for each of the variables were then plotted to discern emergent patterns.

#### ***4.3.2 Evaluation of variables***

The handwriting samples were assessed and coded for formation, size, spacing and alignment according to the following guidelines.

1. Formation of individual letters was evaluated by completeness of the form of the letter with attention to line joining within the letter symbol, shape and conformity to model. Judgments were made as to perceptual thresholds between one letter form and another. The formation of each letter was inspected and was counted as a variation from form if:

- the letter was omitted;
- a symbol was present but unrecognizable, e.g. a “scribble”;
- the symbol could not be distinguished from among similar symbols, e.g. n/h/r or r/y/v/w;
- a different letter was used, e.g. reversal of symbols, p/b/d;
- a capital letter was used inappropriately.

Using these guidelines, a count was made of all the letters in the sample and all of the letter formation variants in the sample. The number of variants was subtracted from the total number of letters in the sample, with number symbols omitted from the count. A percentage of the correctly formed letters in the sample was then calculated and recorded for each writing sample.

2. Letter size was assessed for conformity to the space between the lines, as was emphasized in the initial literacy class instruction to the writers, and to the relative proportion in size to the other letters in the same sample. Using a standard-grid notebook paper used by all learners, the model provided in class extended from a baseline upward two spaces for “short letters”, e.g. a/s/m and three spaces for “tall letters”, e.g. f/l/k, with ‘t’ taught as being the same height as ‘l’. The model given during instruction for “hanging letters” extended below the baseline one space.

To assess each writing sample, an initial inspection of the individual sample was made to determine the acceptable letter size for that particular sample, with one, two or three spaces for “short letters” being used as a guide for the whole sample, according to which would give a better representation of a standard size for the particular sample being assessed.

Letters which were either too large, extending beyond the line spaces, or too small, not filling the spaces between the lines, were judged to be variants. The count of variations in symbol size was subtracted from the total number of symbols used in the sample, excluding numbers, and a percentage of the letters of the appropriate size was calculated and recorded for each writing sample.

3. Spacing was assessed according to the orientation of the symbols on the page with reference to spacing between letters as well as between words. For samples of individual letters, spacing was determined by the grid on the

notebook page. Learners were instructed to leave a space between letters, or when writing double letters, to leave a space between the sets of letters.

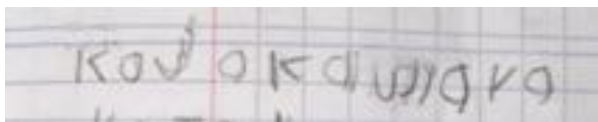
A count was made for each writing sample of the number of spaces appropriate for the sample and another count of the spaces in the actual sample, counting both added and omitted spaces as variants. The number of variations in the sample was subtracted from the number of appropriate spaces for the sample, and a percentage of correct usage of spacing was calculated and recorded for each sample. If the number of variant spaces exceeded the number of appropriate spaces, the sample was assessed as zero.

4. Alignment was evaluated according to the positioning of text on the lined pages of the exercise notebook and to being situated on the same line as other symbols in that portion of the writing sample. If the letter symbol did not touch the line, but left space between the symbol and the line on the page, it was judged to be an alignment variation. If a letter symbol that was not a “hanging letter” crossed over the baseline, it was judged to be a variation. If part of the letter was on the line and part was not, i.e., a “crooked” placement, it was judged to be a variant form of alignment. Letter height and size were not factors in the alignment assessment. The number of variants in alignment was then subtracted from the total number of letters in the writing sample, and a percentage of correct letter alignment was calculated and recorded for each writing sample.

These elements were evaluated from the earliest to the latest lessons completed by the learners in basic Bambara literacy classes at one-month intervals. When text writing was evidenced in the participants’ notebooks, additional percentage calculations were taken for these samples to be considered in the final step.

Results of these assessments were then plotted on line graphs to show the pattern of interplay of the four variables over the three-, four- and five-month learning spans, with the one six-month set of writing samples being added to the 5-month group for purposes of comparison. The separate variables of letter formation, size, spacing and alignment were then compared within themselves in each of the three time-span groupings to see if any one of the four factors behaved differently to the others.

In a final step, the five- and six-month samples were then re-evaluated, separating out the distinct writing strands of single-letter formation, copied text writing, and connected text writing. The results were then compared for output and pattern. A practical example of the application of these guidelines to a small portion taken from one of the writing samples will serve to clarify the coding procedure.



**Writing sample 1. Kaja's signature**

In the example above of a learner's name, Kaja Kamara:

*Symbols: 10*

*Formation: 5/10 variant, 50%*

The 'k's are not joined, the first 'a' is substituted as 'o', the 'm' is something between w/un/m, and the 'r' more closely resembles 'v' or backwards 'y'.

The 'j', though overwritten and out of alignment, is the proper form, as are the remaining 4 'a's. So letter formation is assessed at 50%.

*Size: 9/10 variant, 10%*

None of the letters in the sample fill the space between the baseline and the line above, the 'k's do not extend above the second line, the 'j' is not large enough to fill the space and extend below the baseline if it were in alignment, but the 'r', if it were in proper alignment, would fill the space between the lines on the page adequately. So the size is assessed at 10%.

*Spacing: 2/3 variant, 33.3%*

A total of three spaces would be appropriate for this text: one before, one between the two names, and one after. There are two spacing errors in the sample, an insertion between 'j' and 'a' and a deletion of the word break between the second 'a' and the second 'k'. Subtracting the number of errors from the number of possible correct spaces and determining the percentage, spacing is assessed at 33.3%.

*Alignment: 8/10 variant, 20%*

The first two letters connect well with the baseline, but the 'j' should extend beyond it. The following three symbols are placed crookedly, with one part of the letter resting on the line and another part either above or below the baseline, and the remaining four symbols all extend inappropriately below the baseline.

Subtracting the eight variants in alignment from the total of ten symbols, the percentage of correct alignment is 20%.

In this manner, all of the writing samples were assessed by the same individual, using the above-specified criteria.

#### ***4.4 Analysis of development***

As stated earlier, the data require a form of analysis that is responsive to the interaction of a variety of influencing factors as they progress over time. This progression may be of a recursive nature and may vary in the data sets provided by each individual in the study. An analysis that reveals non-linear pattern progressions within the individual and among the individual data sets may bring to light the combination of factors that precipitates a new stage of writing capacity (De Bot, Chan, Lowie, Plat, & Verspoor, 2012:194, 198). In the preceding discussion, the variety in the terminology currently used in the literature was addressed, as were the backgrounds of the academic fields of research from which the different terms arose, with the result that the term Dynamic Systems Theory was selected to be used consistently throughout this study. The next section will briefly introduce Dynamic Systems Theory as a form of analysis that is able to respond to the needs of the current data, extending and further specifying the application of the theory by reviewing language as an example of a dynamic system, and proposing the study of emergent handwriting as a fractal reflection of the broader field of language study.

##### ***4.4.1 Dynamic Systems Theory***

In the discussion to this point, it has been seen that “[d]ynamical systems has [sic] grown from various roots into a field of great diversity that interacts with many branches of mathematics as well as with the sciences” (Hasselblatt & Katok, 2002:1). Over the past 15 years, researchers in the fields of physics, mathematics, chemistry, biology and social and behavioral sciences have become interested in how systems with a variety of influencing elements produce patterns (Thelen & Smith, 2006:271). Dynamic Systems Theory (DST) addresses the seeming randomness arising from multiple causal or influencing factors in the system under investigation, such as weather phenomena and traffic patterns (Busemeyer, 2003:15).

Dynamic systems involve space, time and change over time. A space, or phase space, is defined by a set of elements or influencing factors which represent a possible state or structure to the system. Time may refer to a particular moment or a span, but the study of a dynamic system must include enough of a timeframe to reveal change over the span of time to allow for the development of a “notion of behavior” to be shown in the data. Change over time, or evolution, is represented by the interactions of the action of time on influencing factors in a given phase space. The theory of dynamic systems addresses the change or preservation of a given structure or set of defined elements over time. The distinguishing characteristic of DST as opposed to other analyses is the emphasis on “asymptotic behavior,” or the reaction of a variable or variables as they approach a limit (Hasselblatt & Katok, 2002:14-16).

As the name implies, dynamic systems are variable, concerned with motion and the force or energy which precipitates that motion. They are comprised of a number of factors whose influence on each other is not directly causal, or linear, in effect, but whose interactions may give rise to patterns, or “preferred states,” which are more complex than the sum of the factors may suggest. Systems characterized as dynamic are self-organizing, but may exhibit differing levels of stability to their organization. Perturbations in stability cause disruptions in the patterns of the system, causing a shift or change to what eventually becomes a more stable state. These changes do not occur in a linear progression; new patterns are sensitive to the initial or pre-existing conditions. The incremental changes resulting in a previous phase may influence the interactions of the parameters of the current phase, leading to a shift or change in the results of the interactions. This hysteresis, or influence of history on the interactions in the present phase, may result in the same interactions yielding different results (Thelen & Smith, 2006:277). Change can be sudden and catastrophic, occurring after a time of more incremental, gradual development in one or more of the influencing factors (Thelen & Bates, 2003:282-290). Dynamic Systems Theory examines these moments, or phases, which lead to a change in pattern to determine the interplay of influences, referred to as attractors and repellers, which affect pattern stability and instability (Larsen-Freeman & Cameron, 2008:16; Thelen & Smith, 2006:272-274).

As noted above, chaos, as a term used in DST, refers to systems that initially seem random but which, when plotted over time, exhibit structure and pattern. The emergence of, or “settling into,” a pattern or a preferred set of patterns enables the systemic behavior to be described by a smaller number of influencing factors. These are referred to as order parameters or collective variables. At some points, the system of variables may react in a linear, progressive manner. Points of nonlinearity in DST signal a threshold of change, small shifts in parameters that result in larger phase shifts, yielding instability. This instability of the phase indicates a new development in the system’s pattern (Thelen & Smith, 2006:272-275).

Another critical characteristic of dynamic systems is their reiterative nature. Referred to by Thelen and Smith as a “nesting of changes on multiple timescales” (2006:277), this property reflects a tendency of the system to return to a preferred state, yet that preferred state itself is altered by the passage of time and immediately preceding context, so that the system at the same time continues to evolve, re-organize and change, while still retaining a self-similarity in a new phase. In dynamic terms, this is referred to as a fractal nature (Van Geert, 1994:50-51; Larsen-Freeman, 1997:142; Thelen & Smith, 2006:277).

The tension at the intersection between chaos and fractal reflection of an emerging stable pattern is the focus of research in DST. Through mathematical modeling, DST provides a new avenue of insight into the process of development and learning. Thelen and Smith (2006:289-290) offer the following steps in moving from theoretical speculation to application in search of a model:

1. Identify those elements of the system to be observed. These are the collective variable of interest.
2. Within that set of variables, characterize the phases or patterns into which the system tends. These are the attractor states.
3. Describe the progression of phases, or dynamic trajectory, of the collective variable.
4. Identify the transition points between phases. These points may be characterized by the following terms:

- bimodal score distribution: a score is either present or absent, without an intermediate representation;
  - inaccessibility: intermediate states are unstable; this is related to bimodality;
  - sudden jumps: performance shifts quickly without an intermediate phase;
  - hysteresis: the preceding phase is seen to influence current performance;
  - divergence: the system response varies to changes in different parameters;
  - divergence of linear response: a nonlinear response may indicate a greater effect than expected from a small change in control variable (indicative of a threshold of change);
  - delayed recovery of equilibrium: following a perturbation, a slower return to a stable state;
  - anomalous variance: unusual or increased variability outside of emerging patterns.
5. Identify likely control parameters. Through mapping the dynamics of system change, is it possible to identify the point of change and thus, perhaps, the agent of change.
  6. Work with the assumed control parameters to postulate probable future transitions.

To summarize, a dynamic system is “a set of variables that mutually affect each other's changes over time” (Van Geert, 1994:50), employing the features of non-linearity, self-organization, complexity and chaos that allow the construction of models of development in terms of iterative functions and attractors within fractal systems (i.e., systems which are geometrically self-repeating at different levels of their structure) (ibid.: iix, 50-51, 58; Larsen-Freeman, 1997:149, 158). The advantage of employing DST in this current study lies in the development of a comprehensive theory which considers a variety of influencing factors to develop



an interactive model of what precipitates learning and what causes, or may cause, a regression (ibid.:159).

#### ***4.4.2 Language as a dynamic system***

The principles of dynamic systems developed by mathematicians and physicists to describe complex phenomena in the environment, such as chemical reactions and weather patterns, may also be useful to the study of human development. The foundational characteristics of stability and change, nonlinearity and self-organization, and open systems whose variables produce synergistic leaps forward, are readily applied to a study of developing organisms (Thelen & Smith, 2006: 267-268). DST provides a coherent framework to reflect the continuous interaction of a variety of components, reflecting the multicausality, self-organization and shift of phase over time of such complex tasks as reaching and learning to crawl (ibid.:281).

The challenge to any theory of development is to explain the synergistic effect of “how to get something more from something less” (Smith & Thelen, 2003:348). In certain contexts of human development, traces of future capacity may be observed prior to the complete skill becoming available. Studies over time and at multiple levels of analysis such as is possible with DST may provide insight into what Thelen and Bates referred to as the “confluence of many elements” which may well occur asynchronously (Thelen & Bates, 2003:348). “In human development, every neural event, every reach, every smile and every social encounter sets the stage for the next and the real-time causal force behind change” (Smith & Thelen, 2003:348).

Specific to the development of language as a dynamic system, Beckner Blythe, Bybee, Christiansen, Croft, Ellis, Holland, Ke, Larsen-Freeman and Schoenemann (2009) offer the following four characteristics:

- language systems exhibit interaction among multiple agents in the speakers of the speech community;
- language as a system is highly adaptive, as speakers’ past and current interactions inform future behavior;
- competing variables in the language system such as perception and social motivation influence a speaker’s behavior; and

- patterns expressing the structure of language arise from interactions among subsystems of personal experience, social interaction and cognitive processes. (Beckner *et al.*, 2009:2)

Larsen-Freeman (1997) was among the first to apply DST to the study of second language acquisition, describing language as a nonlinear system of complex interactions of subsystems, emergent and changing over time (Larsen-Freeman, 1997:149). Beckner *et al.* (2009) reinforced this stance, defining language as a complex adaptive system according to seven characteristics:

- it is emergent over time at both an individual and a collective level;
- it is intrinsically diverse, with no one ideal representative;
- it is an open system, constantly changing and re-organizing;
- it has multiple interacting contributing or inhibiting factors;
- within the system, small quantitative differences lead to larger qualitative shifts;
- its internal structures affect the interactions of the system;
- its complexity grows out of several different cognitive skills (Beckner *et al.*, 2009:14-18).

Language use is built up through the categorization of utterances, as is evidenced at an individual level even in the emergence of adult grammar. The same phenomenon can be observed at a more generalized level within and across languages (Beckner *et al.*, 2009:7). This perceptual use of categories to incorporate new information reflects dynamic pattern shifts of self-organization through links with perception, action and cognition (Thelen & Smith, 2006:285).

DST views language as a dynamic set of patterns which develop through use. The complexity of the system of second language acquisition grows from the interactions of the variables as they self-organize and adapt, with the relative effect of each variable changing over time. Use of the theory in second language acquisition study is useful in integrating the contextualized, dynamic nature of language into language analysis (Larsen-Freeman & Cameron, 2008).

#### ***4.4.3 Writing as a subsystem of language***

Larsen-Freeman (1997) proposed ten parameters to describe systems as “dynamic, complex, nonlinear, chaotic, unpredictable, sensitive to initial conditions, open, self organizing, feedback sensitive, and adaptive” (Larsen-Freeman, 1997:142).

Given the fractal nature of language (ibid.:149), it is evident that each of the above-mentioned characteristics can equally be applied to emerging writing skills.

Writing, or more specifically, the system of learning to form written symbols to represent speech sounds, is dynamic in the sense that development of capacity changes over time. An individual’s ability may increase, but as statistics of new literate skills show all too frequently, the capacity to write may also diminish over time if not adequately reinforced. Writing development is complex in the sense that it has multiple contributing factors relating to physical, psychological and linguistic processes of development, but it is also complex in the sense that no one single factor determines writing outcome. Each variable interacts with the others, as an awareness of the sounds of the language may trigger the letter the writer wishes to form, but awareness of the form that sound takes as a letter, or the motor skills to reproduce the symbol on the page, will either inhibit or enhance the final outcome. This is seen in early writing samples as writers distinguish with varying success the difference between ‘h’ and ‘n’ or ‘b’ and ‘d’ as the writer’s awareness of letter forms is refined, spatial orientation increases, and fine motor skill development permits the reproduction of the desired symbol. Any one of these factors could disrupt the process, but no one single factor would yield success. In this very specific example, emergent writing skills may be seen as operating as a complex system.

It may at first appear oxymoronic, or at worst a poor attempt at punning, to describe the writing process as nonlinear but, as has been described in the literature (Deford, 1980:162), the progression of the *development* of writing skills does not move from strength to strength in a straight line. Thresholds of learning may occur after seeming periods of regression, or unexplained “growth spurts” in ability may occur, apparently without explanation. This disproportionate response to input defines writing as nonlinear in nature, but also points to the chaotic aspect of learning to write.

Chaos, as the term is used in DST, refers to the variable response to stimulus as being reliant on the initial state at the time the variable is introduced. So, the seeming unpredictability of a response may in fact belong to a larger pattern of behavior when moving from one stable state to the next. Teachers are well aware of the phenomenon of students who struggle and seem frustrated until one day, “something clicks.” This is an example of moving from a chaotic state to a stable state, and the “something” that made the difference one day when it had made no sense the day before grew out of a different starting point from which comprehension could as last dawn.

In studying the assessment of writing in second language learners, Weigle (2002) noted that there was a high level of variation among individuals in respect to the differing aspects of writing ability and to the rate of writing acquisition (Weigle, 2002:121). These phenomena speak to the nonlinear aspect of writing development, but also to the chaotic nature of writing. Each individual learner begins at a different initial state, which affects both the rate and the order in which skills are acquired.

Open systems, just as the term implies, may receive input or stimulus from outside of the previously interacting variables of that system. As open systems respond to new variables, they may react with different behavior, adapting to the new element, evaluating the usefulness of that element, and incorporating it into a new pattern of response. An example of writing as an open system may be seen in the continuing development in the skills of the writer after specific writing training has ended. Should the new writer continue to seek to express new ideas, writing skills continue to develop. Conversely, if the new writer ceases to practice writing and reading, undisturbed by new information, a closed system develops, in which the variables will tend toward the lowest level of a stable state, in this case, a loss of capacity to read and write known as neo-illiteracy.

Of specific import to this discussion of language as a dynamic system is the fractal nature of a system defined as complex or dynamic. It is possible to speak of language as it is practiced cross-linguistically, in a broad perspective of language, as communication among humans, and sometimes other species. It is possible to address the issue of language as practiced by one community of speakers of an agreed-upon set of vocabulary and structures, i.e., one particular language. It is

also possible to study language as it develops as a communication strategy within individual speakers, or as it is acquired as a second language. At each of these levels of inquiry, because of the reiterative patterns of development of language, it is possible to discern influences of one level of language on another. An example of this can be seen in the following passage:

<sup>5</sup> The Gileadites captured the fords of the Jordan leading to Ephraim, and whenever a survivor of Ephraim said, “Let me cross over,” the men of Gilead asked him, “Are you an Ephraimite?” If he replied, “No,” <sup>6</sup> they said, “All right, say ‘Shibboleth.’” If he said, “Sibboleth,” because he could not pronounce the word correctly, they seized him and killed him at the fords of the Jordan. Forty-two thousand Ephraimites were killed at that time. (Judges 12:5-6, The Holy Bible, New International Version)

In the passage, the influence of the phonological system of the spoken language of the Ephraimites affected the individual speakers as they attempted to apply their language skills to a second language, that of the Gileadites.

It is further possible to study language in its component parts, or as subsystems within the dynamic system of language. Most notably, studies of second language acquisition (among others, Larsen-Freeman, 1997, Verheyden, Van den Branden, Rijlaarsdam, Van den Bergh & De Maeyer, 2012, Verspoor *et al.*, 2011) and first language acquisition (Van Geert & Van Dijk, 2002) have employed DST. In this study, first language handwriting development is proposed as a dynamic subsystem of language and therefore metonymic for the understanding of the larger, open-ended and fractal experience that is the study of language and language acquisition (Kramsch, 2012:8).

#### **4.4.4 Summary**

The aim of DST is to obtain a better grasp of the reality of change, growth and development as it actually occurs, thus making it possible to perceive patterns, e.g. in relation to the interaction between factors that may affect ‘learners’ in specific circumstances (Verheyden, 2010:116).

Dynamic Systems Theory may be employed as “one overarching theory that allows to account for these ever interacting variables, non-linear behaviour, and sometimes unpredictable outcomes” (De Bot, Lowie & Verspoor, 2007:8), with particular attention to the areas in which the data appear to show regression and

interplay between the defined factors of the study, because “change occurs at the borders between chaos and order” (Larsen-Freeman & Cameron, 2008:158).

DST has been chosen for this study because it is sensitive to the open-ended nature of learning, the interaction of multiple variables involved and the intra- and inter-individual variation that occurs in the data (De Bot *et al.*, 2012:194), indeed highlighting that variation and bringing it to the forefront of investigation, rather than focusing on normalization of the data. In DST, the fluctuation in data signifies a change in phase, which is reflected visually by a change in the model. Applying this theory to writing development, a fluctuation in data is produced by a change in the writer’s performance. A change in phase in the model produces a visual rendering of emergent patterns of performance, which may be interpreted as a visual representation of the individual’s learning. DST offers, then, a new perspective on the analysis of handwriting development heretofore untried in the domain of adult learning and emergent writing.

In the chapter that follows, a dynamic systems analysis is applied to writing samples taken from 20 Bambara women in a basic literacy course. Particular attention is given to emergent patterns and divergence from a linear progression as the four influencing factors interact to influence the women’s writing output over the course of the literacy instruction.

## **Chapter 5.**

### **Analysis of data**

A pattern in a dynamic system is coherent because of the cooperation of the components (Thelen & Smith, 2006:275).

Verheyden (2010) has demonstrated that we should refrain from interpreting the capriciousness of the variable components as trivial, meaningless “noise”, but rather should view it as meaningful intra-individual variance in its own right. The collective variable of interest in this study, as stated earlier, has been defined as being composed of letter formation, size, spacing and alignment. These elements are coded according to the guidelines for assessment outlined in the section on methodology, and the percentages of correct output without adjustment for variation are graphed to show the emerging discrepancies and patterns of cooperation and divergence in the interactions of these four features as the new writers’ capacities develop.

From a DST perspective, the primary question to be addressed is how development can be seen to emerge through the types of interactions among the variables: which variables seem to develop before the others (precursors), which ones appear to develop concurrently (connected growers) and which seem to emerge in opposition to each other (competitors) (Schmid, Verspoor & MacWhinney, 2011:48). The four variables used in this study will now be compared on this basis and in relation to their interactions and progression to determine what, if any, patterns may emerge.

Because of the nature of the study of change over time, data is presented in clusters of corresponding time spans, beginning with learner writing samples taken over the course of three months. The data may be limited in time span for a variety of reasons: the individual may have joined the class late, thus only having participated for three or four of the six months of teaching; the participant may have dropped out of the class before its completion; the participant’s attendance may have been irregular throughout the course term, so that her progress does not

reflect the complete learning experience; or the participant may have chosen, for whatever reason, only to provide partial data for the period represented here. Attendance at and participation in informal adult education courses, as indeed participation in a study such as this one, are not mandatory, but the nature of real data, gathered in the normal course of events as opposed to an artificial setting constructed for a study, provides a wealth of natural information which more than compensates for the messy or incomplete forms of the data itself.

For each group, the analysis of the variables is compared at an intra-individual level and at an inter-individual level by a cross-grouping of each of the factors. The same procedure of analysis will be followed for data of writing samples that span three months, four months and five- to six-months. For the sake of organizational structure, the data are presented within each group beginning with the youngest member according to self-reported age and continuing to the oldest participant for that time span sample group. Each of the women gave permission for their data and their names to be used. In this discussion, each woman will be referred to by her given name when referring to the data that she provided in an effort to lessen the confusion of more designated numbers as well as to subtly underline the awareness that each of these women is a unique individual, as will be reflected in their learning patterns.

### ***5.1 Three-month samples***

The three-month time span sample contains data from ten women ranging in age from 23 to 50 years old. Each woman's writing was evaluated for letter formation, letter size, spacing and alignment at one-month intervals over three months. In this section, the data for each participant are represented by a chart of the progression of the collective variable of interest, with each of the four factors assessed as to its progression or regression as a precursor, a connected grower, or a competitor in relation to the development of the other factors. The full data samples, coded for these four factors and translated from the Bambara where pertinent, can be found in appendix A.

#### ***5.1.1 Assan***

The data from Assan, the youngest participant in the first group at 23 years of age, shows a markedly higher performance in letter formation in comparison to the

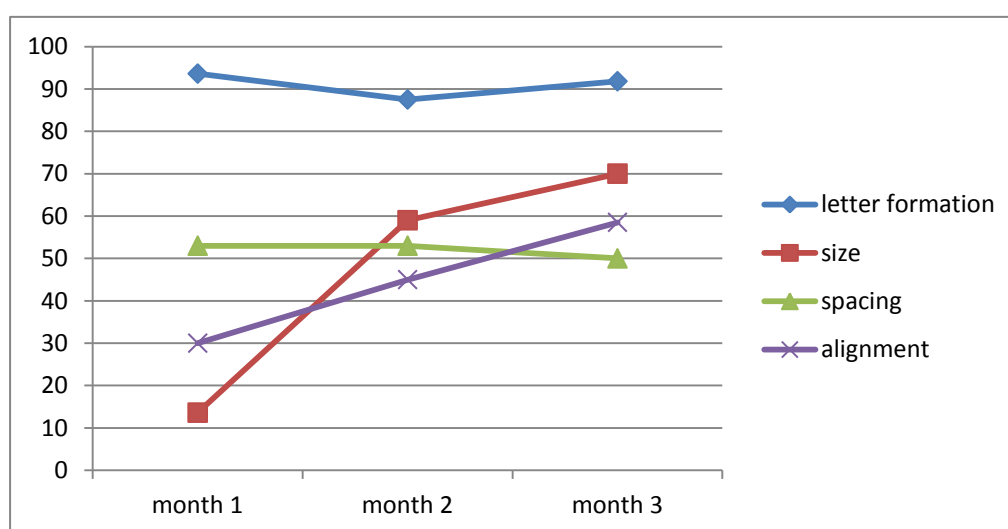


other three variables. This appears to be a clear example of a precursor variable, in which a skill, as identified by one of the influencing factors, is achieved as a forerunner to the others. Whether this is a manifestation of a necessary hierarchy of skills development or an emphasis imposed by the teaching methodology cannot be ascertained from the data, but it will be of interest to note what other participants' data show us regarding this factor.

Size and alignment develop largely along a similar growth line, though size makes a bigger leap in development after the first month and maintains a margin of success running almost parallel and superior to that of alignment. This parallelism of development indicates that these two factors may be connected growers.

The spacing variable, however, shows a slightly downward trend, falling from 53% to 50%. Whether this is significant or more indicative of a static state is not as informative to this analysis as is the fact that the other three factors were all on an upward trend by the third month, thus the spacing variable is categorized as a competitor.

It is interesting to note the wide divergence in performance of each of the four components at the one-month stage, followed by a much closer clustering at months two and three. From month one to month two, two factors, size and alignment, show an increase in performance, one, letter formation, showed a slight decrease, and one, spacing, remained constant. From month two to month three, three factors, letter formation, size and alignment, all show an increase in performance, while one, spacing, decreases slightly.

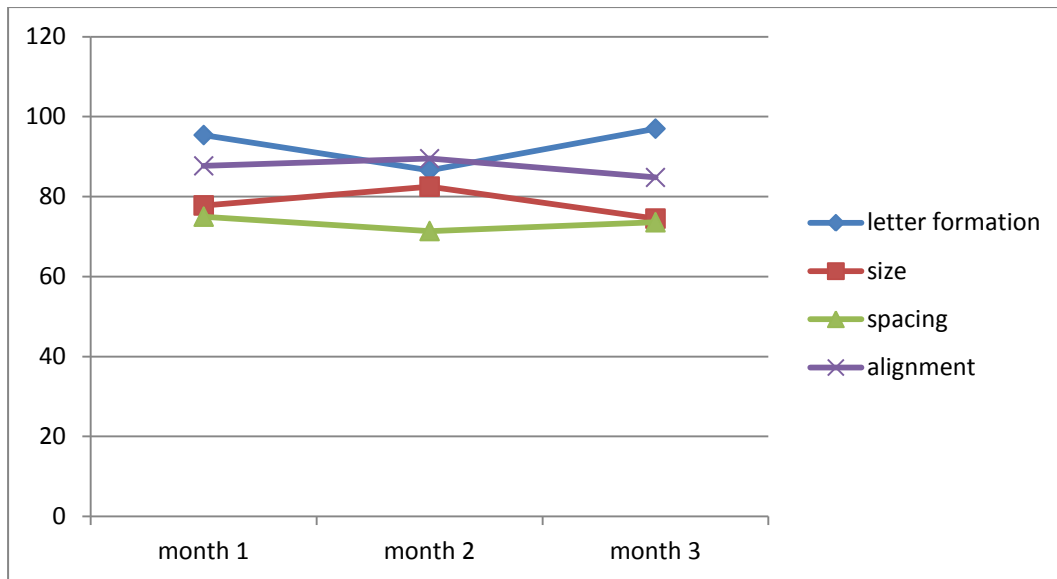


**Chart 1. Assan, age 23**

### 5.1.2 *Ami S.*

Ami, age 26, showed a much tighter clustering of results in all three months. Even so, a superior performance in letter formation and a greater challenge in spacing are still in evidence, and letter size and alignment are again running in parallel to each other, as they were for Assan, but here, alignment output is consistently superior to letter size output. For these reasons, size and alignment will again be categorized as connected growers in this sample, with letter formation again a possible precursor. Spacing, even in this sample with higher outputs in general, is still on the bottom rung among the four components of the collective variable of interest, and will be held lightly as a possible competitor or as a static variable. It is also possible that letter formation and spacing may be reacting as connected growers, almost as a pair in competition with the pairing of alignment and size. The inverse chevron patterns formed by the two pairings of factors are intriguing, but the stronger argument may be that formation is a precursor, influenced in a negative direction in the second month by the strong gains in both size and alignment.

In the clustering of the data assessment output for the four factors at each interval, it is interesting to note that the order among the four remains almost completely consistent, with only one slight overlap (representing a 3.1% difference in scoring) between letter formation and alignment in the second month. From month one to month two, two factors, letter formation and spacing, decreased slightly in performance, and two factors, alignment and size, increased. Then from month two to month three, that pattern reversed itself, as mentioned earlier, with letter formation making very strong gains and spacing recovering slightly, while alignment and size performance both decreased.



**Chart 2. Ami S., age 26**

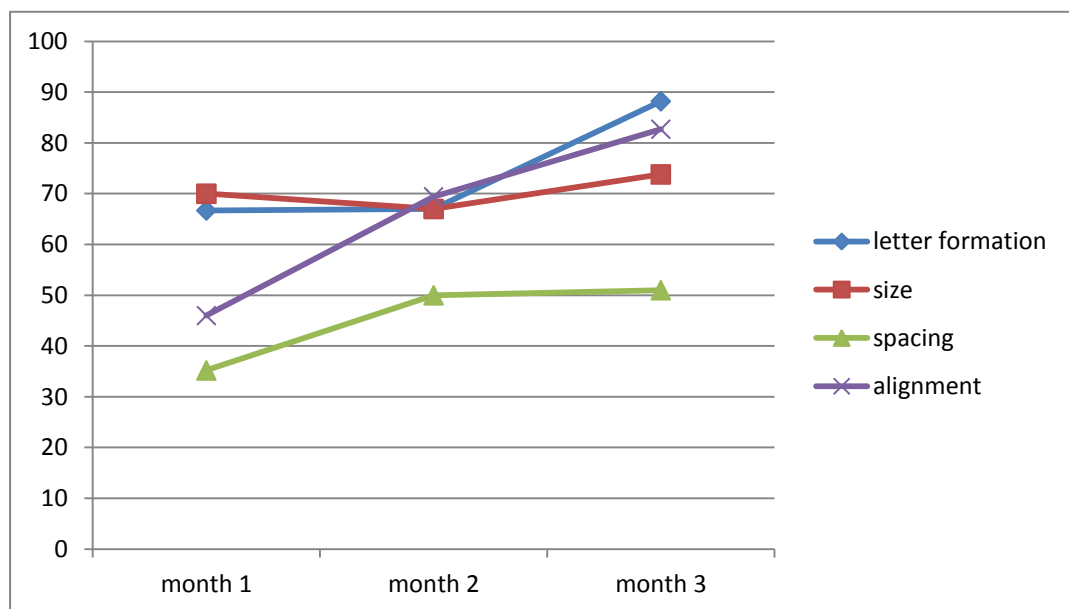
### 5.1.3 *Fatoumata*

In the data from Fatoumata, age 28, there is the first instance of letter formation not being at the consistently highest output among the four factors. While there appears to be no clear precursor element to the performance of any of the components, the results recorded for months two and three would seem to show a close alignment in the development of three of the factors, namely letter formation, alignment and size. These three elements seem to be operating as connected growers, while the factor of alignment again seems to lag behind. The question arises again in this set of data, as it did in Ami's, as to whether the component of spacing is acting as a competitor or as a static factor. There is a slight coupling in the patterns of development between alignment and spacing, but the degree of difference in the percentage points of their output, with an ever increasing gap from 10.8 percentage points in month one to 19.4 percentage points in the second month and of 31.7 percentage points in month three tends to weaken that view. The possibility of a negative attractor which causes the other components to react in an opposite direction, for example if the mental and physical energy required to attain the proper spacing detracts from the performance in the other factors, should also not be ignored.

It would also be possible to interpret the data as displaying a pattern similar to Ami's in the immediately preceding example. One can see a double chevron of

letter formation and size, connected growers, in competition with the inverse chevron patterns of alignment and spacing, possible connected growers to each other, but reacting in opposing patterns of progression and regression to the first two factors. This interpretation of pattern is not as clear as it was in the preceding sample, but is nonetheless observable.

From month one to month two, there is a marked improvement in both alignment and spacing, while letter formation remains virtually constant and letter size performance regressed slightly. This results in a very tight clustering of the elements of letter formation, size and alignment for month two, with spacing a distant element throughout. From month two to month three, the results for all four spread out again, with letter formation taking pride of place, as it has consistently in previous participant examples, but with alignment and size factors also showing distinct improvement in their development. Spacing again shows the least amount of either output or development among the four components for the stage between month two and month three. The strong performance of letter formation in month three may indicate a developing role of precursor for that element.

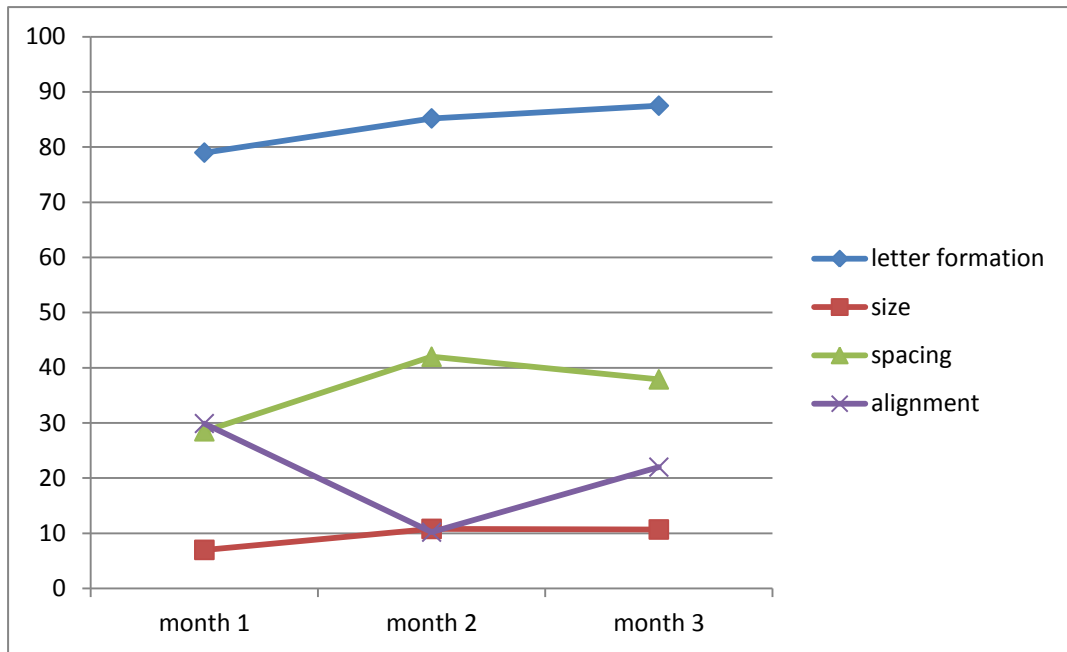


**Chart 3. Fatoumata, age 28**

#### 5.1.4 *Mai*

The data from Mai, age 35, gives another example of letter formation far in advance of the other elements in the collective variable of interest, i.e., a precursor to the other factors. Yet unusually in the data seen thus far, the second strongest performing factor is spacing, albeit still only assessed at 40% and below. The most highly divergent from a linear response is the factor of alignment, jumping from 29.9% the first month, to 10.2% the second month, recovering slightly to 22% by month three. The most challenging factor for Mai appears to be letter size, which hovers around 10% all three months. Though letter shape and size share a similar pattern form in developmental progression, the two occur at a remove of more than 70 percentage points; thus, none of the patterns in the factors would appear to be connected growers. From the divergence seen in the almost mirror-image progression patterns in spacing and alignment, however, these two factors might be characterized as competitors. This interpretation would yield from among the four variables one precursor, two competitors divergent in linear response, and one static element, this last factor being different from the static factor noted in the data of the three previous participants. This new configuration in the collective variable of interest might suggest that, while spacing might be a predominantly more difficult factor to master by the majority of learners, the greater influencing element at work might be the number of factors that the writer is able to juggle at any given time. At this stage of the data analysis, it is too early to do more than suggest such a stance, but that possibility has been raised by Mai's data.

In this set of data, the shift in development from months one to two is in a negative direction for only one of the factors, that of alignment. The other three factors are widely spaced in terms of actual correct output, but each of the three makes positive progress. In moving from month two to month three, two of the factors, letter formation and alignment, make progress while size remained virtually constant and spacing experienced a slight regression. In examining all three months, it could be posited that the learner is interacting primarily with only two of the factors, i.e., spacing and alignment, with letter formation posing little challenge and size largely left behind to be dealt with at some future point in time not encompassed by these data.

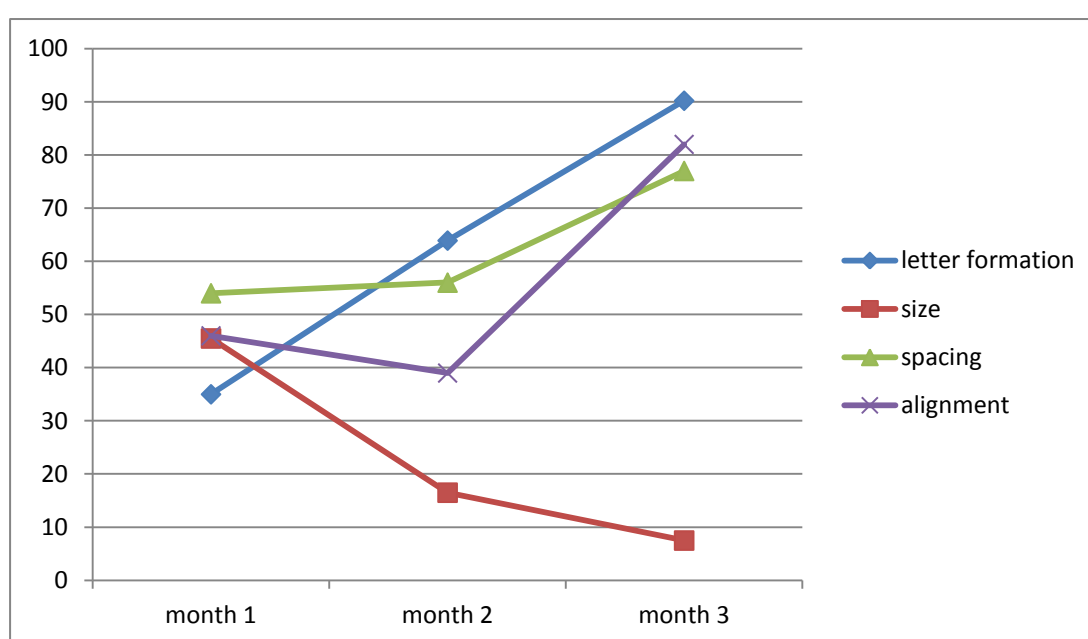


**Chart 4. Mai, age 35**

#### 5.1.5 Djara

In the data for Djara, age 39, letter formation begins in fourth place for correct production, but very rapidly progresses over the three months to become the strongest of the four factors, with a rapid linear ascent from 35% to 63.9% to 90.2% month by month. While three of the factors, letter formation, spacing and alignment, could be interpreted as cooperative growers, the dramatic development from lowest to highest performance and the continued dramatic increase in letter formation skills speaks strongly in favor of letter formation once again being a precursor factor among the collective variable of interest. Spacing and alignment behave very similarly, as connected growers, with alignment performance overtaking that of spacing in the third month, but in direct opposition to the patterns seen in the immediately preceding data. Size, in this case, appears to be acting as a competitor, heading downward almost as dramatically as letter formation improves. Again, this underscores the possibility that one of the four variables might need, in the process of learning, to be left aside while others are mastered. In this case, as with Mai's data, it is the letter size that seems to be ignored, although at the beginning of the study, size and alignment were very closely clustered.

In fact, in the first month, there is not a large discrepancy among the four variables, but in the transition between the first and second months, a wider range of output developed. From the second to the third month, the marked increase in performance of both alignment and spacing is mirrored by a marked decrease in output for the factor of size. With letter formation in the ascendancy, the significant improvement of two factors again raises the possibility that of the four components, one must act as the precursor, and if so, it is possible for the learner to cope with two other elements, but the fourth, as a general principle, will lag behind the first three in developmental progression.



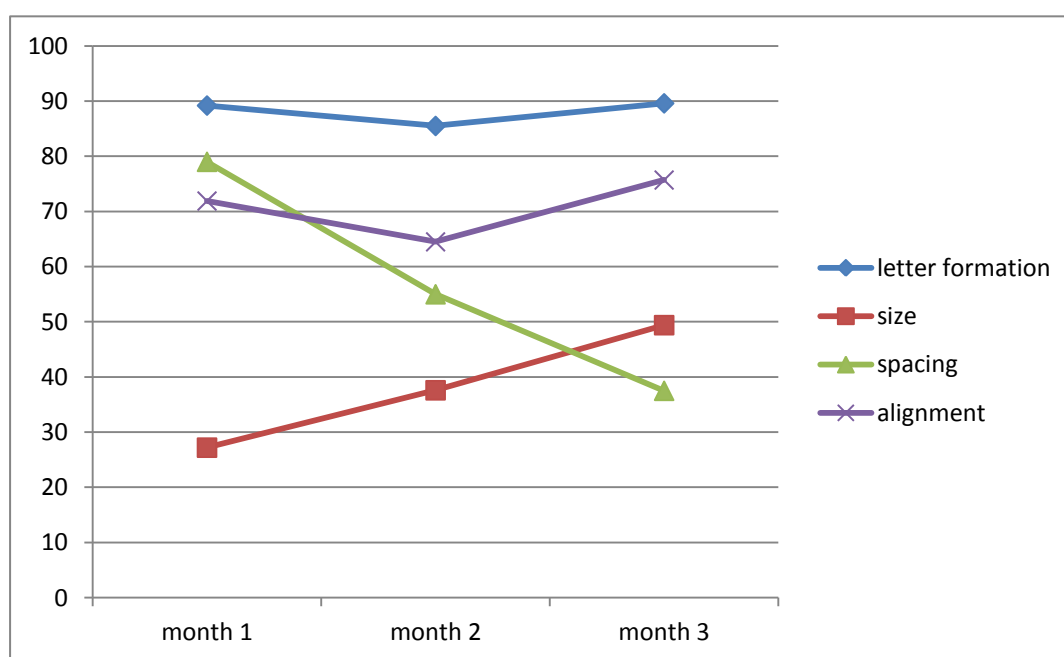
**Chart 5. Djara, age 39**

#### 5.1.6 Sadjo

In the data submitted by Sadjo, age 40, the factor of letter formation is again clearly a precursor to the other three factors. Spacing, exhibiting a downward development in opposition to the other elements, would take on the role of competitor, while size and alignment performance reflect the functions of connected growers. The pattern here is more open, due to the fairly wide-spread beginning points of each of the four factors, and they remain so throughout the three months. Though the order of the progression of the factors change, at no point did the results of the different factors cluster around the same level. From these data, as from Djara's in the preceding chart, we might observe that the

starting point is not necessarily a predictor for which factors will act as connected growers and which will act as competitors. It is the patterning that emerges that will define the roles of each of the factors.

An interesting juxtaposition of the two monthly transitions shows an improvement in only one of the factors, that of size, whereas there is regression in the other three. The downward trend is slight for letter formation, but is more appreciable for spacing and alignment. Yet in the second transition, there is positive development in three of the factors, again only slight in letter formation, but also in alignment and size factors, and a regression in only one, that of spacing. While results were not closely clustered, there was a seeming ‘dip’ in overall performance in the second month’s data which might indicate a period of settling in and ordering of tasks to be mastered. It is evident even in the short time from month one to month two that each factor has already begun to function in its role of precursor, competitor or connected grower, roles that are confirmed by the data in the third month.



**Chart 6. Sadjo, age 40**

#### 5.1.7 Mariam

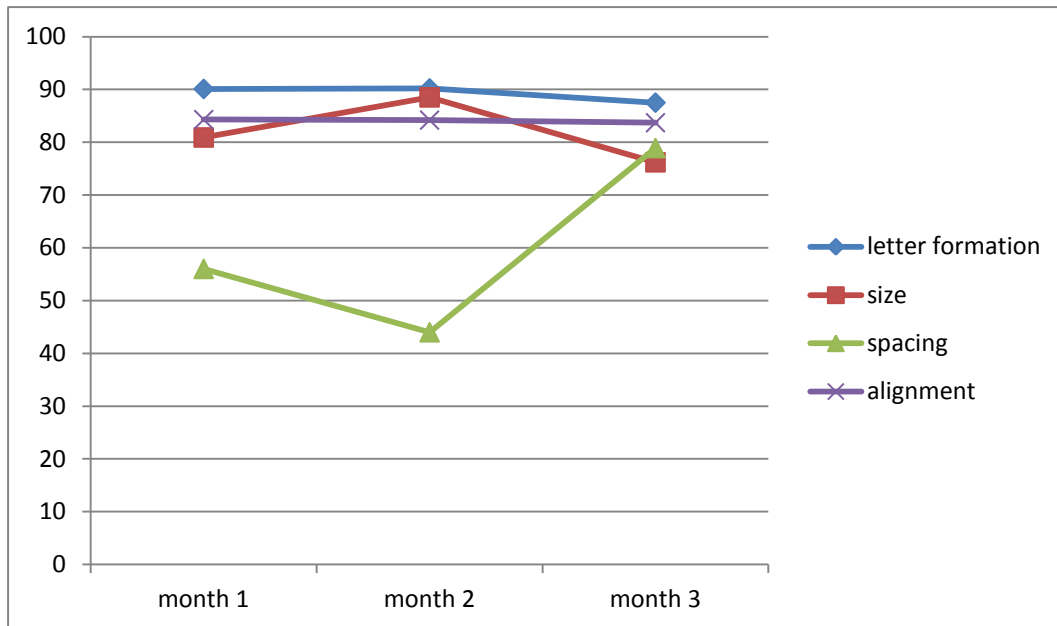
The data for Mariam, age 41, give an example of partial information from a participant who chose to submit her data for only a later stage in her learning, perhaps out of shame or embarrassment at her early writing attempts, perhaps for



some other reason. However, the three month data, while incomplete, can still be informative to the analysis. The information that was submitted shows a pattern of development occurring later in the learning process, although sadly, we do not have the benefit of the earlier data from the beginning of the class.

The factor of letter formation appears again as a constant precursor, with scores consistent and consistently higher than the other factors. At this later stage in the class, however, a second factor, that of alignment, has also achieved a stable stage of development at a high level of competence. Size, as the third most highly developed factor, is still divergent in linear response, but most likely had been interacting with alignment as connected growers up to this point. The interesting phenomenon to note at this later stage in the learning process is that the fourth factor, spacing in Mariam's case, which had been lagging behind in correct output, is now beginning to pick up momentum. But this increase in development appears to be coming at the expense of the least stable of the other three factors, i.e., that of size. From these observations, the additional question might be posed as to a hierarchical progression in the acquisition of the different factors in the collective variable of interest. This three-month snapshot of data taken at a later stage in the learning process strengthens the hypothesis that dips in the progression of one factor potentially signal a developmental gain for a different factor, seemingly the least stable of the more highly developed factors.

In the shift from month one to month two, the factors of letter formation and alignment exhibit stable behavior at a high level of competence. The factors of size and spacing act as competitors, as is further exhibited in the shift from month two to month three, when the performance of the two factors actually switch places again in their levels of progression, with the factor of spacing just surpassing the factor of size in its performance. This shows how the functions of different variables change as their context and relationships shift, displaying a growing, dynamic system.



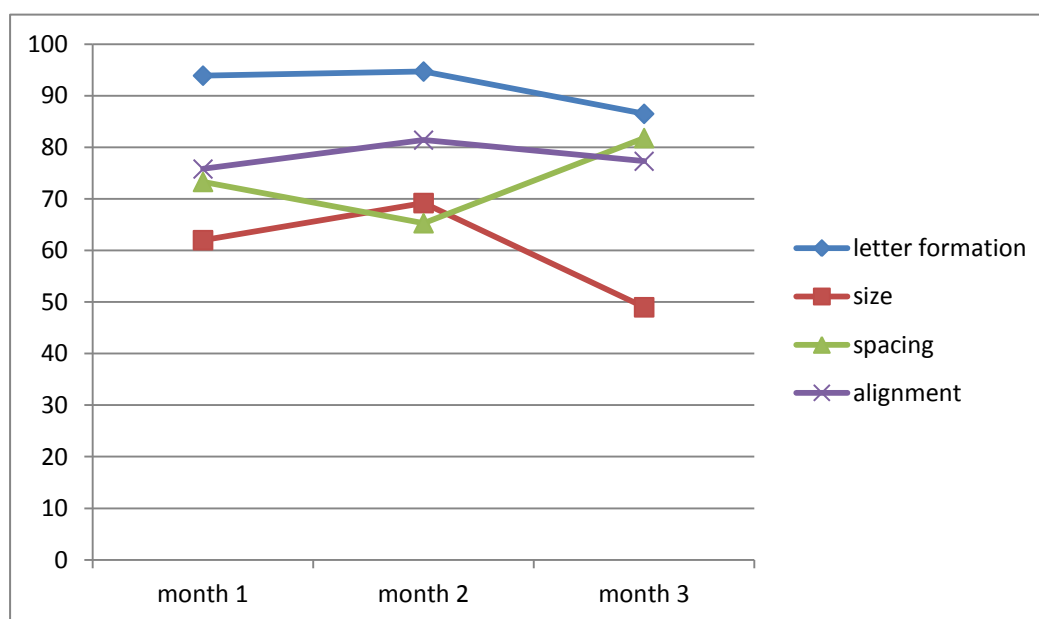
**Chart 7. Mariam, age 41**

#### 5.1.8 *Mama*

In the data rendered by Mama, age 48, a high concentration on the accuracy of letter formation is in evidence, indicating again a precursor role for this variable. The factor of spacing displays a significant regression from the first to the second month, not seen in any of the other factors, and its rate of recovery in the third month creates an opposition in pattern to the collective grower patterns of the factors of size and alignment. The significant increase in spacing performance in month three may have precipitated the decrease in letter formation performance, supporting the theory that, in the interplay of elements within the collective variable of interest, a regression in one element may not reflect a lack of learning or “unlearning” for that particular element, but may signal an increase, or learning spurt, in another of the components.

While these roles of precursor, connected growers and competitor, seem clear and useful to the establishing of a more generalized pattern of development, it should also be noted that a different interpretation of the functions of the elements is possible. The overall high results of Mama’s letter formation performance would support, as stated above, the action of a precursor variable for letter formation. However, the drop in performance in letter formation in month three produces a similar pattern to that of alignment and size, making it possible that all three could

be linked as connected growers, with the fourth element (spacing) acting as a competitor. With letter formation performing in the 85% to 95% range, alignment in the range between 75% to 81% and size between 49% to 62%, the broad range of performance levels could be seen to weaken that connection. Still, the pattern is evident and could support a theory that the collective variable of interest is split with three factors acting in tandem as connected growers and one factor acting as a competitor to all three.



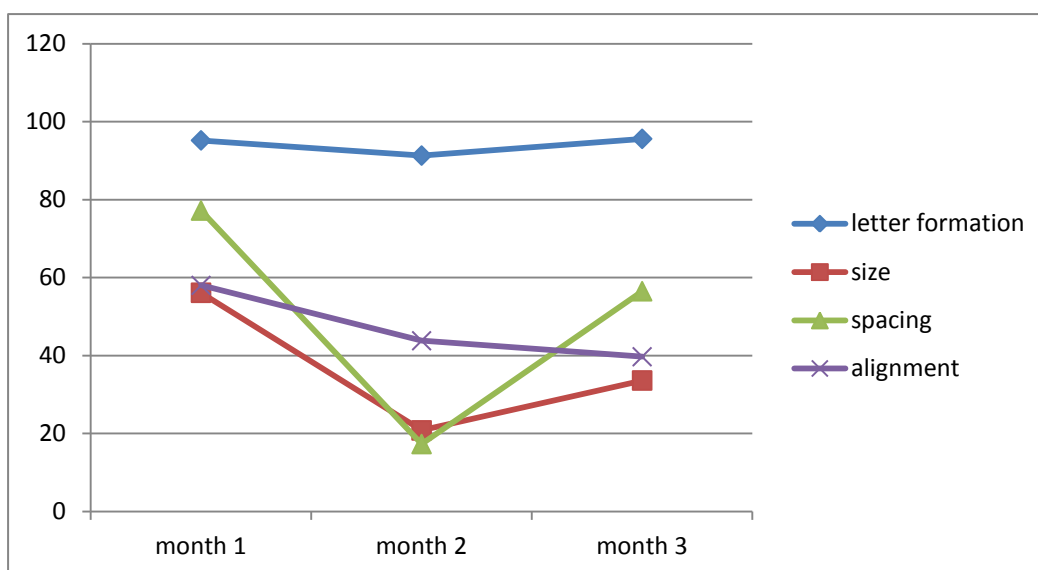
**Chart 8. Mama, age 48**

#### 5.1.9 Sali

The data from Sali, age 50, gives another example of letter formation in a precursor role, but the data from that point is skewed by the content of the sample that was submitted to the study. Sali's writing samples included no examples of single letter-writing exercises and very few words in isolation, consisting primarily of sentences. In the first month, there were 24 isolated words and one four-word sentence, but no single letter exercises. The second month's data contained one six-word sentence, one 16-word sentence fragment and seven words in isolation, but again, no single-letter exercises. In the third month data, there were three full sentences, one four-word sentence and two 12-word sentences, which had been dictated by the class facilitator. As we have seen in the literature and will see again more specifically later in this study, the recursive nature of writing is such that previously mastered skills regress when a more

difficult level of text is treated. Just as the data thus far have demonstrated that some variables develop first and others later in the learning process, even these variables, once mastered, will regress when the required level of composition is raised. Sali's data demonstrate this regression, while at the same time showing overall progress in her writing skills.

Sali's choice not to turn in letter-writing exercises may relate to her own perceptions of what is "worthy" to show to an outsider, or she may not have written the single letter exercises at all, seeing the task of learning to read and write as appropriate for adults only if meaningful text is used. It is beyond the scope of this study to address the perceptions, motivations and expectations of adult learning, but whatever the reasons, Sali's data does not include single letter-formation exercises in her notebook writing practice. In this instance, the value of real data that is not rigidly controlled for form and content demonstrates the validity of the premise of the study. For the purposes of this study, Sali's data can still demonstrate an interaction among the four variables, but the regression from month one to month two is more pronounced, due to the level of composition that the writer demanded of herself. Even so, the progression from month two to month three shows that even at a more complex level of writing, a pattern will develop among the four variables, with the factors of size and spacing regressing and recovering in a similar manner, allowing us to characterize them as connected growers, and the factor of alignment continuing in a regressive pattern which by the third month demonstrates more clearly in the role of competitor.



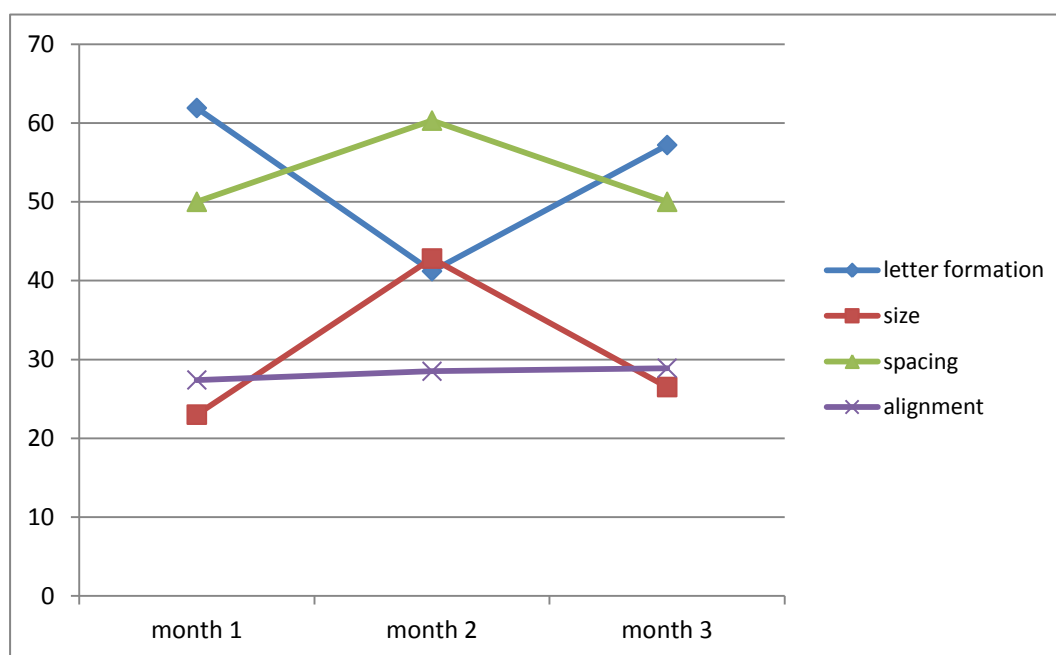
**Chart 9. Sali, age 50**

#### 5.1.10 Kadia

In the data given by Kadia, age 50, a true debutant writer is evidenced. Single letter formation is a struggle, and there is little concept of alignment. The pattern Kadia presents is, unusually for the data thus far, of letter formation as a competitor. Even though this variable's output for months one and three was higher than the other three factors, the assessment for the second month falls to third position among the four factors, and the overall movement indicated in the pattern of letter formation development is negative. The factors of size and spacing react in tandem as connected growers, while the variable of alignment is static, virtually unchanging throughout the three months. Given the high output of letter formation in the first and third months, it would also be possible to posit that letter formation is functioning as a precursor, but given the highly variable nature of the new learner, the high outputs of both spacing and size in the second month may have influenced the precursor to have a negative progress, as was seen in the data for Ami.

In the first month data, Kadia scored well in letter formation, but struggled with the other three factors of spacing, alignment, and size. In the transition to month two, the factors of spacing and size progressed well, but at the cost of letter formation. By the third month, letter formation was taking central focus again, and the overall gain in spacing and size from month one to month three, while

present, was minimal. These interactions demonstrate the learner's need to focus on no more than two elements of the collective variable of interest at a time.



**Chart 10. Kadia, age 50**

#### *5.1.11 Intra-individual comparison of performance by factor*

In the preceding ten writing samples, eight show letter formation acting as a precursor to the other factors. In one of the remaining two samples, letter formation acts more as a connected grower, and in the other it is a competitor, but at the high-performing end of the scale for the individual in both instances. In seven of the ten samples, the factors of size and alignment act as connected growers. In two samples, size and spacing act as connected growers, and in one sample, size remains low-performing, with 7%, 10.7% and 10.8% accuracy across the three months. Spacing functions as either a competitor or as a static variable in eight of the ten samples. If fluctuations in letter formation functions between precursor and highly-performing connected grower are included in the same category, and if spacing as a competitor and as a static factor are included in the same category, a single model of functioning would account for 70% of the data.

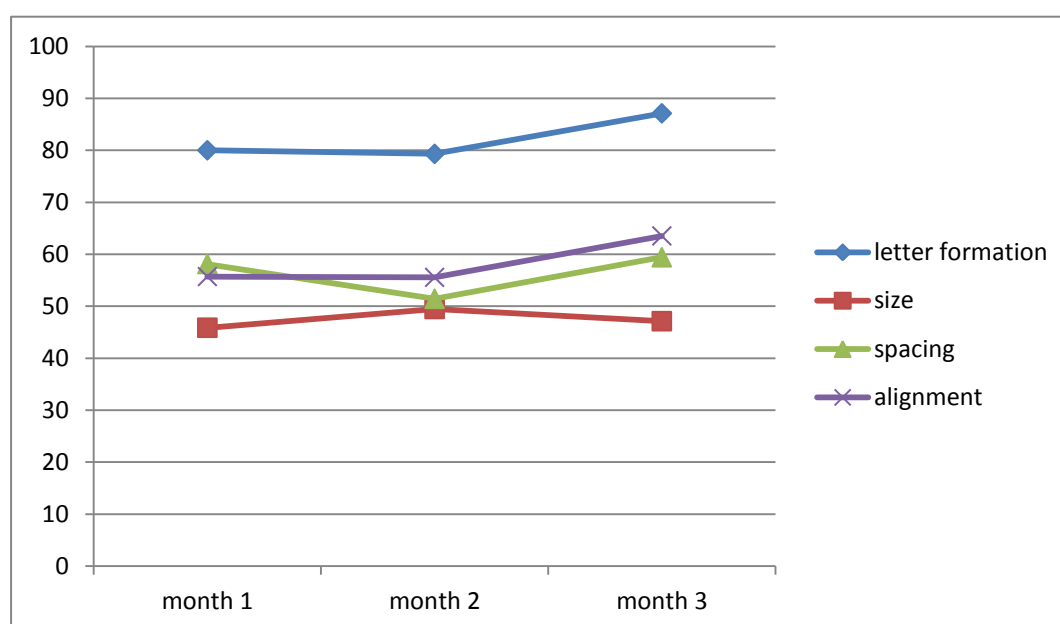
Table 5 gives a summary of the functions of the four variables examined in the data. Where an alternative interpretation of the data is possible, that function is noted by a question mark.

**Table 5. Factor functions, three-month data**

	Precursors	Connected Growers	Competitors	Static		Precursors	Connected Growers	Competitors	Static
1. Assan					6. Sadjo				
formation	x				formation	x			
size		x			size		x		
spacing			x	?	spacing			x	
alignment		x			alignment		x		
2. Ami S.					7. Mariam				
formation	x				formation	x			
size		x			size		x		
spacing			x	?	spacing			x	
alignment		x			alignment		x		?
3. Fatoumata					8. Mama				
formation	?	x			formation	x	?		
size		x			size		x		
spacing			?	?	spacing			x	
alignment		x			alignment		x		
4. Mai					9. Sali				
formation	x				formation	x			
size		x		?	size		x		
spacing		x			spacing		x		
alignment			x		alignment			x	
5. Djar					10. Kadia				
formation	x	?			formation	?		x	
size			x		size		x		
spacing		x			spacing		x		
alignment		x			alignment				x

From the data in table 5, a certain consistency begins to emerge. One representation that does not show this consistency, however, is a simple line graph representation of the four variables for each of the ten participants (see appendix A. three-month span data), which quickly becomes illegible, a visualization of the

white noise referred to in other DST studies (Verheyden, 2010; De Bot *et al.*, 2012:199). In a more successful effort to reduce the distraction and identify common trends among the ten sets of data, the percentages of output for all ten participants were averaged for each of the four components. The averages were then charted as for each of the individual data sets above, and the results are shown below in Chart 11. In it, the variable of letter formation can be seen as performing as a precursor. At the same time, its overall trajectory is similar to those of spacing and alignment, which are much more clearly aligned in the chart as connected growers. The variable of size acts as a competitor, progressing and regressing in opposition to the connected growers, but the range of reaction (51.43% to 59.42%) could also indicate a static variable, which must await the available focus from the learner to develop at some future point.



**Chart 11. Average of the collective variable of interest for three-month data**

While comparing the results for all ten participants, care must be taken to ensure that overgeneralization does not overlook the individual differences evident in the data. As nicely and neatly as the averages of the data fit into a predominant model of development of the collective variable of interest, alternative interpretations of the data also suggest the interactions of two variables as connected growers and two as competitors, as seen in the data from Ami and Fatouma, or the possibility of three connected growers and one competitor or static variable, as is possible in the data from Mai, Djara, Sadjo and Mama.



These three possible models of development suggested by the data thus far are informative, but it is also useful to note the absence of two patterns in any of the data: there is no straight, linear progression of all four variables demonstrated anywhere; neither is there a straight sequential linear process in which first one element is learned and mastered, then a second, then a third. All of the data sets reveal a dynamic interaction of divergence, sudden leaps in both positive and negative direction, and crossing over of lines of progression and regression among the variables, suggesting that there is more to the development of learning than a simple presentation and subsequent practice and mastery of a certain set of skills.

There could be some frustration at the curtailed nature of the data in this, the largest group of participants, but it does provide a basis from which to investigate patterns seen over a longer time period, to see whether they bear out the incipient patterns that may be discerned from the information in the three-month data group. This will be the focus of the following sections.

## ***5.2 Four-month samples***

The four-month time span sample contains data from five women ranging in age from 16 to 52 years old. As with the preceding data, each woman's writing has been evaluated for the four components of the collective variable of interest in accordance with the guidelines established in the chapter on methodology. The sections discussing data for each individual will be numbered consecutively beginning with 11, to continue from the end of the three-month data. As before, data will continue to be referred to by the individual's name. Each participant's performance is again discussed and represented by a chart of the progress of the four influencing factors at one-month intervals over a course of four months. Attention is paid to the patterns exhibited in the data with respect to the roles of precursor, connected grower, competitor, or static variable, as well as to the interactions in the collective variable of interest at each stage. After this, the development of each of the variables is examined separately across the data of all five women, and possible emergent patterns are considered. With an extra month added to the time span of the data, more complex patterns of interaction may be visible.

The full data samples, coded for the collective variable of interest and translated from the Bambara where pertinent, can be found in appendix B.

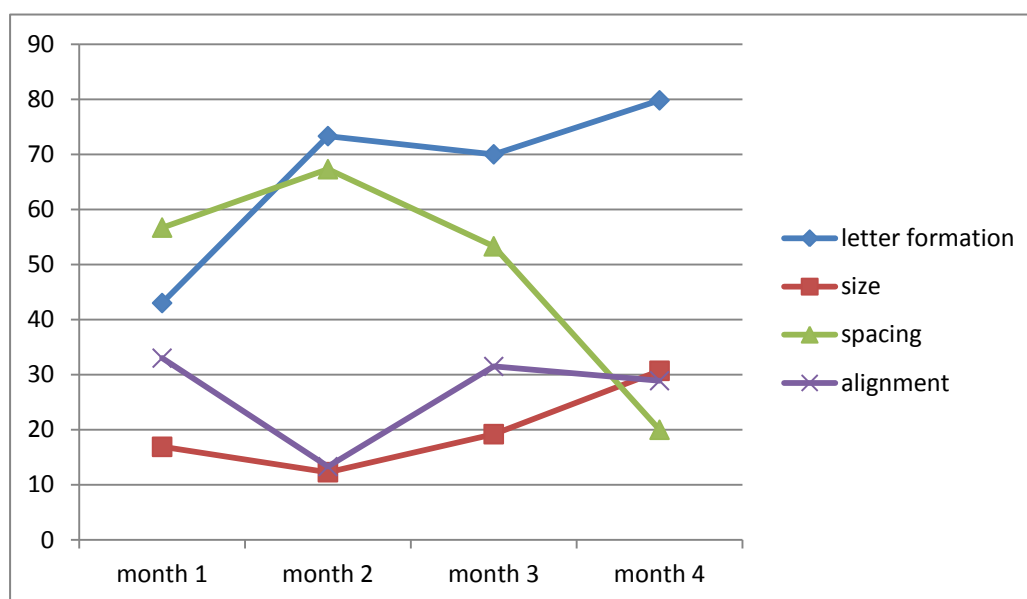
### *5.2.1 Minata*

In the data from Minata, age 16, the early months reveal a split between the four variables, with two pairs of variables developing in loosely parallel patterns. Even as late as month three, the factors of letter formation and spacing operate as connected growers, while alignment and size also act in patterns that are roughly similar to each other, but in opposition to the former pair, resulting in competitor roles for these two factors.

The period between months two and three appears to be a significant transition point. Patterns considered from month two to month four show letter formation as a precursor, while spacing output illustrates a steep regression, becoming a competitor to the progression made by the connected growers of alignment and size. In this later period of development, the pattern of letter size mirrors that of letter development, though at a distant performance level.

In the first month, all four factors are evenly spaced, but by the second month, letter formation has taken the ascendancy. Month two shows the closest alignment of letter formation and spacing, while alignment and size factors take a dip in performance. By month three, letter formation is established as the predominant strength, and this continues into month four, while spacing regresses in performance. It cannot be ascertained from the data whether the progression of alignment and size in month three precipitates the regression of spacing or if the primary influences work in the other direction, but the trend is continued, particularly in relation to the interplay between spacing and size, in month four. It could further be posited that the strong progression in the factor of letter size from month three to month four may also have influenced the slight decrease in performance for alignment. By the fourth month, we again see a pattern of progress in two variables and regression in two variables, but the roles and relations of those variables have changed. Even though from month two, formation is functioning as a precursor, the clearest overall design shows formation and alignment in competition with each other and size and spacing in

competition with each other over the whole four months. These data allow us to surmise that this learner focuses best on two elements at a time.



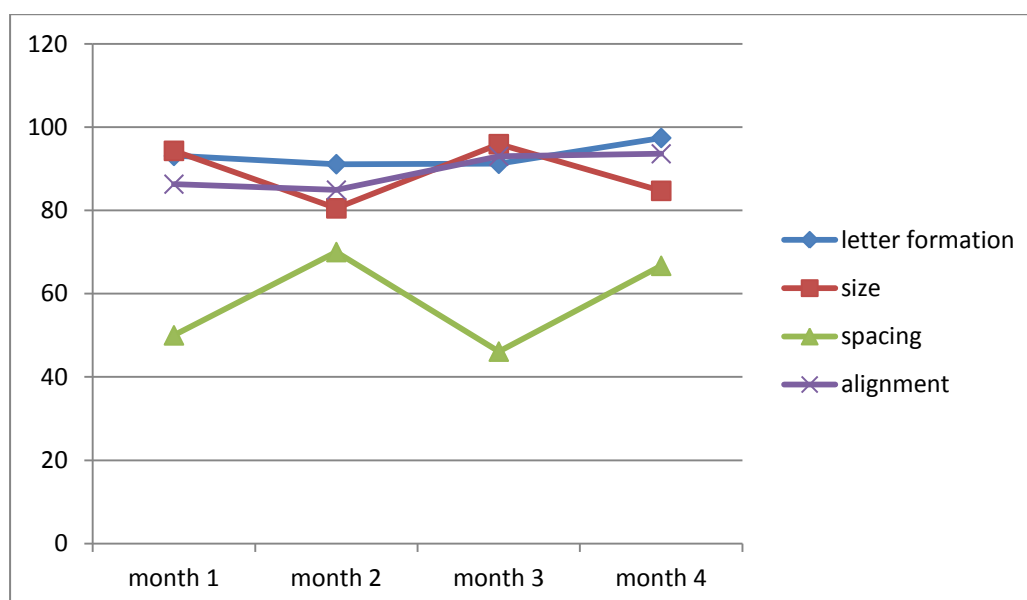
**Chart 12. Minata, age 16**

### 5.2.2 Siata

The data from Siata, age 39, begins at an impressively high level and presents a strikingly clear pattern. Letter formation remains consistently high, indicating the previous development of this variable as a precursor. The factor of alignment also begins at a relatively high level, and continues to make progress throughout the four months. Indeed it is almost as if the skills were being acquired sequentially: letter formation first, then alignment, then size, and finally, spacing. But it is the pattern created by the interactions of size and spacing that is the most intriguing in here: there is an almost mirror-image reflected in the patterns of the two variables. These developmental progressions would seem to indicate that, in this individual learner, there are primarily two factors that are undergoing developmental shifts, and they cannot, or at least, do not, develop concurrently. The variable of size displays an output pattern of a slightly inclined zigzag line, with output percentages beginning at 94.3%, regressing to 80.5%, progressing to slightly higher than the first benchmark at 95.9%, then regressing again in the fourth month to just above the second month benchmark, with 84.7%. The remaining variable, that of spacing, presents a slightly declining zigzag pattern in opposition to that of size, beginning with 50%, increasing to 70%, regressing to

below the first point with 46.1%, and progressing the fourth month at slightly below the second month level, with 66.7%. While letter formation remains high and alignment improves slightly, the two factors of size and spacing still battle against each other in a competitive relationship.

The variable of alignment could be interpreted as displaying faint signs of a zigzag pattern over the first three months as some sort of hybrid precursor/connected grower with the variable of size, with percentage outputs at 86.3%, 84.9% and 93%. It is interesting to note that in month three, when size has its strongest performance to that point, letter formation makes no progress from the preceding month before rebounding in the fourth month up to 97.4%, while size regresses in the fourth month. The interplay of all of the elements in the collective variable of interest continue to engage in a dynamic mix of interrelated waxing and waning, with, by the fourth month, only one of the elements not showing progress. This intriguing evidence suggests that Siata may indeed be a serial learner, taking each of the elements in an order, beginning with letter formation, then focusing on alignment, next on size, and finally on spacing, not completely mastering one element before moving on to the next, but establishing a competent level of ability which still fluctuates to a small extent in reaction to the other elements.

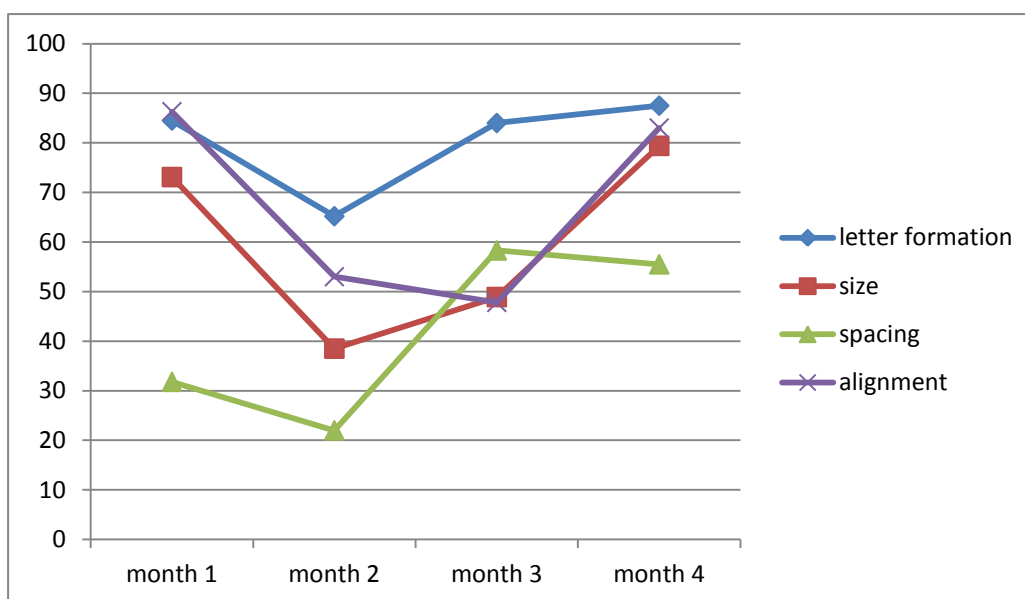


**Chart 13. Siata, age 39**

### 5.2.3 *Ami D.*

In the data from Ami D., age 40, the factor of letter formation, as in so many other data sets, develops first, thus acting as a precursor, but in this case, with a distinctive pattern very similar to one of the other factors. Of particular interest are the points of interaction among the influencing factors in months three and four. After a disappointing general decline from month one to month two, months three and four show clearly that the four elements are again split in half, as in Minata's case, with two factors acting in tandem and in opposition to the other two, also closely parallel, factors.

The transition from the third to the fourth month opens up a new window into the dynamic patterning among the four components of the collective variable of interest. Between months one and two, all four factors decrease, and from month two to month three, only alignment does not increase. But in the patterns emerging during the final two months, it is clear that what might at first have seemed to be four connected growers are in fact again pairs of elements in opposition to each other. The variables of letter formation and spacing show a parallel pattern across all four months, and can be categorized as connected growers. Size and alignment show a comparable parallel pattern, despite the regression of alignment in month three. That regression may have been influenced by the performance gain in both letter formation and spacing factors. Even if this is the case, the patterns of development for alignment and size remain strikingly similar to each other, with alignment moving in opposition to letter formation and spacing in both months three and four, and size progressing with alignment from month three to month four.



**Chart 14. Ami D., age 40**

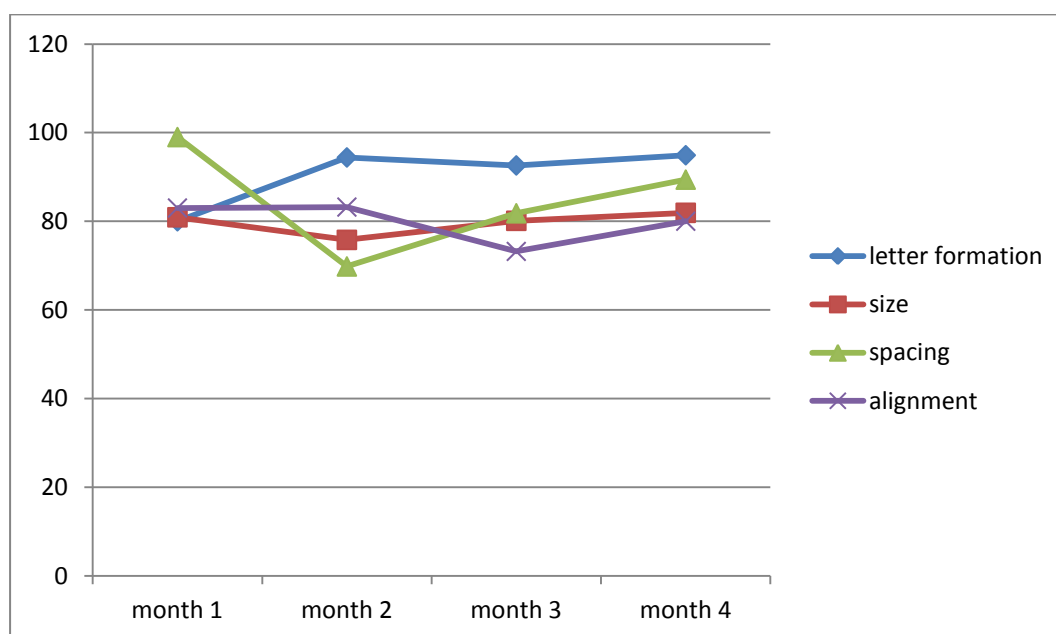
#### 5.2.4 Awa

In the data from Awa, age 40, the dynamic patterns of the elements are closely interwoven. From month one to month two, the factors of spacing and size both regress, while letter formation shows progress and alignment remains constant. But from month two to month four, letter formation remains fairly constant with a high output with slight fluctuations. Such a high and consistent performance would suggest that letter formation is once again acting as a precursor. It has developed first and has cleared the way for the interactions among the other three factors.

From month one to month three, spacing and alignment appear to be acting in opposition to each other, switching places at each of the three monthly stages. In that same time frame, the factor of size, while not fluctuating widely, exhibits the same patterns of regression and progression as spacing. These relationships in movement would characterize spacing and size as connected growers in the period from month one to month three, and the variable of alignment as a competitor during the same time.

An interesting aspect of Awa's data is seen in the developmental patterns and interactions of variables between months three and four. The patterns appear to be split, with two pairs of variables acting in parallel, specifically, letter formation and size showing quite small gains (2.3% and 1.8% respectively), and spacing and

alignment moving closely in parallel with larger gains (7.6% and 6.8% respectively). This is the first time in all the data seen thus far that split parallelism has been seen while the pairs have not been moving in opposition to each other. It may be posited that the first pair is almost static, allowing for greater focus and effort to be given to spacing and alignment. The data do still support the notion of two variables developing in tandem.



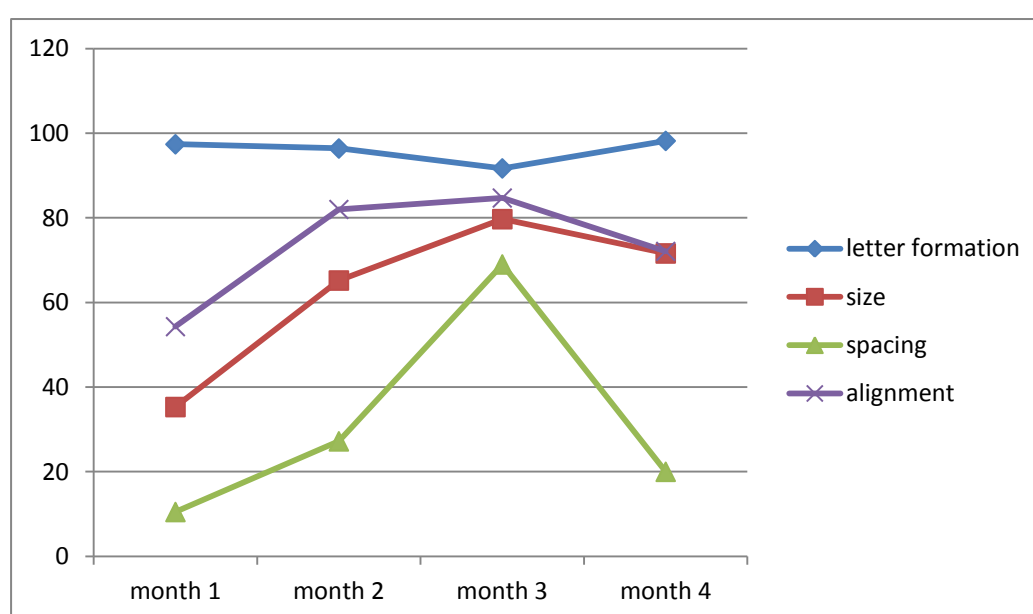
**Chart 15. Awa, age 40**

#### 5.2.5 Fana

In the data provided by Fana, age 52, the variable of letter formation functions as a precursor, beginning at a high level of performance and never falling out of the 90<sup>th</sup> percentile. It is still influenced moderately by the other three variables, regressing slightly when they progress in months two and three and rebounding in month four when the other three regress. Given this opposition, letter formation could also be interpreted as a competitor, but the consistently high level of performance provides stronger evidence for a precursor, albeit one which is influenced by the other variables to a lesser degree.

The variables of alignment, size and spacing act as connected growers, with alignment and size very closely connected in performance. Given such similar patterns of progression and regression, at admittedly different rates, it would appear that Fana is addressing three elements at once in her learning process. It should still be noted that spacing shows a greater degree of fluctuation in

performance and is the weakest of the influencing factors. This could suggest that alignment and size are acting as connected growers, with their close output in both percentage and in pattern, and the spacing variable is beginning to develop along the same lines. This would suggest a serial pattern of development, with no competitors, but a greater emphasis on two elements at a time. In this interpretation, letter formation is not viewed as a competitor, but is slightly influenced by the weight of the other three elements even though it is a well-established precursor. More will be said about the factor of spacing and probable influences on its performance in the conclusion to this section.



**Chart 16. Fana, age 52**

#### 5.2.6 Intra-individual comparison of performance by factor

In the preceding data for five individuals over a four-month period, letter formation performed highly and could be interpreted as a precursor, while still reacting to the other factors, in all five sets of data. In three of the five samples, the four components of the collective variable of interest split in half, with the variables reacting in pairs, collective growers to each other and competitors to the other pair. In one set of data, that of Awa, the initial pattern was of letter formation as precursor, spacing and size as connected growers, and alignment as competitor. An alternative interpretation of Awa's data for the first months could posit letter formation and alignment as connected growers, but in months three and four, letter formation and alignment as acting as connected growers in the first



months, but in months three and four, alignment and spacing act in parallel, as do letter formation and size, adding a fourth instance of the two-two split seen more clearly in the previous three data sets. The fifth set of data showed three of the variables, alignment, size and spacing, in similar patterns of development, but at varying percentage rates of output, while letter formation, though more firmly established as a precursor, reacted to the progressions and regressions of the other three factors slightly as a competitor.

In much the same way that letter formation is of interest in its consistently higher range of performance and role of precursor, the component of spacing merits special attention as the lowest performer in three out of the five data sets, specifically, those of Siata, Ami D and Fana. In a fourth set, that of Minata, the factor of spacing showed a significant drop in output for the fourth month, to end as the lowest variable, although previous performance had been higher. In Awa's data set, spacing displayed the largest range of performance but did not end as the lowest ranked element.

It may be posited that the factor of spacing is the most difficult to master because the criteria that determine its use become more complex as the writing level increases. At the level of writing individual letters, spacing is mastered by noting the end of one symbol and the beginning of the next, keeping spaces even, but at the word- and sentence-levels of writing, there is a higher cognitive interaction between the writer and what is written. The writer needs to determine where one unit of meaning ends and the next begins, and to use the component of spacing both appropriately and consistently – consistent both as to use and as to amount of space. This particular element of the collective variable of interest could perhaps be more accurately assessed by examining writing other than naturally-generated text, i.e. dictated words and phrases later in the writing process. As it is, this study is more focused on the interactions of all of the components as they emerge in the writing produced as a normal part of an adult literacy class than on the development of any single factor.

The factors of size and alignment develop in patterns similar to each other in four of the five sets of data, and as competitors in opposition to each other only in Awa's data. An incipient change in the relationship between size and alignment may be noted in Minata's data, but only in the fourth month, so a new pattern of

interaction had not yet been established in that data set by the end of the time span covered in the data.

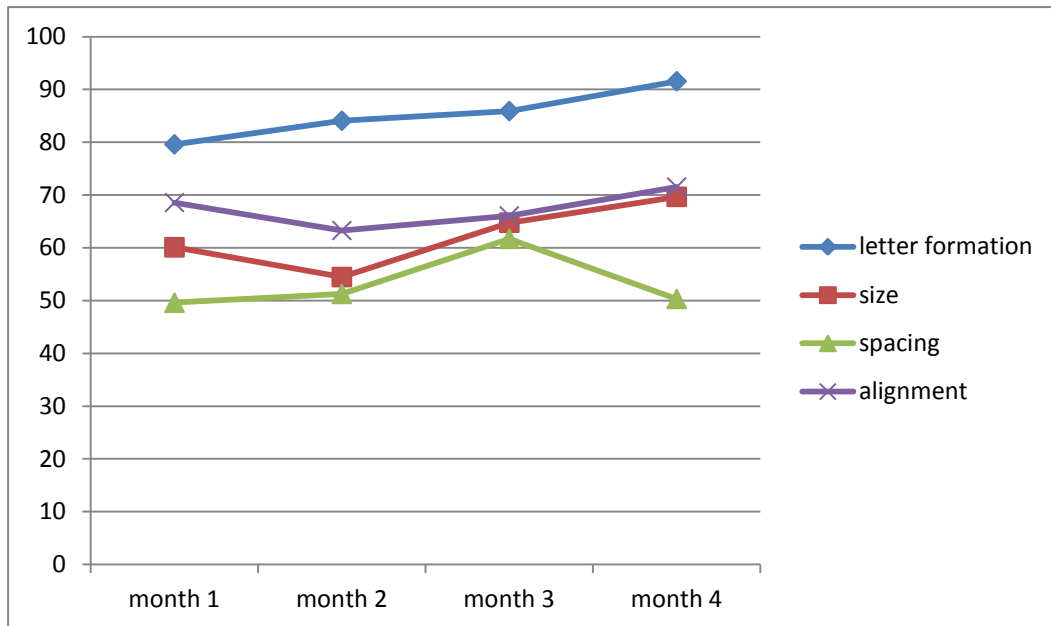
Table 6 gives a summary of the functions of the four variables seen in the four-month data. With the extra month available compared to the three-month data, greater variability can be seen in the interactions among the variables and in the resulting patterns. Where an alternative interpretation of the data is possible, that function is noted by a question mark. Where a new pattern is seen to emerge as variables shift in their relations and interactions over time, the new patterns are noted in a second section of the table, referred to as later-developing patterns. In one case, new interactions were exhibited in the last month of the time span of the available data. Those shifts are noted in the table by the number 4.

**Table 6. Factor functions, four-month data**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
11. Minata								
formation		x			x	4		
size			x			x4		
spacing		x					4	
alignment			x			x	4	
12. Siata					(no change in pattern)			
formation	x							
size		x						
spacing			x					
alignment	?	x						
13. Ami D.		(1-2)						
formation	?	x				x		
size		x					x	
spacing		x				x		
alignment		x	?				x	

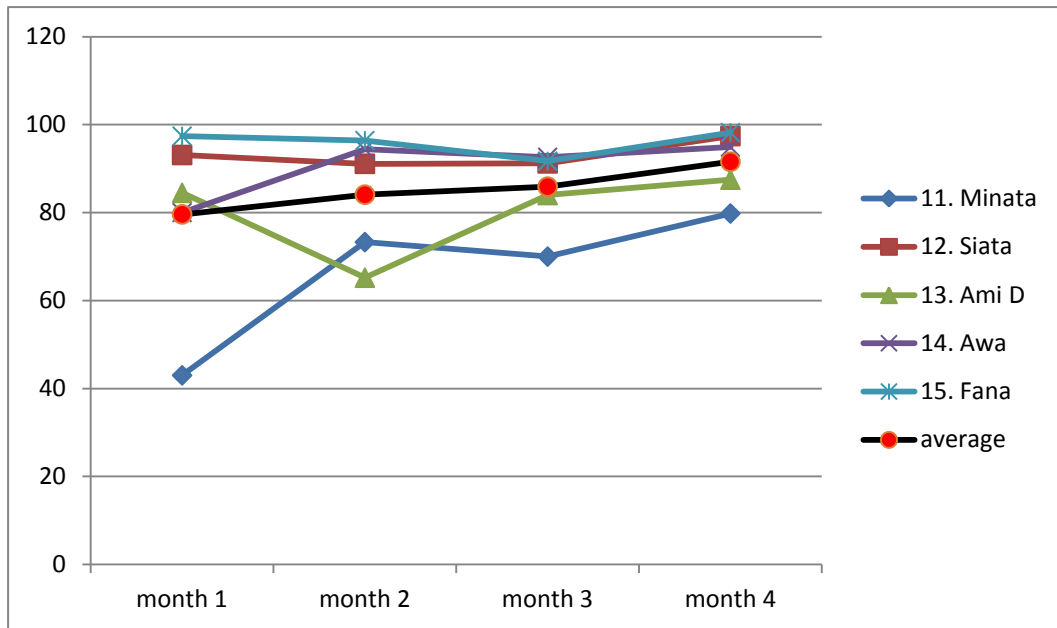
14. Awa								
formation	x				x			?
size		x						?
spacing		x				x		
alignment			x			x		
15. Fana					(no change in pattern)			
formation	x							
size		x						
spacing		?	?					
alignment		x						

From the above discussion of the functions of each of the variables, it is possible to consider the patterns which have developed in the five sets of data included in this time period. As was done for the data in the three-month time span, the percentages of output for all participants were averaged for each of the four components of the collective variable of interest. The averages were then charted as for each of the individual data sets above, the results of which are shown below in Chart 17. In it, the variable of letter formation is performing as a precursor, with alignment and size variables acting in concert as connected growers and the spacing variable performing with the lowest output, acting in opposition to the other variables in the first and fourth months, but in concert with them in the second and third months.



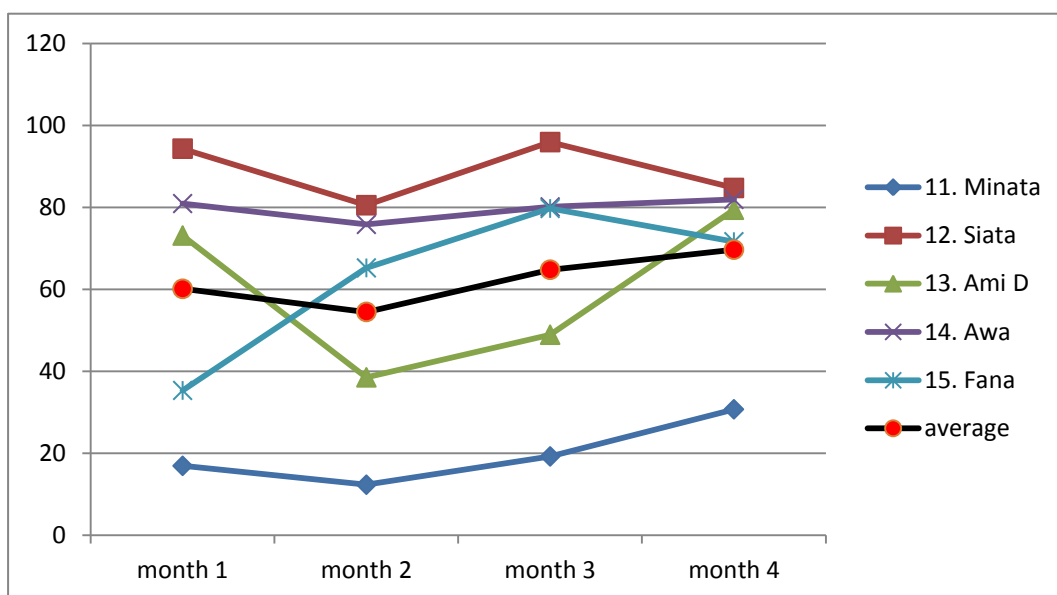
**Chart 17. Average of the collective variable of interest, four-month data**

Given the broad range of outputs and patterns of data among the five participants here, it is doubtful that such an average would be insightful for any but the variable of letter formation, of which the range of outputs and pattern of development were similar among the five sets of data. Chart 18, below, plots the outputs for the variable of letter formation for all five women in the four-month data group, with an additional line plotting the average of all five outputs. Minata's data begins at the lowest level of output for the group, but from month two, began to show a very similar pattern. Ami D.'s performance for letter formation showed a dip in month two, but by month three was back up over 80%. The patterns of development seen together here, in addition to the interactions with the other variables as discussed above, underscore the function of the variable of letter formation as a precursor.

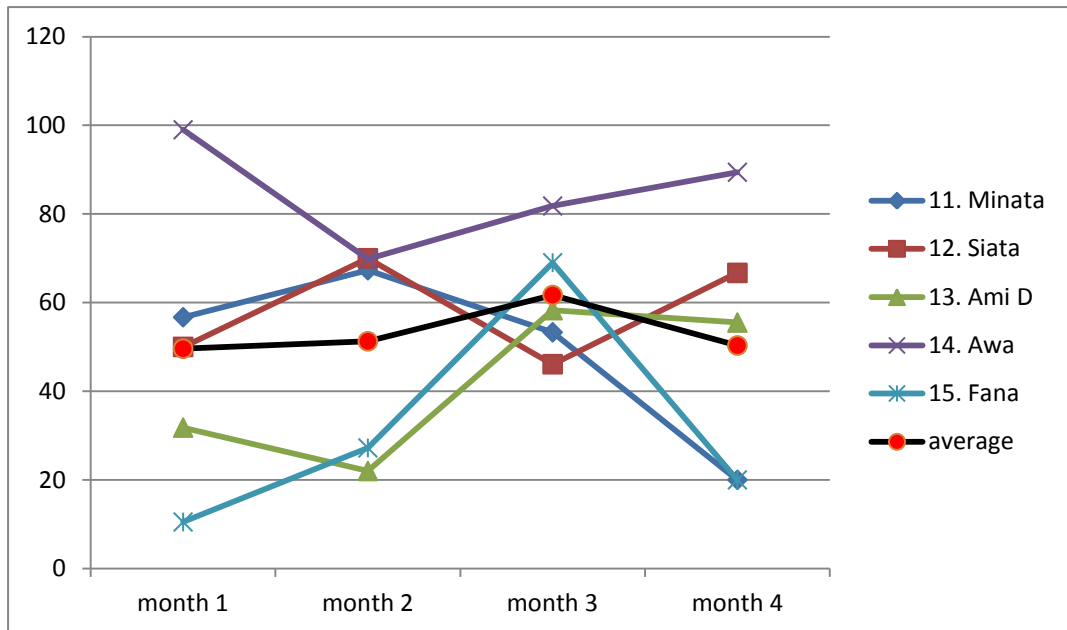


**Chart 18. Letter formation for four-month data with average**

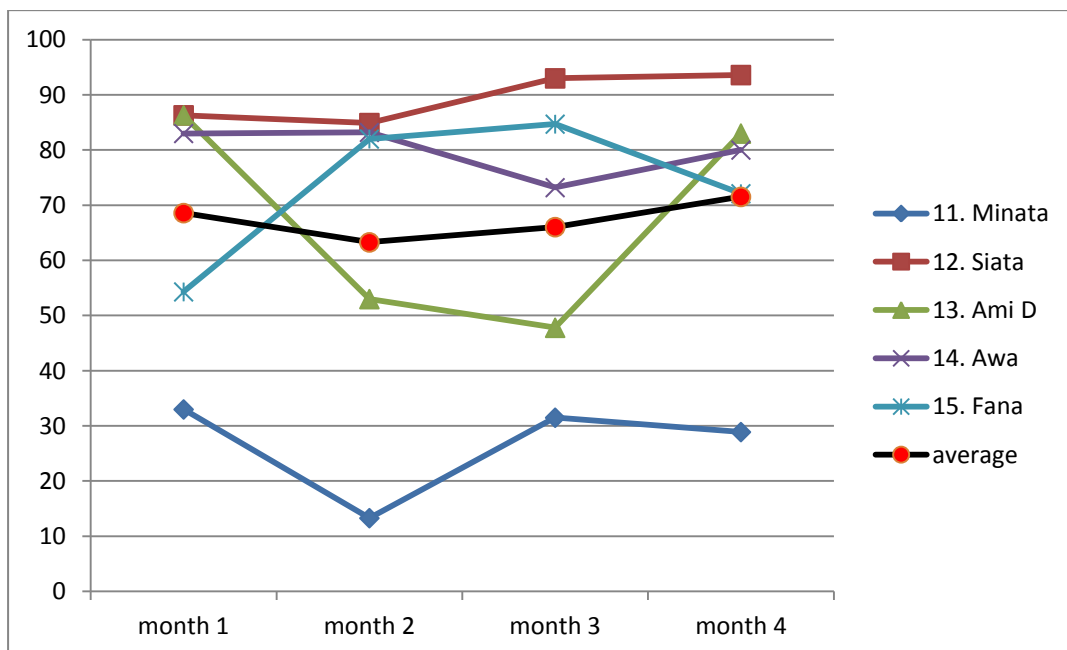
For the other three factors, the average may simply mask the interactions among the four variables which are the focus and the strength of a dynamic systems analysis. In charts 19, 20 and 21 which follow, the variables of size, spacing and alignment are plotted for all five women in the four-month data group with an average of the group measurements added to the line graphs. From these, it may be seen that, given the range of output and the divergence in patterns among the five women's data, an averaging of the outputs does not reflect the data well, nor would it aid in highlighting the interactions of the variables.



**Chart 19. Size for four-month data with average**



**Chart 20. Spacing for four-month data with average**



**Chart 21. Alignment for four-month data with average**

As was noted earlier, four out of the five data sets show the variables splitting to interact in pairs. The level of output of these pairings and the dynamics of their interactions varied with each individual, with, as previously mentioned, only letter formation showing any regularity and spacing performing with the lowest output in three data sets and ending lowest in the fourth month in another set. Even though the factors of alignment and size often are paired, any attempt to characterize the *patterns* of development of these two variables as consistent

across the data would be misleading. Examples of the differences in patterns of the two paired factors can be observed in the cases of Minata, Ami D. and Fana: alignment and size perform together, alignment output is slightly higher than size output, but the upward-opened arc seen in Ami's chart and the downward-facing arc in Fana's negate the usefulness of averaging to discover patterns in this case.

What may be discerned is a slight tendency toward a developmental order of letter formation, alignment, size, and then spacing, but the interaction among these elements and the variation within each individual mitigate against strong generalizations. It may be more useful to focus on the repeated performance of two variables interacting in tandem in the learning process in four of the data sets. Even in the fifth set, Fana's, the elements of alignment and size reacted more closely with each other in both pattern and output level than either of them did with either the element of letter formation or of spacing.

### ***5.3 Five- and six-month samples***

The five- and six-month time span data contain samples from five women between the ages of 34 and 59. As with the two preceding sections, each woman's writing has been evaluated for the four components of the collective variable of interest in accordance with the guidelines established in the chapter on methodology. The sections discussing data for each individual will be numbered consecutively beginning with 16, following on from the end of the section of four-month data, but the discussion of the data will continue to refer to the data set by the individual's name rather than the section number. The data for each participant is again discussed and represented by a chart of the progress of the four influencing factors at one-month intervals over the course of five months, and in the case of one participant, for six months. Attention is paid to the patterns exhibited in the data with respect to the roles of precursor, connected grower, competitor, or static variable, as well as to the interactions in the collective variable of interest at each stage. After this, the development of each of the variables is examined separately across the data of all five women, and possible emergent patterns are considered. The increased time span reflected in these data should reveal a greater range of interactions and patterns than previously seen.

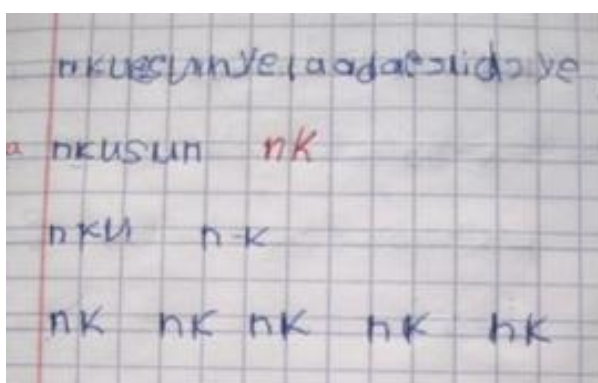
The full data samples, coded for the collective variable of interest and translated from the Bambara where pertinent, can be found in appendix C.

### 5.3.1 Koro

In the data from Koro, age 37, letter formation is shown to act as a precursor, with high output percentages, but still influenced by the progression and regression of the other factors. Size shows a similar pattern, but with a greater degree of divergence in linearity.

From month one to month three, the variables of size and alignment react in opposition to each other, so the latter is characterized as a competitor. From month three to month five however, the outputs of the factors of size and alignment are exactly the same except in month five, when there is a variance of 1.7 percentage points.

Again during the first three months, a particular pattern is discernible for the factor of spacing, which progresses and regresses with both letter formation and size and in opposing direction to alignment. From month three, spacing output diverges from that of size, continuing the regression begun in month two. This regression continues throughout the remainder of the time period. A look at Koro's subsequent writing confirms that the errors in spacing which cause the downturn for this variable occur predominantly in sentences. In the writing sample, the dictated phrase "Nkusun ye laada goli do ye" includes no breaks between words, but in the exercise for writing the letter cluster "nk", spacing is clearly evident.



*Phrase:*

nkusun ye laada goli do ye

*Translation:*

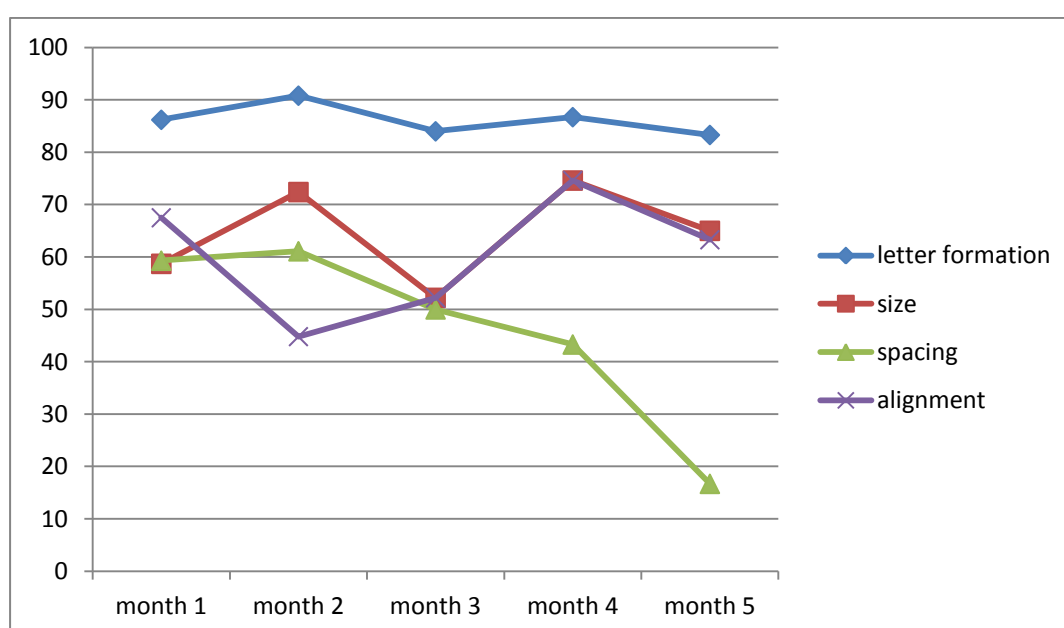
Nkusun (man's name) is normally [traditionally] the other goalie.

**Writing sample 2. Koro, month three**



As the writing exercises focused less on separate letters and syllables and more on meaningful phrases, Koro was not able to discern the breaks between meaningful units of letters so as to insert the proper spaces between words, which caused a steep decline in the pattern of the spacing variable. While the variable does mirror the pattern of regression shown in the other three variables from month four to month five, the regression here is much more pronounced, moving from 43.3% of spacing correct in month four to only 16.7% correct use of spacing in month five.

The additional month available in this set of data shows a general decline across three of the variables from month one to month five, and a regression in all four from month four to month five. As the six-month adult literacy class is drawing to a close, the difficulty of the material may be posing more of a challenge, or the weight of so many learning elements may mean more time and practice is needed to attain proficiency.

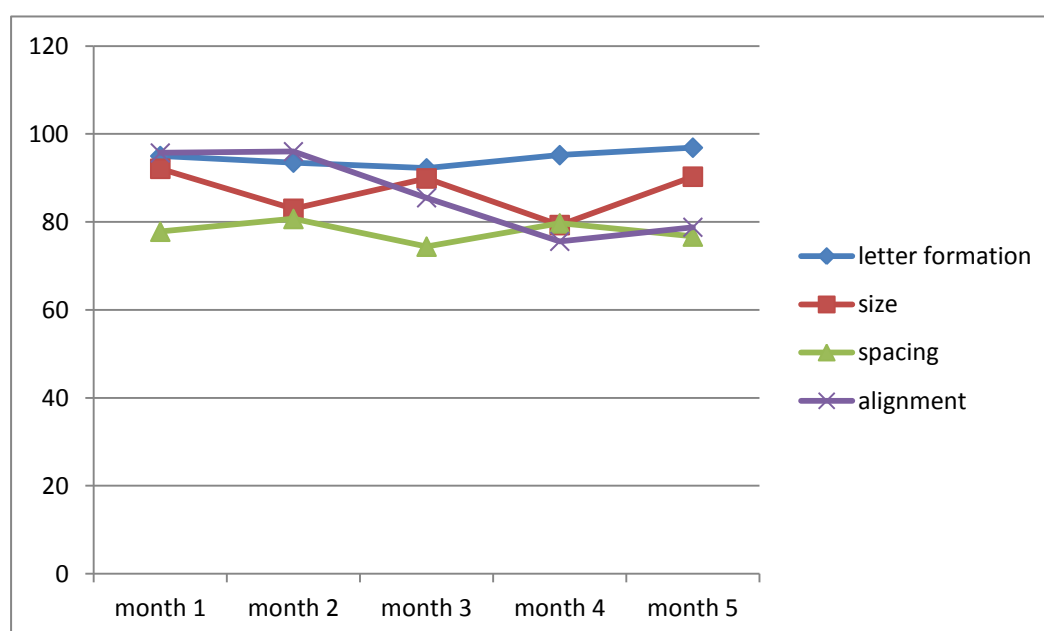


**Chart 22. Koro, age 37**

### 5.3.2 Ramatulaye

In the data from Ramatulaye, age 38, the interactions of the variables again change at month three to produce two separate patterns. The factor of letter formation has a high, consistent output and functions as a precursor throughout the time period. The interactions from month one to month three reveal alignment and spacing progressing and regressing in similar patterns and the size moving in the opposite direction as a competitor, but from month three to month five, size

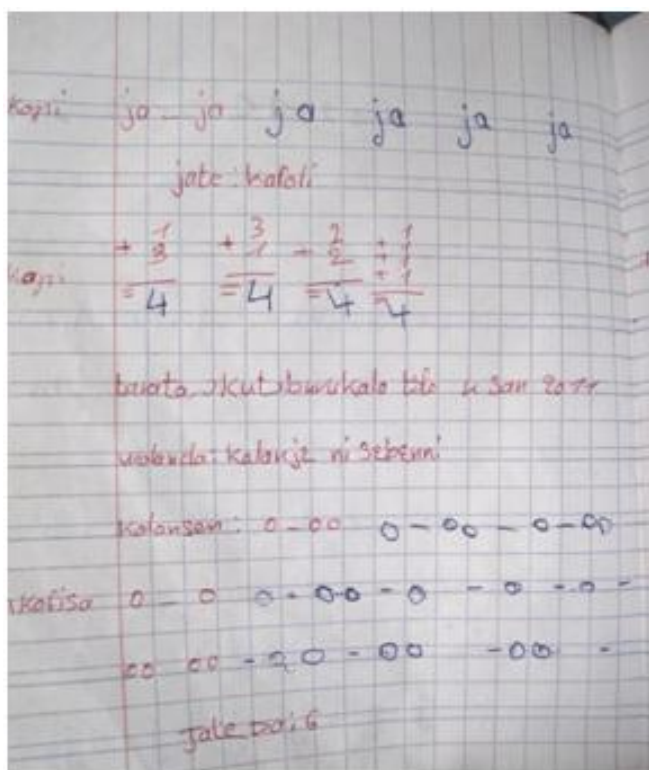
and alignment move in tandem while spacing acts as a competitor. It could also be said that size and spacing are in competition with each other throughout the entire five-month period, while alignment changes roles, in the first three months acting as a connected grower with spacing and in opposition to size, thereafter acting with the size as a connected grower, thus in competition to spacing. This second interpretation would leave a single element as a ‘connected grower’, which runs contrary to the concepts of connection and interaction among the variables at the heart of a dynamic systems analysis. It is mentioned here as a possible interpretation which would span the entire five-month period, but it is recognized that it would be problematic for incorporating the interactions of the variable of alignment.



**Chart 23. Ramatulaye, age 38**

### 5.3.3 Fanta

The data rendered by Fanta, age 50, show a much greater amount of modeling and help rendered by the facilitator on each page of the writing sample for the five-month span. It could be speculated that the age of the participant spurred a kind of cultural respect expressed as attention, but that is not borne out in the writing samples of participants older than Fanta. The additional help may have been required due to vision or motor skills (arthritis) challenges which cannot be determined from the data.

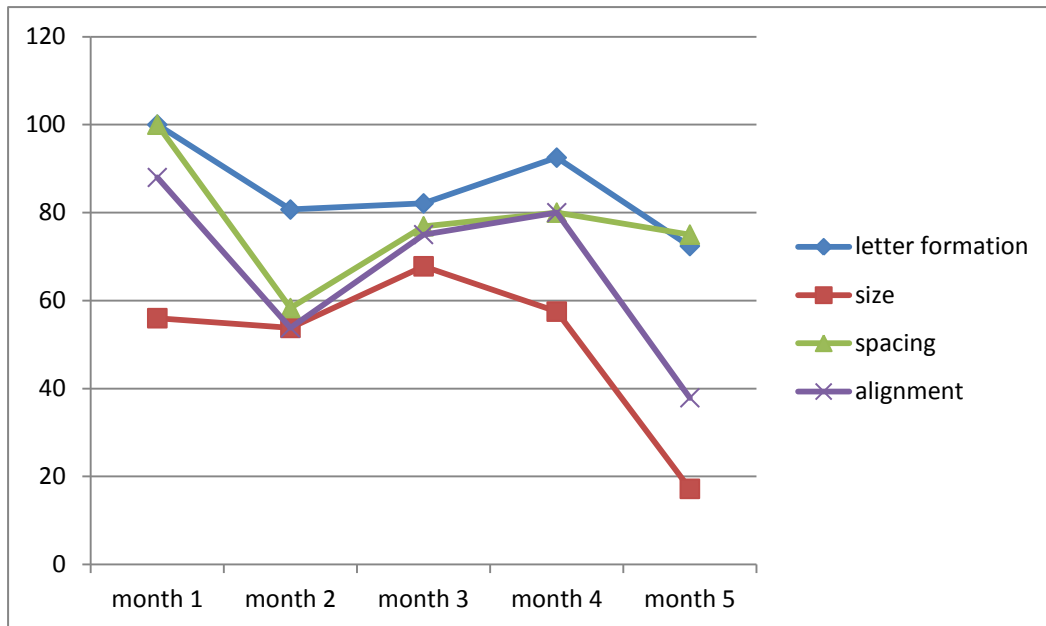


**Writing sample 3. Fanta, month two**

In this sample taken from month two, only the last four “ja” symbols, the solutions to the mathematical problems, and the “o – oo” exercise after the model on each new line were written by the learner. The class facilitator had written the rest of the lesson in red ink as a model for the learner to follow.

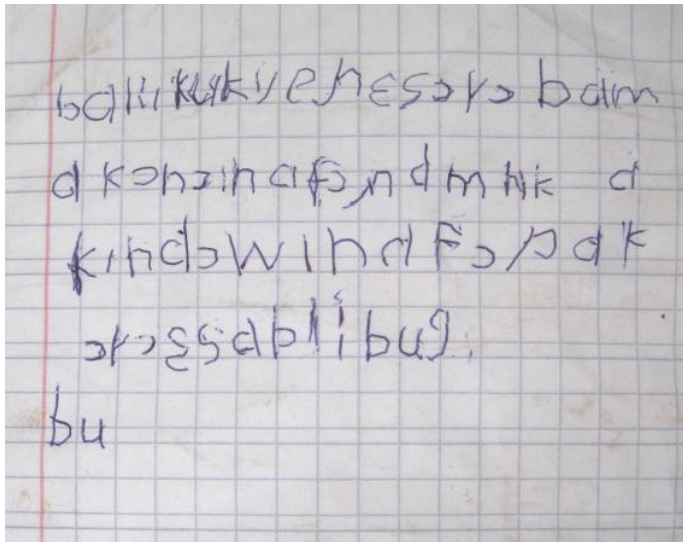
What may be seen in Fanta’s data is a developmental pattern in which the progression and regression of each of the components is comparable, if not parallel. Nevertheless, letter formation out-performs the other three factors over the time period, suggesting a possible precursor element to the learning sequence.

The proximity of output in both range and pattern for the variables of spacing and alignment are of note between months one and four, but from month four to month five, the regression of alignment and size are more closely analogous. It should be noted that Fanta’s writing samples consist largely of letter and syllable exercises, only including a meaningful phrase copied from the board (the date) for the first time in the fifth month. Fanta has not, up to this point, addressed a level of writing incorporating whole sentences, only letters, syllables, and words in isolation. This could explain the higher performance of the element of spacing in this data set. Still, the close correspondence of the patterns of development in all four variables is instructive. The factors of alignment and spacing react together, as in data seen in other participants, with the performance of alignment being just superior to that of size.



**Chart 24. Fanta, age 50**

As mentioned earlier, Fanta's writing sample does not include examples of sentences for the first four months. The data for month five includes an additional entry not yet considered in this part of the analysis. It consists of an attempt to write a sentence, a different compositional level of writing that is not otherwise included in the data. This example is shown in writing sample 4 below. In it, we see the regression of skills of letter formation, size, spacing and alignment as Fanta attempts to come to grips with the cognitive demands of self expression. Left-to-right orientation of the text is clear, but the written lines wander on the page. Letters are situated with less relationship to one another; some letters are partially or completely mal-formed. Three or perhaps four words can be discerned in the first line, but one continues to the second line without regard for the line break. After the first four words, the text disintegrates into random letters which do not correspond to the phonological or orthographical rules of the Bambara language. From the second line of the text, meaningful words are no longer discernible in the text and letter formation worsens.



baliku ye nesoro bam  
[line break] ako  
translation: adulthood  
was attained Bamako (“I  
grew up in Bamako.”)

#### Writing sample 4. Fanta, month five, first sentence

This writing sample is particularly significant in relation to the research question: Do illiterate adults in this language develop handwriting skills according to the same developmental steps as has been documented in children? Because the data for this study is drawn from an adult literacy class, certain expectations and awareness are already in place. The adult learners have an awareness of writing and its purpose. They have been intentional in signing up for a particular learning experience with their own motivations. The writing produced during class springs from a structured environment in which the facilitator is directing, or at least suggesting, the content to be produced. These issues by-pass the initial phases of writing development exhibited in children, as was discussed in chapter 2. For example, scribbling is not present in these writing samples, but because writing instruction is explicit in the classroom, it cannot be discerned whether these women might have passed through a ‘scribbling stage’ or not. The writing sample above exhibits the concepts of linearity and attempts at uniformity, as well as combinations of letters and some spacing, as corresponds to the fifth point in Deford’s proposed framework (1980:162). In the example of the adult learner above, meaning and intent to communicate is already associated with the act of writing, and so may be most closely associated with what Ferreiro referred to as the third level of development, during which the syllabic-alphabetic hypothesis comes into play: some letters represent sounds, but others may represent syllables or words (Ferreiro, 1990:20-25), as may be interpreted for the “d” and “k” written with spacing appropriate for words. Given that the data under analysis is taken at

the fifth month of the learning process for Fanta, this sample lends strong support to the concept that much of the developmental process of writing as it has been documented in children is similar in emerging-literate adults.

#### 5.3.4 *Tene*

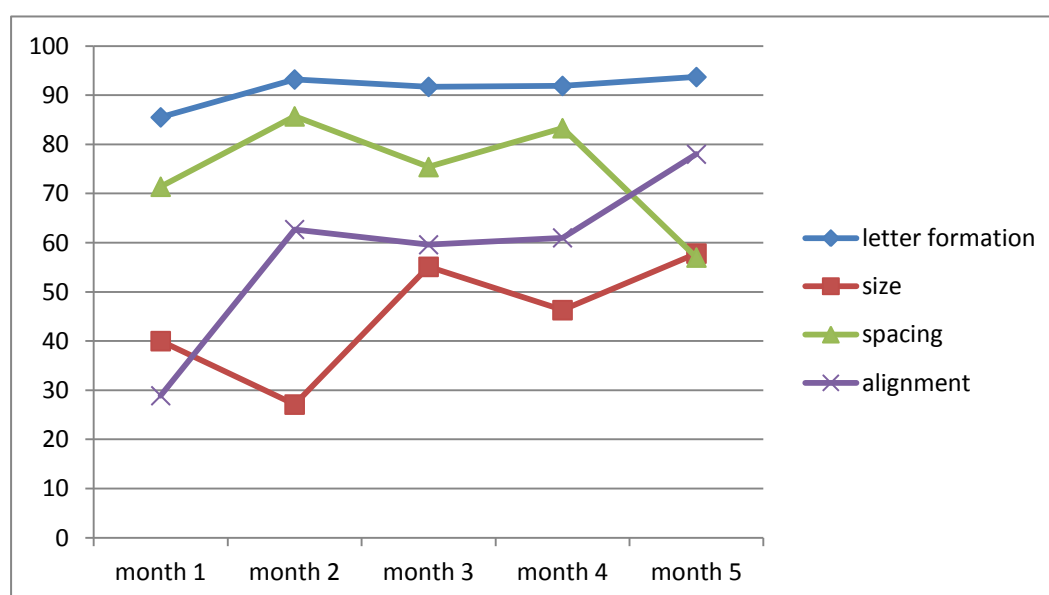
In the data from *Tene*, age 59, letter formation performs as a precursor, with some variation seemingly in response to the movement of the other variables. Spacing and size interact in opposition to each other throughout the five-month sample, but alignment shifts its function at various stages. From month one to three, it acts as a connected grower with spacing and with size as a competitor to both, but from then on it acts in opposition to spacing and as a connected grower with size.

From a more global perspective, it would be possible to correlate the variables of letter formation and alignment across the entire time span, characterizing them as connected growers with spacing and size in opposition to each other, but as for the previous data set, this view, while encompassing the entire time span, does not speak as clearly to the interactions seen in the collective variable of interest.

As in the preceding case, *Tene*'s writing sample does not include instances of whole sentences until month five, which probably accounts for the high performance level of the element of spacing here. The sudden drop in performance for spacing in month five is attributable to the presence of a dictated sentence in the writing for that month. This change in pattern reaffirms the supposition that the factor of spacing increases in difficulty as the level of composition progresses from letters and words in isolation to a meaningful text, in which the writer must determine the units of meaning, or words, as they record what is spoken in written form. This additional mental step adds a level of difficulty which precipitates a drop in the performance of the factor of spacing.

A look at the interaction of variables at monthly stages confirms the role of size as a competitor. From month one to month two, letter formation, spacing and alignment all progress, but size regresses. From month two to month three, the movement is reversed. From month three to month four, letter formation, spacing and alignment improve, while size declines in performance. Even though the movements of letter formation and alignment are marginal, they are consistent in direction with spacing until the transition from month four to month five, when

letter formation, alignment and size all progress, but spacing shows a marked regression. While this shift in pattern is partially explained by the increased complexity in the writing sample for that month, the drop in output for spacing does still seem to be correlated with progress for both size and alignment, the latter being marked. This reinforces the possibility that, in the presence of one element acting as a precursor, the predominant energy of the writer can be focused on two elements at any given time. If the level of difficulty rises for one element, causing a regression in output for that factor, there may be a corresponding increase in the developmental pattern of the other two elements. The notion that regression may indicate an *increase* in learning as demonstrated in these patterns is an important component in the field of dynamic systems analysis.



**Chart 25. Tene, age 59**

### 5.3.5 Kadjatou

The data from Kadjatou, age 34, provide the only example of writing samples submitted for all six months of the literacy class. Her data is included with the five-month data for the purpose of comparison. The writing sample clearly indicates that Kadjatou is not a debutant literacy student, but the data still show a developmental pattern among the four elements in the collective variable of interest. Letter formation is overall the highest performer of the variables and functions as a precursor to the development of the other elements as has been seen

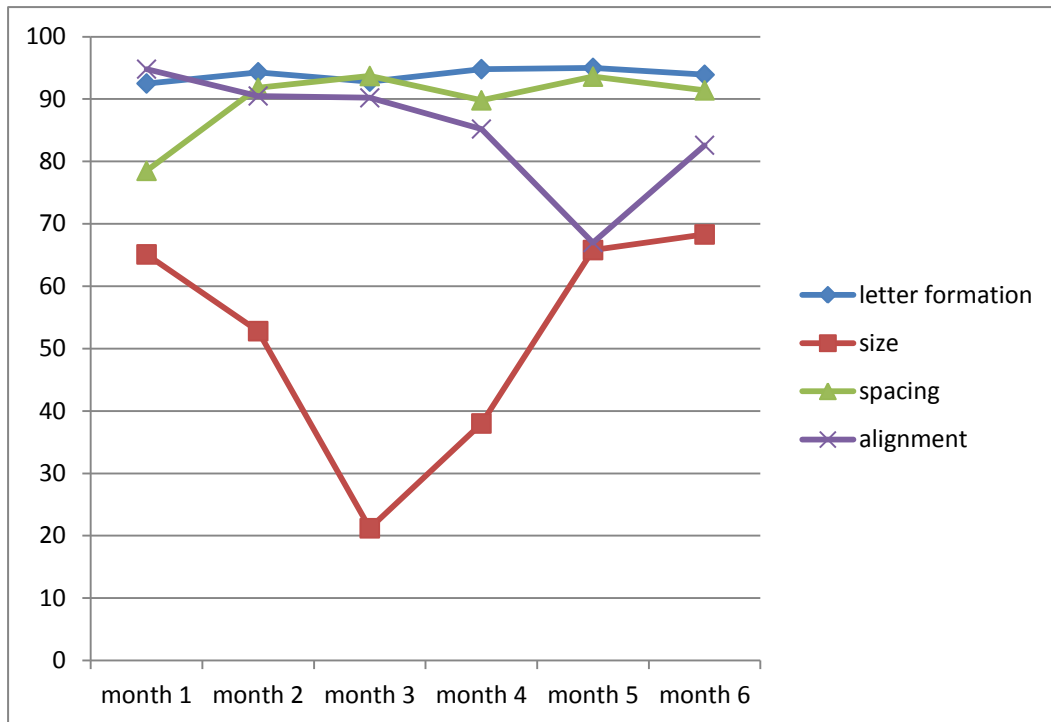
in previous cases. From there, the pattern characterization becomes more complex.

From month one to month two, the factors of letter formation and spacing progress, while the factors of alignment and size regress. From month two to month three, spacing again progresses, while letter formation, alignment and size regress. It would be possible to characterize alignment as static at this stage, with a change of only -0.3%. From month three to month four, letter formation and size progress, and spacing and alignment regress in a closely parallel configuration. From month four to month five, letter formation could be seen as static, with a progression of only 0.2%. Spacing and size both progress in the same time period, while alignment regresses. From month five to month six, letter formation and spacing both regress slightly, while alignment and size progress, though at differing rates.

In a more generalized characterization of movement over time, the factors of alignment and size react in opposing directions from month two to month five. Spacing and size react in opposing directions from month one to month four, but in a connected fashion from month four to month six. Spacing and alignment, therefore, act in similar patterns from month two to month four, and in opposing patterns from month four to month six.

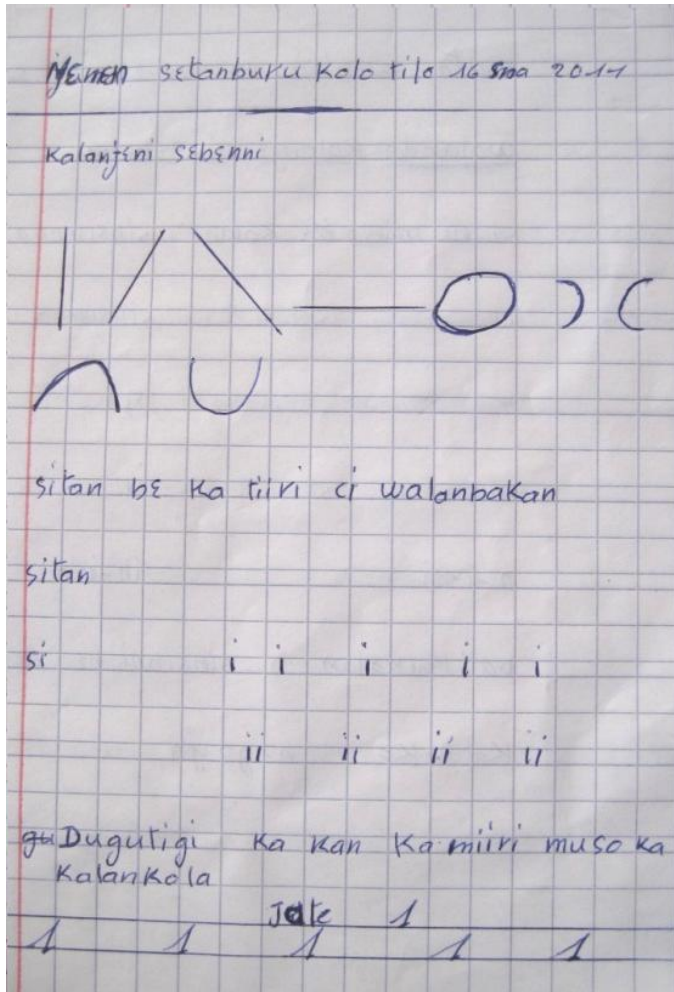
The variables, while switching functions more frequently than has been seen in shorter time periods, continue to interact in pairs, while suggesting an order of mastery beginning with letter formation, then spacing, followed by alignment, with size as the weakest performer.





**Chart 26. Kadjatou, age 34**

Kadjatou does not appear to struggle with the concept of spacing, but has chosen a standard of size for her writing that is very demanding, fitting into the smallest line spacing in the exercise notebook. The largest discrepancy in the development of size is largely due to an attempt to have every letter fit between those two lines, without discriminating between tall letters, short letters, or letters which extend beyond the baseline. In the writing sample below, taken from month one, this penchant for uniformity of size is particularly noticeable in the repeated use and size of the letter “k” in the last sentence, “Dugutigi ka kan ka miiri muso ka kalanko la.”



Ntēnen setanburu kalo tile 16  
san 2011

Monday, September month day  
16 year 2011

kalanjɛ ni sɛbɛnni - reading and  
writing

sitan bɛ ka tiiri ci walanba kan  
Sitan traces a line on the board.

Dugutigi ka kan ka miiri muso  
ka kalanko la.

The chief must think about  
women's study issues.

Jate – numbers

### Writing sample 5. Kadjatou, month one

#### 5.3.6 Intra-individual comparison of performance by factor

In this section, data from five women over five- and six-month periods have been examined for the collective variable of interest of letter formation, size, spacing and alignment. In each of the five writing samples, letter formation scored consistently higher than the others, acting as a precursor, while continuing to respond to interactions of the other three factors. Spacing, such a challenge to the four-month data group, was only problematic for two of the women in this group. Part of that performance was mitigated by a lack of meaningful text in the writing samples, but the patterns and interactions among the four factors continue to exemplify the phenomenon of progression in learning development in the presence of a regressive factor, as well as to demonstrate the increase in complexity of the variable of spacing at more meaningful text levels.

Three of the data sets, those of Koro, Tula and Tene, revealed a switch in factor functions, resulting in a change in pattern halfway through the time period. A fourth set, Kadjatou's, showed three different patterns over the six-month period covered by her data. In all four cases, the patterns showed letter formation as a precursor, accompanied by two connected growers and one competitor, with great variations in both range and direction of development.

A summary of the functions of the four variables seen in the five- to six-month data is given in Table 7. With the additional time available, greater variability was seen in the interactions among the variables and in the resulting patterns.

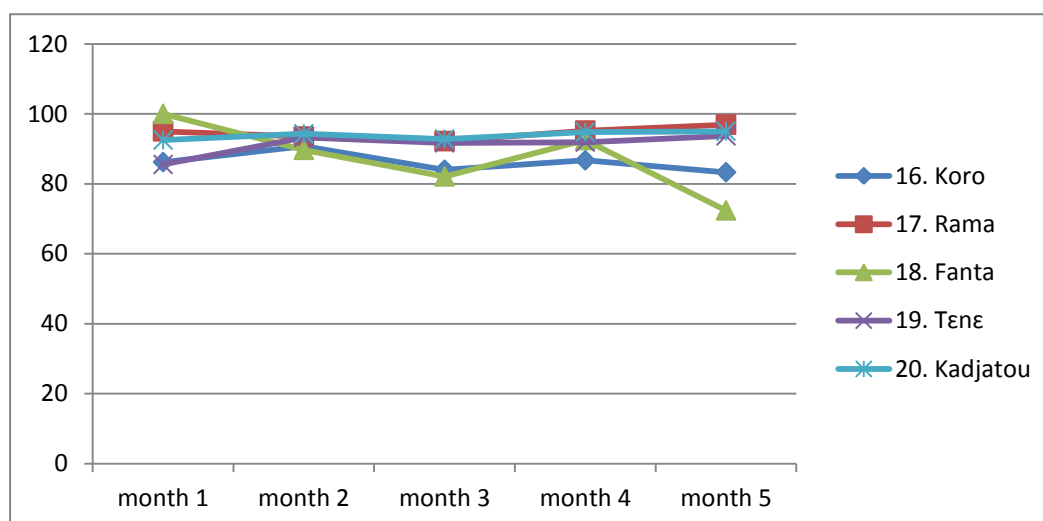
Where an alternative interpretation of the data is possible, that function is noted by a question mark. Where a new pattern is seen to emerge as variables shift in their relations and interactions over time, the new patterns are noted in a second section of the table, referred to as later-developing patterns. In one case, differing interactions are only exhibited in the first month. Those shifts are noted in the table by the numbers 1-2, as they no longer appear beyond month two.

**Table 7. Factor functions, five- to six-month data**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
16. Koro								
formation	x				x			
size		x				x		
spacing		x					x	
alignment			x			x		
17. Ramatulaye								
formation	x				x			
size			x			x		
spacing		x					x	
alignment		x				x		
18. Fanta					(no change in pattern)			
formation	?	x						
size		x						
spacing		x						

alignment		x						
19. Tene								
formation	x	?			x	?		
size			x			x		
spacing		x					x	
alignment		x				x		
20. Kadjatou								
formation	x		1-2		x			
size		1-2	x			x		
spacing		x	1-2			x		
alignment		1-2, x					x	

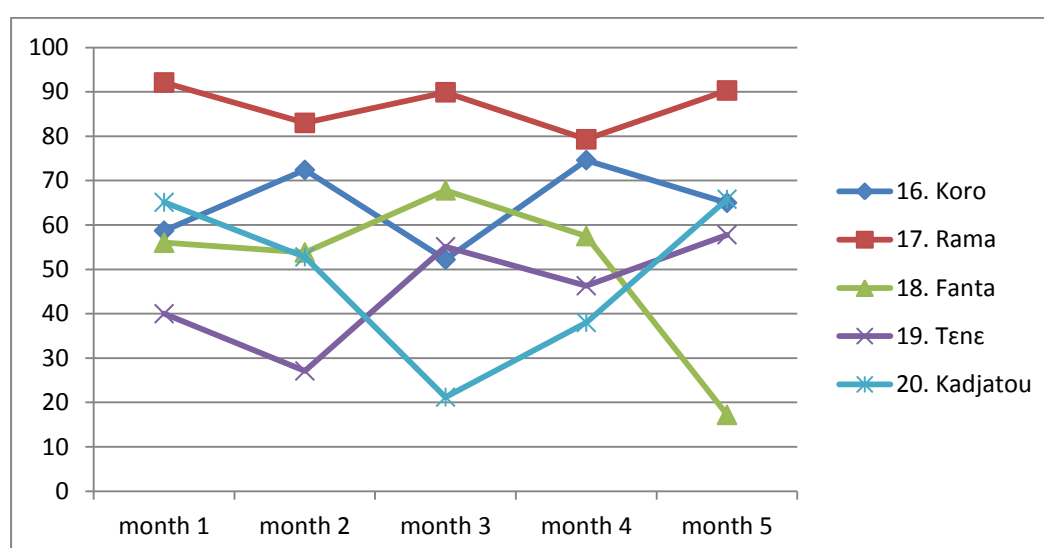
As was seen in the data from the four-month time span, the variation in the patterns from one participant to the next renders an averaging of the scores less than informative. That being said, if the factor of letter formation is considered alone, there is a striking similarity in the direction and patterns of all five sets of data, as may be seen in the chart below. These outputs again underscore the function of precursor of this variable for the five- to six-month data.



**Chart 27. Letter formation factor for five participants, five- to six-month data**

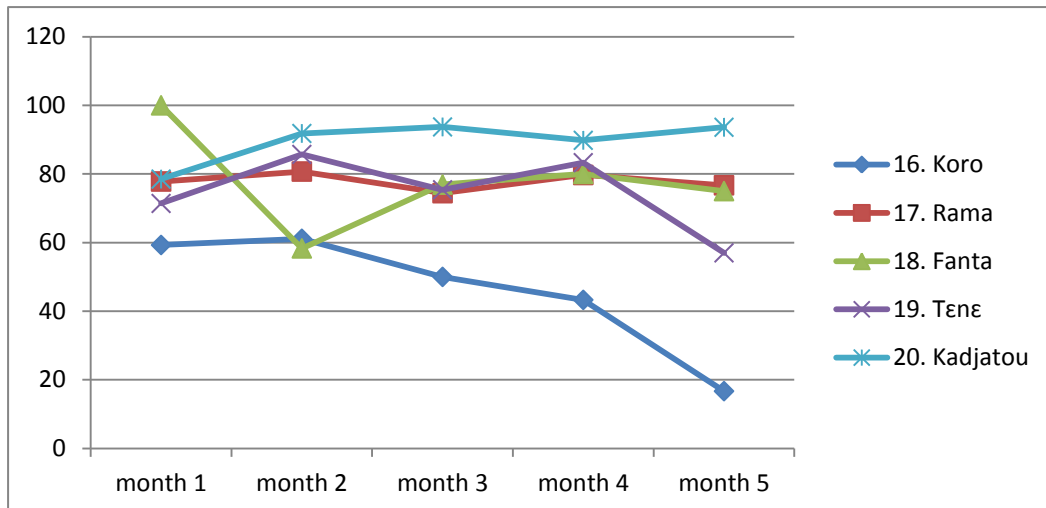
The wide divergence from any linearity of response in the other factors reveals no significant pattern of output from one participant to the next. The following charts represent each of the remaining three factors for all five women.

In chart 28 below, the output for the factor of size in the writing samples of all five women ranges from 92.1% to 40% in month one and from 90.3% to 17.2% in month five. In addition, the outputs of each of the five data sets can be seen to pattern in divergent manners. The patterns of data from Rama and Tene are similar, but they are in opposition to that seen in Koro's data. The data given by Fanta and Kadjatou are largely mirror images for this particular variable, but neither patterns with the other three. Thus there is no single consistent pattern of development for the factor of size among the five women.



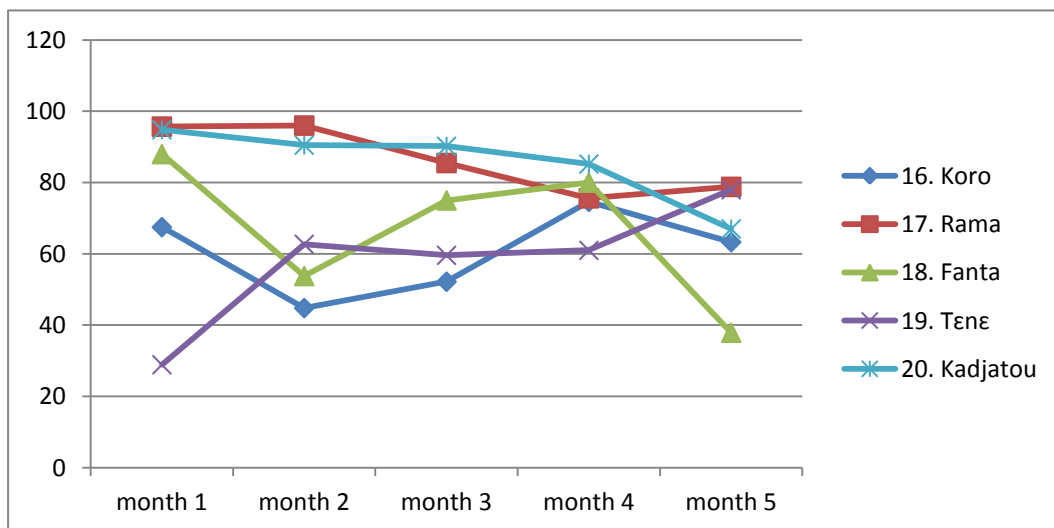
**Chart 28. Size factor for all five participants, five- to six-month data**

A greater similarity of pattern can be discerned for the variable of spacing, as summarized in chart 29, but the range of output, from between 100% and 59.3% in month one to between 93.6% and 16.7% in month five, again precludes any predominant trend. Seeking a generalization of pattern in this data set would diminish the dynamic interactions among this and the other three factors, in turn lessening the benefit to be drawn from the connections and exchanges of functions of all four factors in the development of the learning patterns.



**Chart 29. Spacing factor for all five participants, five- to six-month data**

In chart 30 below, the patterns formed by the factor of alignment, the range falls from between 95.7% to 28.9% in month one to between 78.8% and 37.9% in month five. But to characterize the overall trend as diminishing in performance would negate the progression shown in three of the individual learners' patterns. The value of the data is not found in any single factor, but in the interactions of all of the components of the collective variable of interest for each individual learner.



**Chart 30. Alignment factor for all five participants, five- to six-month data**

From the preceding discussion, it is seen that the separate factors do not develop along predictable lines. Even in the case of letter formation, which repeatedly acts as a precursor, its continued interactions with the other three elements, with the ensuing influence of the other factors on that precursor pattern, result in a high-performing element that is related to the overall pattern of the collective variable

of interest within the individual more than to any pattern created by a single factor seen inter-individually. In addition, the patterns created by data for each individual learner when considered as a whole do not reflect similar patterns that are consistent in variable function inter-individually.

The instructive aspect of the data lies at the points of interaction of the factors and the patterns formed by these interactions intra-individually. While no single, consistent pattern is apparent for all learners, certain developmental characteristics do emerge which may be informative for the learning process. The intra-individual consistency of an emergent pattern, very broadly of a precursor, two connected growers and one competitor element, indicates an organizational concept in the development of an overall learning pattern for all individuals. The functions of the variables continue to shift over time, so that it is not always, even within one individual, the same two variables acting together or in opposition throughout the whole time period, but the shifts in functions create new patterns in which two different variables interact as connected growers, while a previous connected grower takes on the role of competitor at a phase shift in the developmental pattern.

Even this broad generalization does not account for all individual cases in the data. Fana's emerging pattern showed three elements, size, spacing and alignment, acting in tandem and in an opposite direction to the precursor of letter formation, while Mama and Fanta both showed all four elements reacting in similar patterns of progression and regression throughout the data. But in seventeen of the twenty cases presented, the consistency of precursor, connected growers and competitor is evident.

According to dynamic systems theory, a shift in the function, interaction, progression or regression of one of the elements in the collective variable of interest may signal developmental change, or what may be referred to as learning. One of the instigators of change may be an increase in the complexity level of the task being addressed, as has been previously posited for the factor of spacing. In the four-month data group, it was noted that spacing performed more poorly in writing samples that included spacing within a sentence, as opposed to spacing between individual letter exercises. The inverse was noted in the five- and six-

month data group, in which spacing outputs were consistently higher in writing samples which did not yet include whole sentences.

#### ***5.4 Intra-individual performance at varying task-complexity levels***

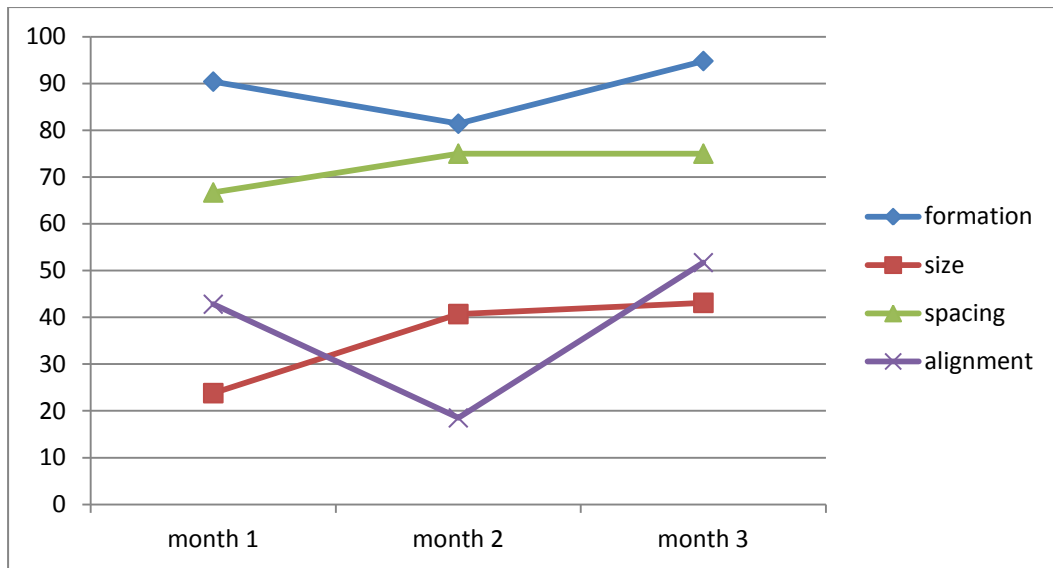
To investigate variable performance at varying levels of task complexity, nine data samples containing instances of three types of writing task were re-evaluated, the three tasks being: individual letters and words, text copied from the board and dictated texts. For the data of each of the women in this group, the writing samples were reassessed for each of these levels of differing complexity to investigate intra-individual pattern development for task level.

The group consists of two representatives from the three-month sample, two from the four-month sample, and all five of the members of the five- and six-month sample. For months in which a particular task was not included in the writing sample, the data was left blank for that task. A complete copy of all nine data samples, coded for the collective variable of interest at each of the three task levels and translated from the Bambara where pertinent, can be found in appendix D.

##### ***5.4.1 Assan, three month sample***

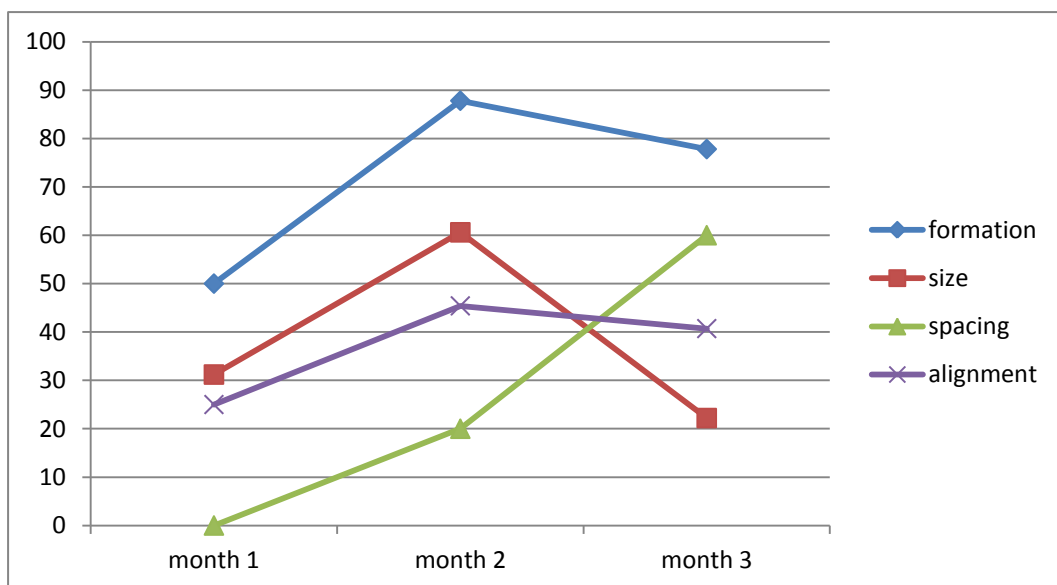
A reassessment of Assan's writing samples looking only at individual letter and word formation shows a clear pattern with letter formation as precursor, with size and spacing acting as connected growers. The variable of alignment is in competition with the connected growers, but mirrors the precursor element, creating a double-chevron and double-inverse-chevron pattern. The range of output for the collective variable is wide, showing a certain level of mastery for both letter formation and spacing between letters. The challenge for Assan at this stage and level of writing lies with spacing and alignment, which juggle with each other for focus and progress.





**Chart 31. Assan, letter complexity level**

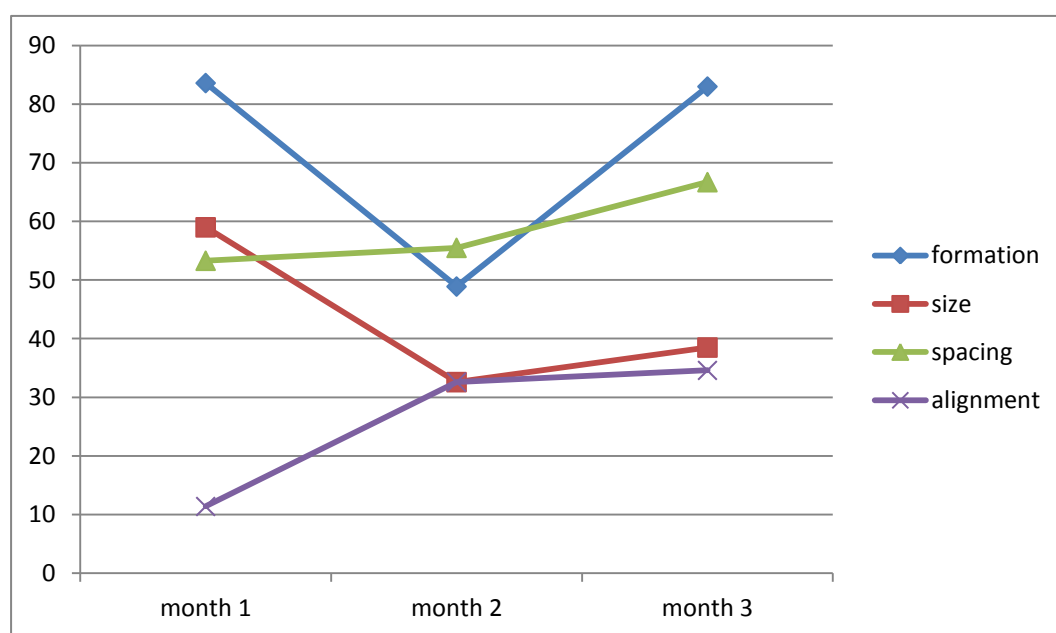
At the level of written text copied from the board, letter formation is again a precursor, out-performing the other factors, but in an overall pattern similar to both size and alignment. A significant drop in the initial output for spacing is seen, since at this level of complexity this element is evaluated in terms of word breaks instead of regular placement of individual letters in isolation or in syllables. Still, all four factors progress in the stage from month one to month two. The almost exact exchange in outputs between size and spacing from month two to month three would seem to indicate that these two elements are struggling for development, while alignment is mirroring the pattern of letter formation.



**Chart 32. Assan, copied text complexity level**

In dictated texts, Assan's data shows a decided dip in month two for letter formation. As she focuses on the demands of writing whole words and meaningful sentences, even dictated phrases which remove the need for her to pay attention to her own thoughts for self-expression, the skill of letter formation suddenly seems to be "unlearned." Through a DST lens of analysis, the interpretation is not one of forgetting, but of accomplishment in two other areas, those of spacing and alignment. After the sudden regression comes an equally sudden recovery, which might indicate that the element of letter formation is a true precursor, albeit still influenced by the gains and regressions of the other elements in the collective variable of interest.

Surprisingly, spacing does not pose a challenge for Assan at the level of dictated sentences. Size and alignment are the two elements which are struggling for development as Assan moves to more demanding levels of writing skills.



**Chart 33. Assan, dictated text complexity level**

It is interesting to note that the functions of the factors change as the complexity of the writing exercise changes, but the outputs of the elements of size and alignment are most closely paired in all three instances: in opposition in the first case of isolated letters, as connected growers in copied texts, and shifting from competitors to connected growers in the dictated text.

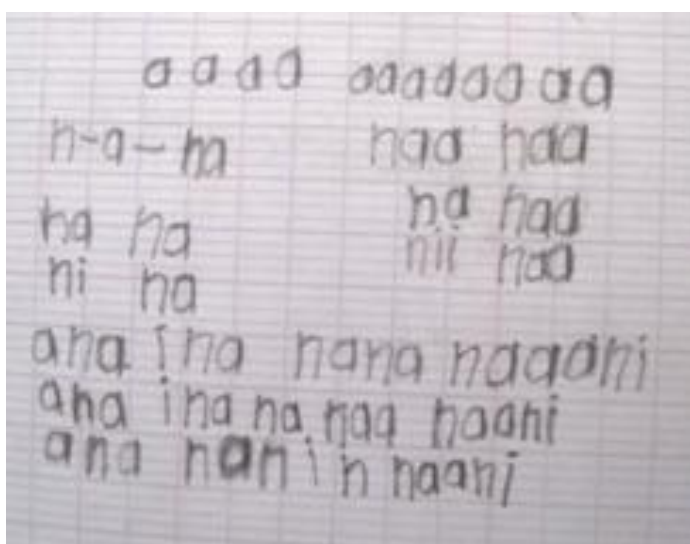
In table 8, the functions shown in the patterns of Assan's output for all three complexity levels are charted for easier comparison. At all three levels, letter formation may be functioning as a precursor. The other three elements reveal a pattern of interaction that varies between three connected growers and two connected growers with one competitor. Each of the three factors fulfills the function of competitor at a different level: at the letter complexity level, alignment is the competitor; at the copied text level, spacing becomes a competitor in a pattern shift, and at the dictation level, size is the competitor to spacing and alignment. The constants within Assan's developmental pattern are a precursor of letter formation function and the presence of one other element acting as a competitor at some point in the time span.

**Table 8. Factor functions for letter, copied and dictated texts – Assan**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
1. Assan – letter								
formation	x		?		(no change in pattern)			
size		x						
spacing		x						
alignment			x					
1. Assan - copied								
formation	x	?			x	?		
size		x				x		
spacing		x					x	
alignment		x				x		
1. Assan - dictation								
formation	?		?		?	?		
size			x			x		
spacing		x				x		
alignment		x				x		

#### 5.4.2 *Mai, three-month sample*

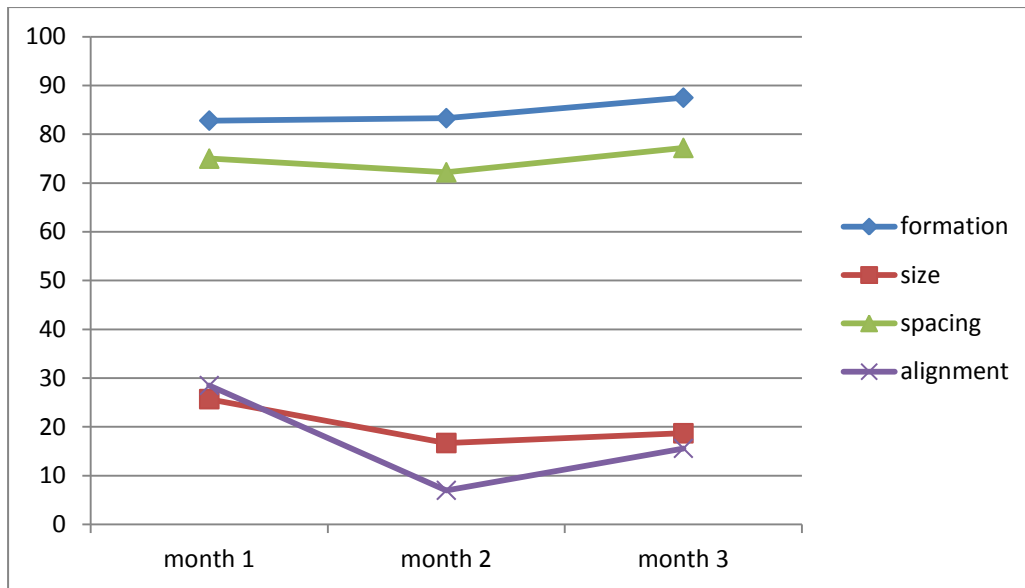
A focus on single-letter, isolated syllable and word production in Mai's data reveals letter formation in the precursor role, but paired closely with spacing. The factors of size and alignment are also paired, but not in opposition to letter formation and spacing, simply lagging farther behind in production. The excerpt from Mai's data for month three seen below in writing sample 6 demonstrates the relative ease of letter formation and spacing between letters as opposed to her struggles to master the size and alignment of those individual letters in her writing production. In this writing sample, the majority of the letters is in a recognizable form and spaced adequately, though there is still variation in the output for those factors.



More remarkable than letter formation or spacing in this sample is the variation in size and in the writer's ability to place letters consecutively on one line on the page of the exercise book.

#### **Writing sample 6. Mai, month three**

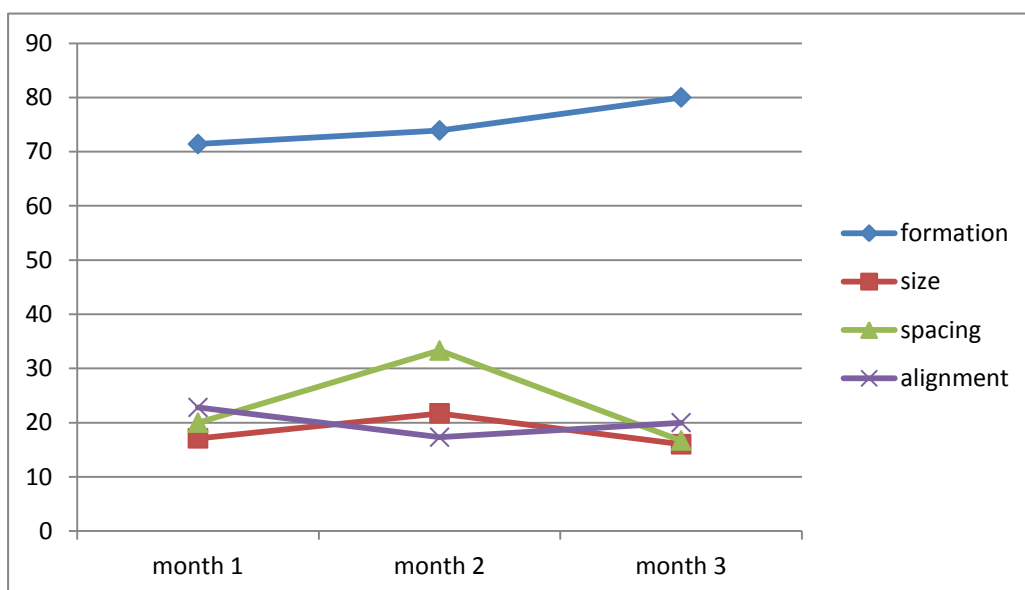
The chart below shows the interactions of all four elements of the collective variable of interest for the levels of single letters, syllables and words in Mai's data. The graphic form of the output illustrates the close pairings and patterning among the variables.



**Chart 34. Mai, letter complexity level**

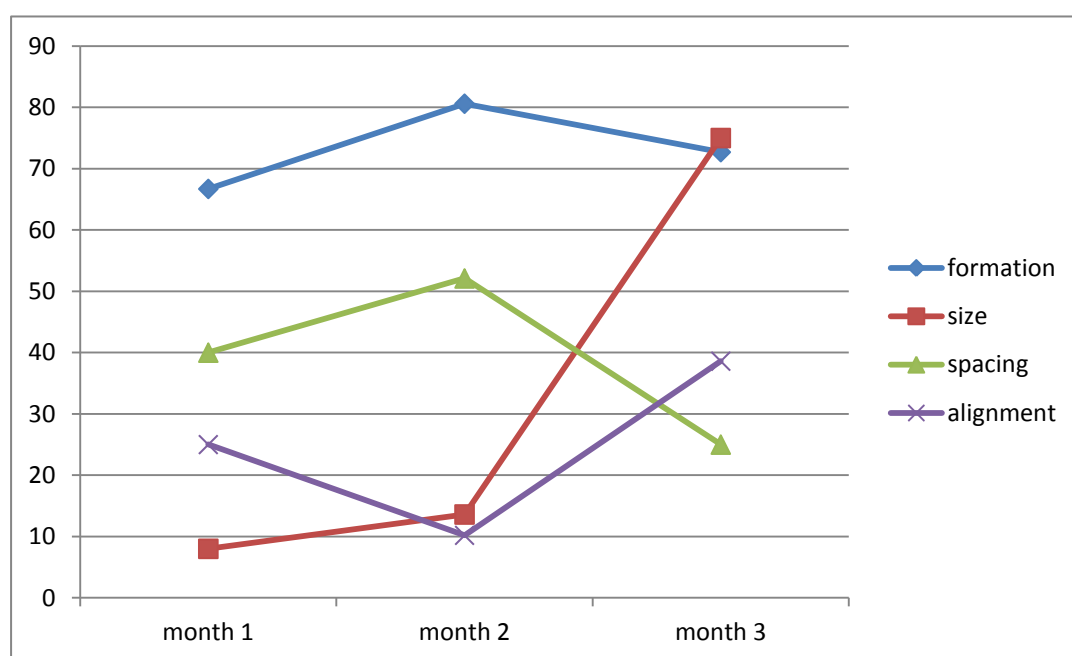
At the level of copied text, which addresses word breaks in phrases and sentences as opposed to words in isolation, Mai's data show a distinct drop in output for spacing. The performance of the letter formation factor continues to act as a precursor, though at a somewhat diminished output, from a range between 82.8% and 87.5% at the letter complexity level to between 71.4% and 80% for the same factor in copied text. This indicates a stability of the letter formation factor as a precursor even in more challenging writing tasks.

The factors of size and alignment are again closely paired in output, but in a competitor pattern, while spacing and size are patterning as connected growers.



**Chart 35. Mai, copied text complexity level**

It is at the level of dictated text that the greatest variety in output is seen in this individual. Letter formation continues to perform as a precursor, but the output, at 66.7%, 80.6% and 72.7% across the three month period, again shows a decrease in performance compared with the preceding levels. This decrease in output, coupled with greater divergence in linearity of the letter formation pattern, indicates a higher degree of difficulty for this complexity level. The pairing returns to an approximation of the patterning seen in the letter formation level, i.e. with letter formation and spacing variables acting together and size and alignment together in opposition to the first two, but the patterning shows the two pairs in a competitive relationship. The variable of size displays the widest divergence from linearity and the greatest leap in performance over the time span.



**Chart 36. Mai, dictated text complexity level**

As was seen in Assan's data, Mai's writing samples show letter formation in the role of precursor, as summarized in the table below. The rest of the data in this sample displays a growing diversity from one level to the next, with the remaining three factors growing together at the letter level, two connected growers and one competitor at the copied text level, and two connected growers and two competitors functioning at the dictation level. This increased variety in pattern suggests an increased struggle on the part of the learner at the higher levels of complexity.

**Table 9. Factor functions for letter, copied and dictated texts – Mai**

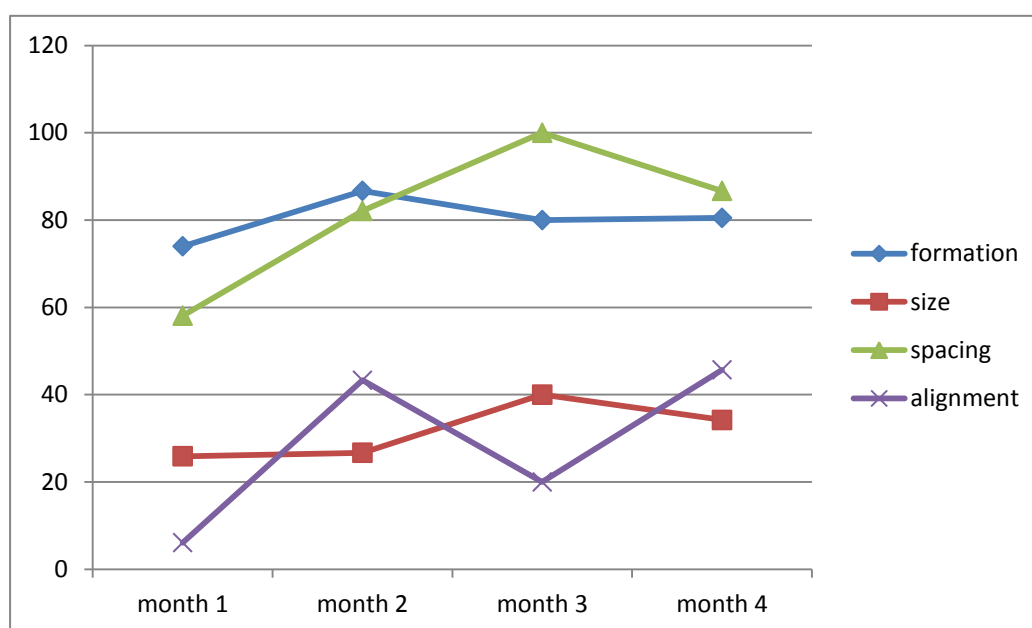
	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
3. Mai – letter								
formation	x	?						
size		x						
spacing		x						
alignment		x						
3. Mai - copied								
formation	x							
size		x						
spacing		x						
alignment			x					
3. Mai - dictation								
formation	x	?						
size			x					
spacing		x						
alignment			x					

#### 5.4.3 Minata, four-month sample

At the letter complexity level for Minata's four-month data sample, there is an interesting coupling of variables for range of output, with different pairings for pattern. All four variables show growth from month one to month two, albeit only from 25.9% to 26.7% for size, but the more telling patterning is seen across the whole four-month period, during which letter formation and alignment react in similar patterns (again, with only a slight increase for letter formation from month three to month four, from 80% to 80.5%) and spacing and size pattern together, but in opposition to letter formation and alignment. These opposing patterns can be further paired according to range of output, which puts letter formation and

spacing more closely paired in a competitive relationship and alignment and size closely paired as to percentage of output, also in a competitive relationship.

From this data, at the level of single letters and syllables and words in isolation, factors appear to develop in pairs and in competition. In addition, the factor of letter formation can be seen to function at a high output rate, though not as the highest among the factors. While it is not clearly functioning as a precursor, it does appear to be developing as one of the first two elements to be established in the emerging pattern.



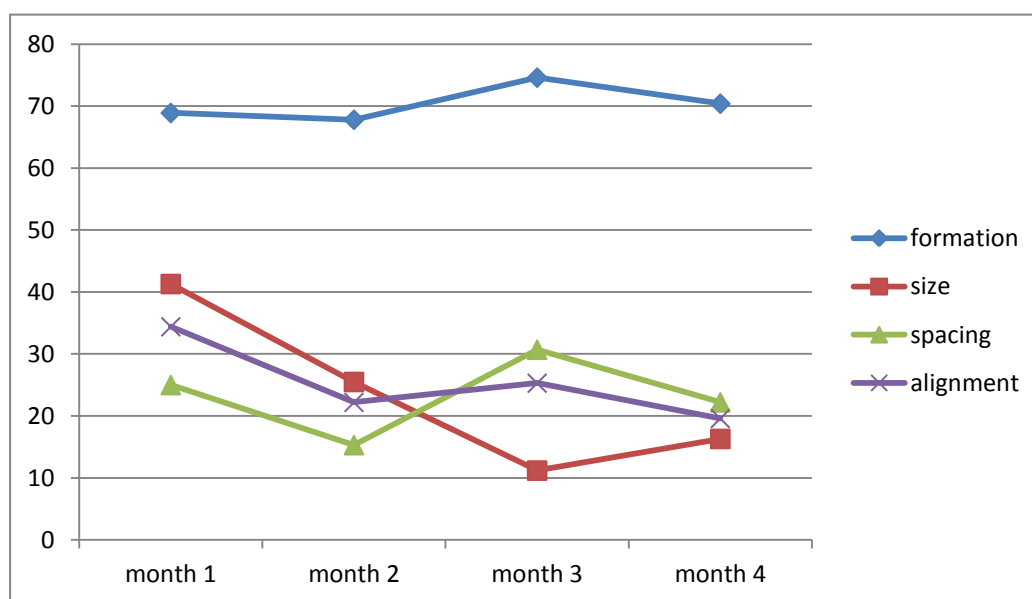
**Chart 37. Minata, letter complexity level**

In Minata's copied texts, the factor of spacing exhibits an extreme drop in performance as compared to the letter complexity level. At this next level of complexity, all four factors show a regression from month one to month two. Across the four-month time span, three of the four factors exhibit similar patterns of progression and regression, those of letter formation, alignment and spacing, but letter formation in this level of data shows a clearly superior performance as a precursor, while continuing to follow the same general directionality as that of alignment and spacing. From month two, the factors of spacing and size react as competitors to the patterns created by the outputs of the other two factors.

There is a further wrinkle in the pattern between months two and three, when the factors of alignment and spacing, which display similar patterns of regression and



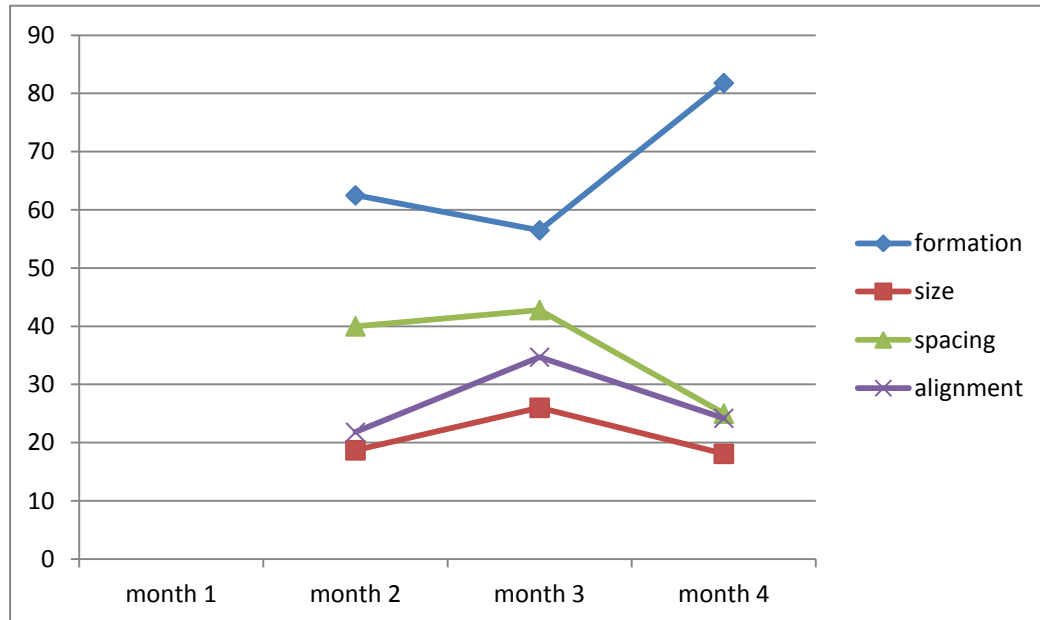
progression within similar range of output, switch position with each other in respect to percentage of output. In months one and two, alignment out-performs spacing, but in months three and four, the situation is reversed. From month two to month four, the factor of size forms an almost mirror-image to the factor of letter formation, at a remove of more than 40 percentage points, perhaps indicating that during this phase of learning the factors of spacing and alignment are in greater focus.



**Chart 38. Minata, copied text complexity level**

The charting of output for dictated texts (below) begins with month two, indicating missing data for month one. The factors at this level of complexity form a new pattern for this learner. Letter formation, though beginning at a lower level than displayed in previous complexity levels, is still performing as a precursor, in a competitive pattern to all three other factors. Letter formation regresses from month two to month three and progresses steeply from month three to month four. The other three factors progress from month two to month three, and decline in output from month three to month four, with the factor of spacing showing the steepest decline of the three from the third to the fourth months. The mirror-image rates shown by letter formation and spacing might suggest a closer interaction between those two variables, while alignment and spacing are closely paired in both pattern and percentage output. This would suggest again the concept of factors reacting in pairs in the learning process, but another

interpretation would show the precursor as competitor and the other three factors acting in tandem. Both interpretations can be instructive to the learning process and developmental order.



**Chart 39. Minata, dictated text complexity level**

As seen previously, Minata's developmental pattern across all three complexity levels reveals an inclination for letter formation to function as a precursor, but it shows a greater tendency for a shared function of connected grower among three elements concurrently at the levels of copied and dictated text. This pattern might suggest that Minata learns more by comparison of similarity than by contrast, with a tendency to coordinate all factors, even at a gradient of output level.

**Table 10. Factor functions for letter**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
11. Minata - letter								
formation	?	x						
size			x					
spacing			x					
alignment		x						

11. Minata - copied								
formation	x				x	?		
size		x					x	
spacing		x				x		
alignment		x				x		
11. Minata - dictation								
formation	x		?					
size		x						
spacing		x						
alignment		x						

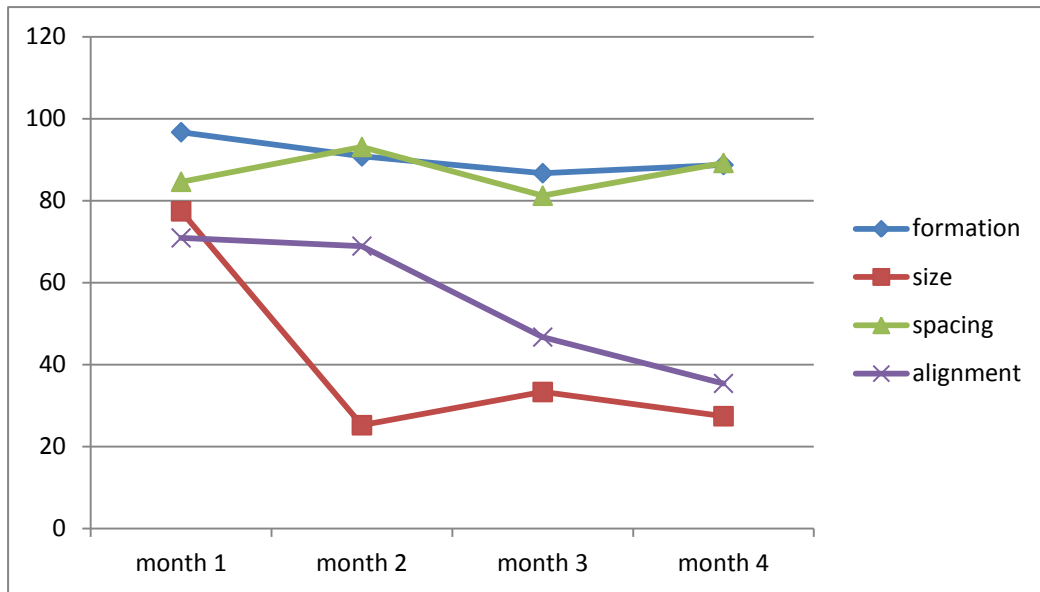
#### 5.4.4 Fana, four-month sample

In the four-month data from Fana, the results for letter formation begin with all four factors scoring above 70%. Whether this is influenced by the number of symbols (31 in month one and 87 in month two), perhaps causing fatigue in later lessons, cannot be determined from the data, but distinct patterns do emerge when the results are plotted. Letter formation, declining slightly, remains a precursor, while spacing and size are in competition throughout the four-month period.

Alignment and spacing are connected growers for months one through three, but from month three to month four, new relationships develop so that alignment and size act together and in an opposite direction to spacing and letter formation.

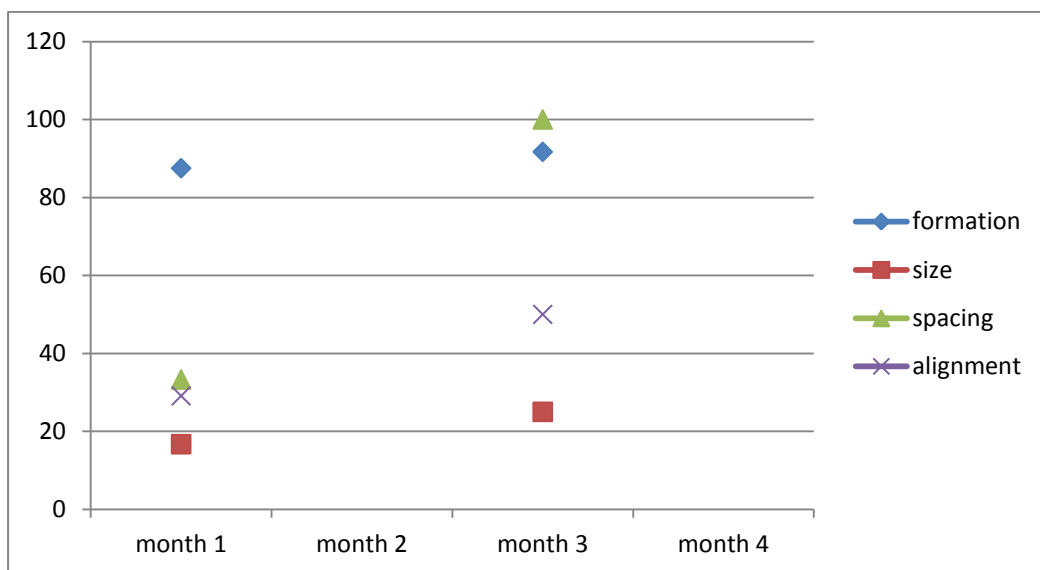
Based on the strength of the opposing patterns seen in spacing and size over time and the decline of alignment in that same period, it could be surmised that the two elements in focus for development are spacing and size, while letter formation is a precursor and alignment will play a more central role later in the learning process.

It is interesting to note that in the last month, the new pattern emerging is that of two pairs of elements with close percentage ranges and in opposite pattern directions to the other pair.



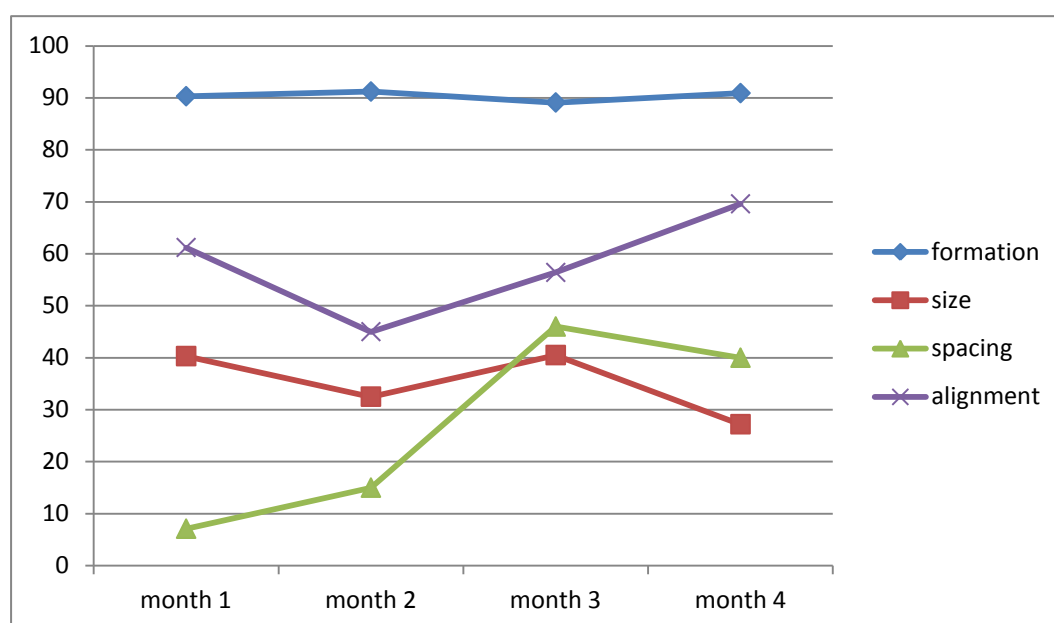
**Chart 40. Fana, letter complexity level**

Unfortunately for this study, Fana was not consistent in copying the material on the board into her exercise book. With only two months of data available for copied material from this study participant, nothing can be learned from pattern design. It can be noted, however, that from month one to month three (the only two months that had copied text in that data), output for all four variables move in a positive direction. Letter formation continues to have a high output and may be posited to have a precursor role, while spacing made an impressive leap forward. Alignment and size were the two trailing factors, most probably with spacing being the factor to need the most remedial work, or to need more time to develop.



**Chart 41. Fana, copied text complexity level**

For the complexity level of dictation, Fana's data show a very high and consistent level of output for the factor of letter formation, which once again acts as a precursor. For the other three variables, two patterns are at play over the four-month time period. From month one to month three, alignment and size act as connected growers. Spacing acts as a competitor from month one to month two, transitions to a connected grower from month two to month three, then from month three to month four, spacing and size are connected growers, actually in regression, while alignment, in a competitor role, progresses.



**Chart 42. Fana, dictated text complexity level**

A comparison of the patterns in the two levels of available data for Fana reveals letter formation again acting as a precursor at both levels. Chart 40 above (the letter complexity level) shows a shift in function, but not in the pattern of functions: letter formation continues as a precursor, with two connected growers and one competitor. In the complexity level of dictated text in chart 42, although the patterns themselves and the roles of the variables change, there are two variables in each of the patterns which act as connected growers and one as a competitor. These interactions are interpreted here as two patterns with a transition period instead of three patterns in which the phase from month two to month three is seen as three connected growers. This interpretation is preferable because of the proximity of output and similarity of pattern design between alignment and size for months one, two and three, the proximity of output and similarity of pattern design between spacing and size for months three to four, and

the growth of the variable of spacing from month two to month three, which surpasses that of size. These interactions create more of a transitional phase than a consistency of pattern among three factors. In these two levels, Fana shows a consistency in learning preference, or developmental pattern.

This patterning of functions among the variables may be more easily demonstrated in the following table. For letter formation, one variable consistently functions as a precursor, while two act as connected growers and one as a competitor. Even though the variables which fill those roles change, the pattern of interactions within the collective variable of interest has remained constant. The same patterns occur for the dictation level, with one precursor, two connected growers and one competitor, but here there is a transition phase from month two to month three as the factor of alignment shifts in function from connected grower to competitor.

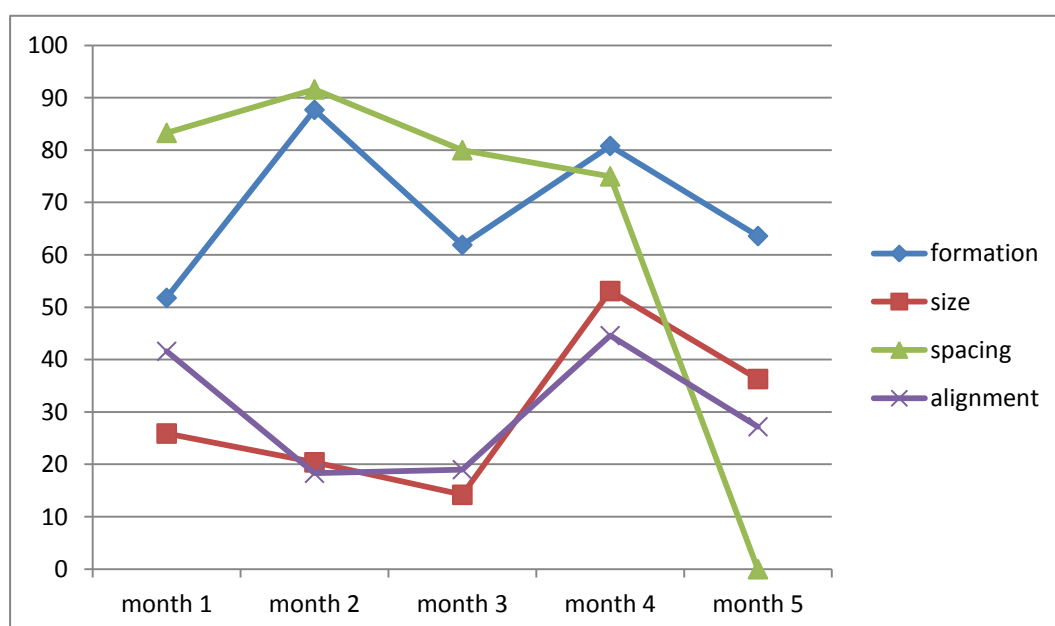
**Table 11. Factor functions for letter**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
15. Fana - letter					(months three and four)			
formation	x				x			
size			x			x		
spacing		x					x	
alignment		x				x		
15. Fana - copied	(gap in the data)							
formation	?							
size								
spacing								
alignment								
15. Fana - dictation	(months one to three)				(months two to four)			
formation	x			x	x			
size		x				x		
spacing			1-2			x		
alignment		x				2-3	3-4	

### 5.3.5 Koro, five-month sample

In the five-month data for letter complexity level from Koro, letter formation does not function as a precursor throughout, but it does emerge as the highest performing factor by the end of the learning period. It performs in a pattern similar to that of spacing and in an opposite direction from alignment and size for months one to three, and then transitions to run parallel and superior to alignment and spacing for months three to five. The period from month three to month four signals a transition for the variable of spacing, which bottoms out in month five. The strongest pattern similarity for this level of the data is between alignment and size, a relationship similar in both direction and percentage of performance throughout the full five months.

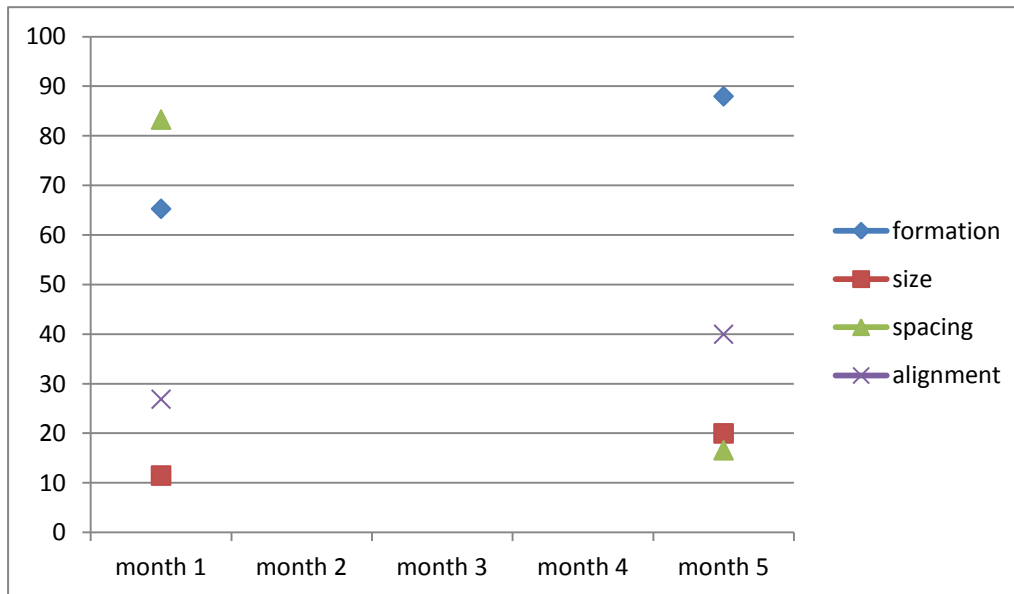
These interactions give two basic developmental patterns over the time period, one of two pairings in opposition to each other and one with all four factors which are in regression. Even in this last phase, it should be noted that the variable of letter formation has begun to out-perform the other three factors, and may be taking on a precursor role, but it has not yet, at the end of the five-month period, fully achieved such a function.



**Chart 43. Koro, letter complexity level**

The data for the level of complexity of copied text is only available for two of the five months in Koro's writing samples, so there are no patterns to be discerned

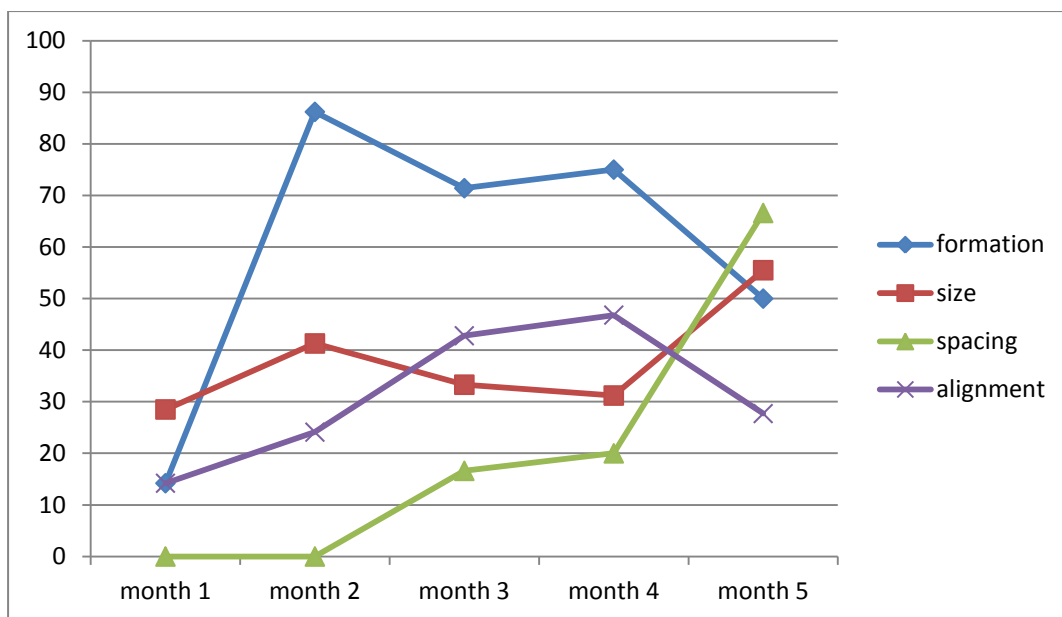
here. It can be noted, however, that spacing has again started strong then plummeted in its output, as in the letter complexity level data set, and that letter formation scored significantly above the other three factors in month five. The factors of alignment and size are again at the bottom of the table, but moving in tandem.



**Chart 44. Koro, copied text complexity level**

In Koro's data for dictated text, a wide divergence from linearity is seen over a broad range of performance in all four factors. The factor of letter formation is still not seen as a precursor throughout, in fact declining to third place in the fifth month. What is of note is the pattern similarity between the factors of alignment and spacing, which run in parallel from month one to month four. The factor of size reacts as a competitor to these two variables in months two through four, but all four elements move in a positive direction from month one to month two, and letter formation moves in parallel with alignment and spacing from month three to month four. At month four, a transition occurs, and from month four to month five, the factors of letter formation and alignment decline in parallel, while the factor of spacing and size progress, with spacing surpassing size in month five. In general, it is seen once again that there is significance in the pairing of elements in their development.

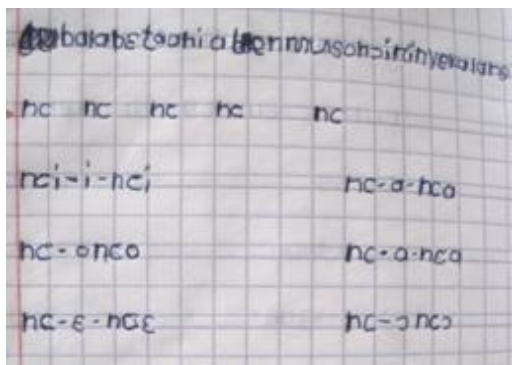




**Chart 45. Koro, dictated text complexity level**

To gain a different perspective on the transition in the patterns from month four to month five for the complexity level of dictated text, writing samples from months four and five in Koro's data are given below. In the writing sample from month four, there are samples of a dictated sentence and letter-syllable combinations. Only in the analysis of the dictated text do the outcomes of the four elements of the collective variable of interest result in a hierarchy of letter formation in the top position, followed by alignment, size, then spacing.

This outcome can be verified by a visual inspection of the sentence: letter formation, while not as clear as in the letter exercise following it, is identifiable for the majority of symbols and those symbols are, again for the most part, on the line in the exercise book. Letter size is more challenging, but it is clearly seen why spacing is ranked as the poorest output in dictated text, with only one space between words discernible in the entire phrase.



**Writing sample 7. Koro, month four**

*What is written:*

bala be taa ni a ben muso noirin ye kalans

*Correct phrase in Bambara:*

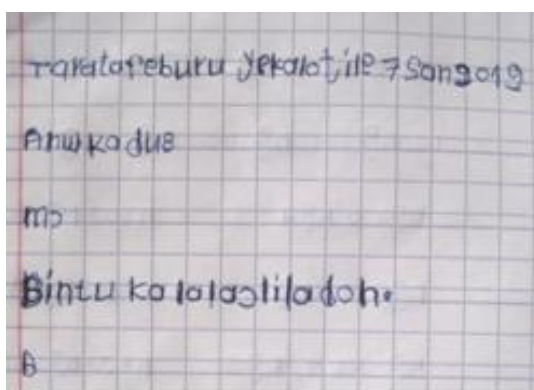
Bala be taa ni a be muso neon ye kalanso la.

*Translation:*

"The porcupine is going and it sees a female quill in the classroom."

(There was a pet porcupine in the room.)

In the writing sample for month five, examples are present for all three levels of complexity, with the day and date copied from the board, single letters and syllables, and a dictated sentence. Letter formation for the dictated phrase performed poorly due to letters being over-written, as well as several additions and substitutions in the word for school, “lakoli.” In such a short data sample, the errors of the repeated “la” in place of “k” show up noticeably in the percentage of output. Spacing between words was improved, as was relative size, as was shown in chart 45 above.



Tarata feburuye kalo tile 7 san 2012  
 Tuesday, February month day 7 year 2012  
 Anw ka duB (fragment)  
 “We must ...”  
*written:* Bintu ka lalaoliladon.  
*correct:* Bintu ka lakoli ladon  
*translation:* “Bintu must welcome school.”

#### **Writing sample 8. Koro, month five**

A comparison of the charting and the writing samples shows the merits of a charted analysis of factors to identify areas of challenge and of progress. Pin-pointing specific areas of growth and regression from a visual inspection of the writing sample is not as specifically instructive as is the chart analysis in this case, but a pairing of both gives a clearer picture of the learner’s performance.

In table 12 which follows, a variety and fluctuation in developmental pattern are observed at both complexity levels available in the data. As was seen in the writing sample from month five above, Koro continues to struggle with writing at the end of the learning period. A more structured presentation, with more opportunity to practice and develop greater automaticity in writing, might help Koro to develop learning patterns which would help her written output to improve.

**Table 12. Factor functions for letter, copied and dictated texts – Koro**

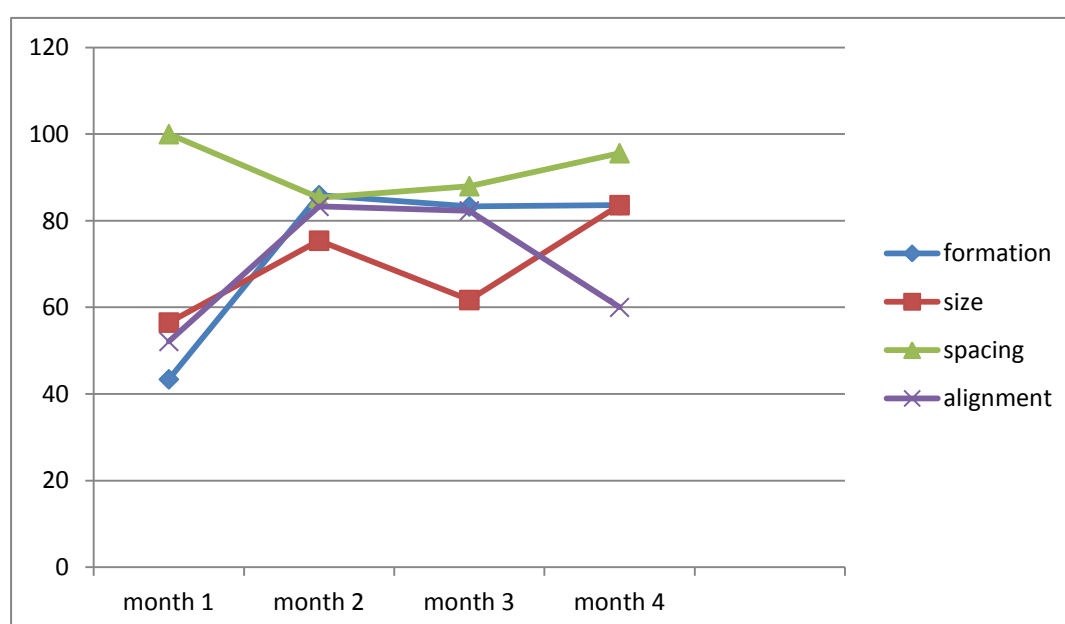
	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
16. Koro - letter	(months one to four)				(months four to five)			
formation	?		?		?	x		
size		x				x		
spacing			?			x		
alignment		x				x		
16. Koro - copied	(gap in the data)							
formation								
size								
spacing								
alignment								
16. Koro - dictation	(months one to four)				(months four and five)			
formation		1-2, 3-4	2-3				x	
size		1-2	2-4			x		
spacing		x				x		
alignment		x					x	

### 5.3.6 Ramatulaye

In the data given by Ramatulaye, there were no single letter or syllable exercises for month five, so this column of data was left blank. In the four months shown in this data set, two patterns emerge. From month one to month three, letter formation, alignment and size act as connected growers, though the decline in the performance of the factor of size from month two to month three is much greater and may indicate a lag in development behind the other two factors at this stage. The factor of spacing reacts as a competitor for these three months, indeed as a direct competitor with the factor of alignment for all four months. The stage from month three to month four shows a shift in functions of the variables. The

previously lagging factor of size changes roles and performance outputs with the factor of alignment, so that in this later phase, size is now acting as a connected grower with spacing, while alignment continues a competitive relationship with spacing. From month three, the factor of letter formation remains as a static factor.

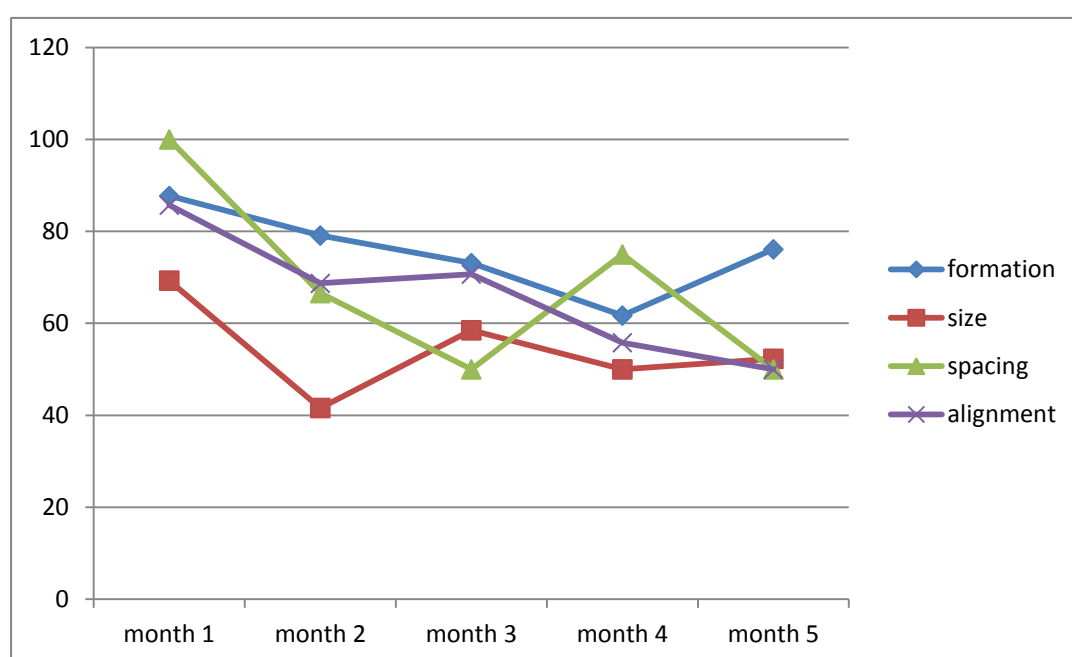
From these patterns, it is possible to reinforce the hypothesis of a preferred learning pattern with one variable preceding the others, in this case as a competitor more than a precursor, two variables relating in tandem, and one variable, while still interacting with the progressions and regressions of the other three elements, performing at a lower developmental level. Even when the functions of the factors shift, the number of variables fulfilling each role remains constant. This learner appears, at this level of complexity, to be focusing on two variables in her developmental pattern.



**Chart 46. Ramatulaye, letter complexity level**

In her copied texts, Ramatulaye struggles with the higher level of complexity. Overall, the trend in output is downward, but the interplay among the elements of the collective variable of interest reveals more than negative growth. The variables of alignment and size show similar patterns and increasingly closer levels of output until month five. The variable of spacing regresses in a manner consistent with that of size from month one to month two, but from month two to month five, it acts in competition with size. In a vagary of the automated charting

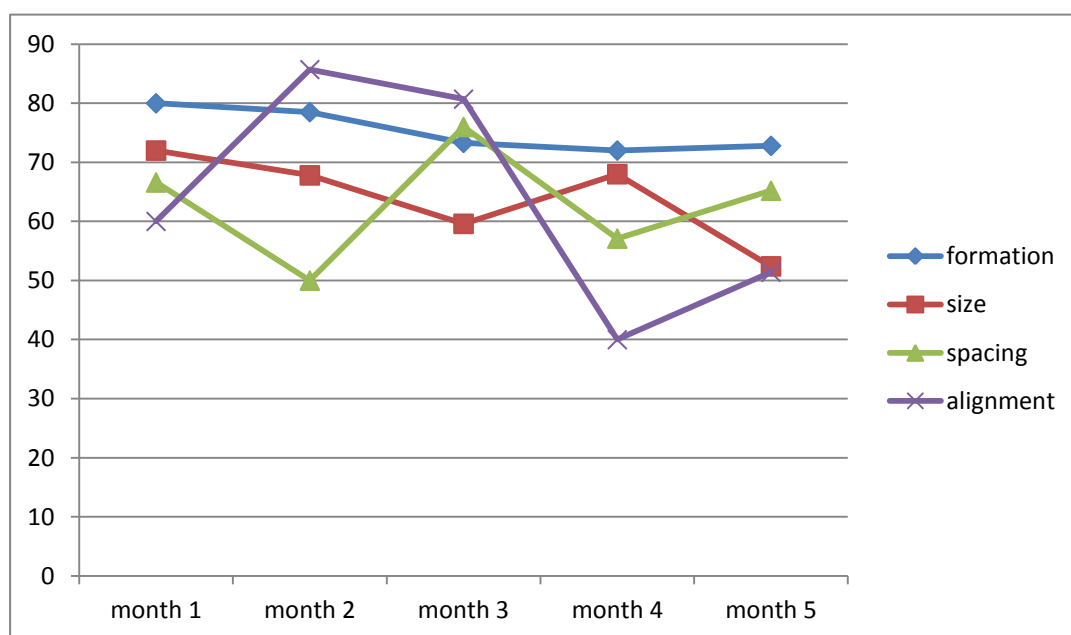
process, the line denoting the variable of spacing almost appears to have stepped on the line for alignment in month five, seeming to push it uncharacteristically out of a pattern which follows that of the size variable. The factor of letter formation, while ranking closely in performance with the other variables, shows a lesser degree of pattern similarity to the others. It can be characterized as reacting in close patterning with alignment from month one to month two, but from month two to month three, it regresses similarly to spacing, though at a higher performance level, then from month three to month five, interacting as a higher-performing connected grower with both size and alignment, in competition with spacing. This divergence at so many different stages may indicate a strength of performance as the factor struggles to function as a rather weak precursor. Across the five-month period, it is out-performed only twice, each time by the factor of spacing.



**Chart 47. Ramatulaye, copied text complexity level**

At the complexity level of dictated text, new interactions and patterns emerge, the most dramatic being between the variables of alignment and spacing. Between these two factors, two patterns appear over the five-month period: competition from month one to month three, and connected growth from month three to month five. In these same blocks of time, letter formation and size react together until month three, but in a gradual regression that is first contrary to alignment and in complementarity to spacing from month one to month two, then in opposition to

spacing and in harmony with alignment from month two to month three. It would appear that the variables are paired in their interactions, but the reactions of one set of factors do not interact closely with the other set. At month three, the pairing of letter formation and size is dissolved, as letter formation appears to function more as an established precursor, or at least as a static variable. Size, from month three to month five, becomes a competitor to the two variables of spacing and alignment.



**Chart 48. Ramatulaye, dictated text complexity level**

In all three complexity levels summarized in the table below, Ramatulaye shows a shift in pattern at a mid-point (month three for dictated text and copied text, but with a transitional phase from month two to month three in the four-month data available for letter complexity). In the first half of the learning period, three factors are frequently in connection, while in the second half, two factors are more likely to be reacting together. This might be related to the struggle of letter formation to achieve a precursor or static role, as is accomplished in the second phase of patterning.

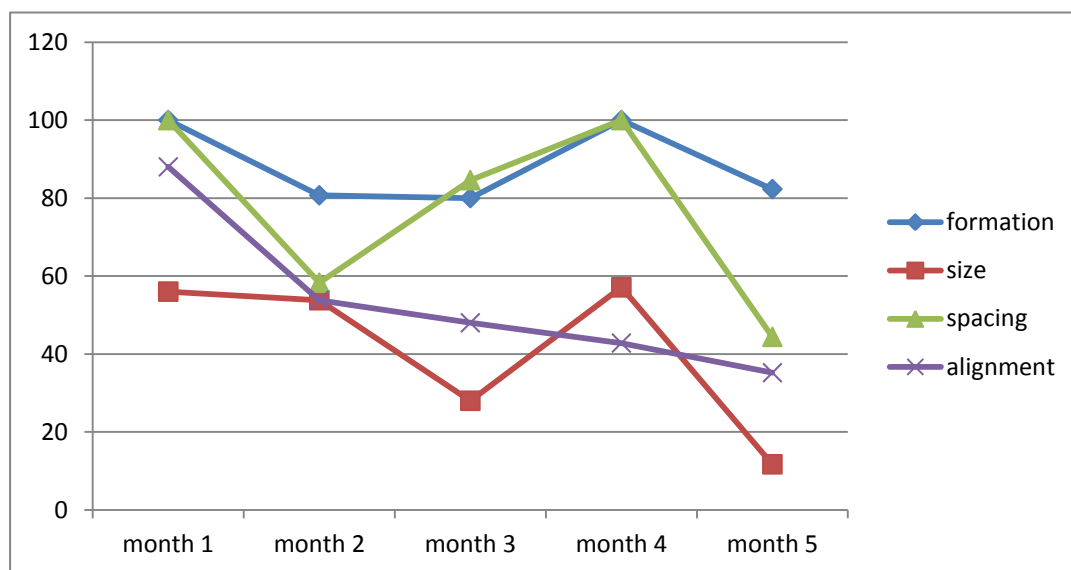
**Table 13. Factor functions for letter, copied and dictated texts – Ramatulaye**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
17. Ramatulaye - letter								
formation		x			?			x
size		x				x		
spacing			x			x		
alignment		x					x	
17. Ramatulaye -copied								
formation	?	1-2	2-3		?	3-5		
size		x				x		
spacing			x				x	
alignment		x				x	5	
17. Ramatulaye – dictation								
formation	?	x			x			?
size		x					x	
spacing		1-2	2-3			x		
alignment		2-3	1-2			x		

#### 5.4.7 Fanta

Fanta's letter complexity level shows a change of pattern at month three, but the functions are less consistent during the first three months. All four factors decline from month one to month two, but the factor of size may actually be more static in this time, while yielding slightly to the overall regression. From month two to month three, letter formation and alignment react in tandem, with alignment interestingly picking up where size left off in month two with a gentle decline. The factor of size displays a greater rate of regression in this same time, with spacing becoming a competitor. A transition occurs at month three, with three of the factors aligning in developmental pattern and the fourth, alignment, continuing

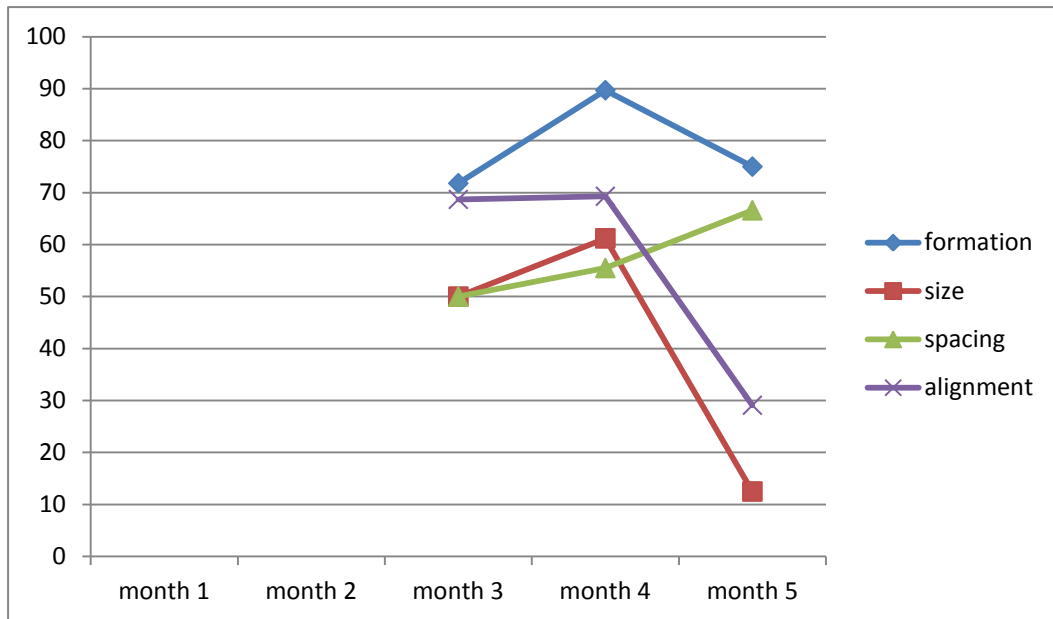
a more general decline in output, again possibly more of a static state influenced by the much stronger decline of the other three factors.



**Chart 49. Fanta, letter complexity level**

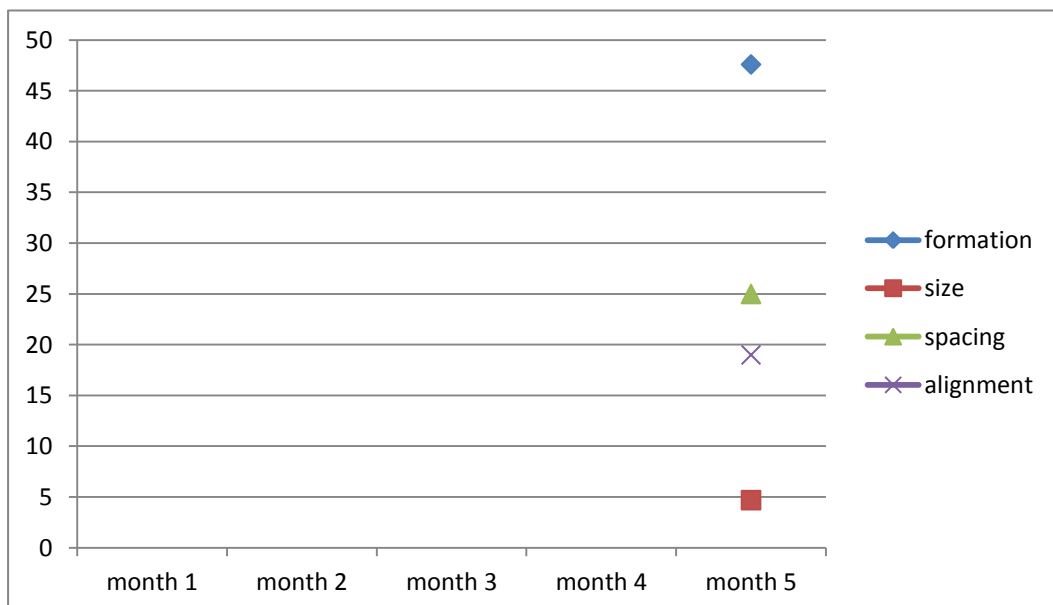
Data for copied texts were not available for the first two months of Fanta's writing samples, so the design created by the outputs is limited to the last three months of the class. Letter formation, in this case, seems to be functioning as a precursor. From month three to month four, all four variables progress, but the strongest relationship is seen between alignment and size as connected growers. Letter formation continues to react with these two factors, but at a higher percentage of output. The factor of spacing progresses from month three to month four and continues in a positive climb from month four to month five, in opposition to the other three factors. Even in this shorter period of data, it can be noticed that the factors of spacing and letter formation are reacting in opposition from month four to month five. The dip in letter formation may be allowing or caused by the more rapid progress of spacing. The pairing of factors, two in tandem, two in emerging opposition, encourages speculation about the cognitive focus required for the collective variable of interest, but more data over a longer period of time would be necessary to take this speculation any further.





**Chart 50. Fanta, copied text complexity level**

Fanta's data includes dictated texts only in the fifth month, but the high performance of letter formation in relation to the other factors indicates a possible precursor role at this complexity level. The factors of spacing and alignment perform in a narrower range, while size is lagging behind. Without more data to form a pattern, it can only be noted that perhaps we are again seeing one established precursor, two developing variables, and one variable which is slower to develop.



**Chart 51. Fanta, dictated text complexity level**

Given the abbreviated nature of Fanta’s data, care must be taken to avoid overgeneralization, but similarities are present between the levels of letter and copied text complexity. The factor of letter formation performs highly in all three data sets, but is more highly interactive than the other factors, displaying a high divergence from linearity, suggesting that the function of connected grower might be the stronger role, particularly at the level of individual letter and syllable production. Fanta’s data show a greater affinity for three connected growers. The regression in overall performance at both levels in month five is steep, prompting the question whether the attempt at dictated text, present for the first time in the month five data, might not have taken the focus and energy for the writing sample that day.

**Table 14. Factor functions for letter, copied and dictated texts – Fanta**

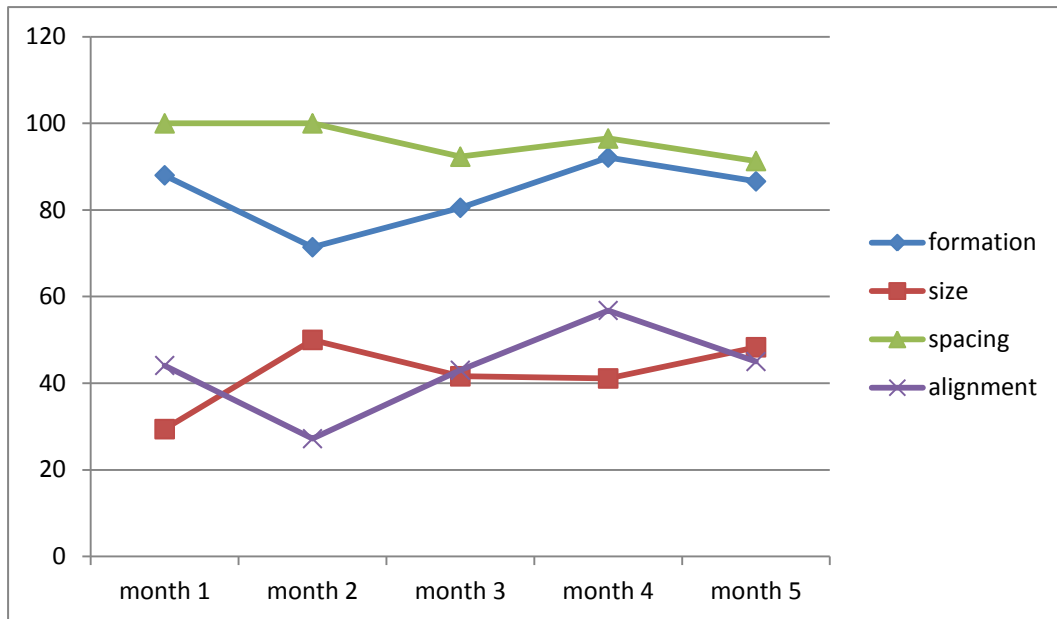
	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
18. Fanta - letter								
formation	?	x			?	x		
size		x		1-2?		x		
spacing		1-2	2-3			x		
alignment		x					3-4	?
18. Fanta - copied								
formation	x	?			x	?		
size		x				x		
spacing		3-4					4-5	
alignment		x				x		
18. Fanta - dictation	(limited data available)							
formation	?							
size								
spacing								
alignment								

#### 5.4.8 *Tɛnɛ*

In the data for the letter complexity level in *Tɛnɛ*'s writing sample, letter formation and alignment function as connected growers throughout the five-month period. It is possible to posit the factor of spacing as a precursor, particularly in the first two months, but it also interacts from month one to month three with the factor of size as a competitor to letter formation and alignment, and from month three to month five as a connected grower with those same two factors. The factor of size functions as a competitor to letter formation and alignment throughout the five-month period.

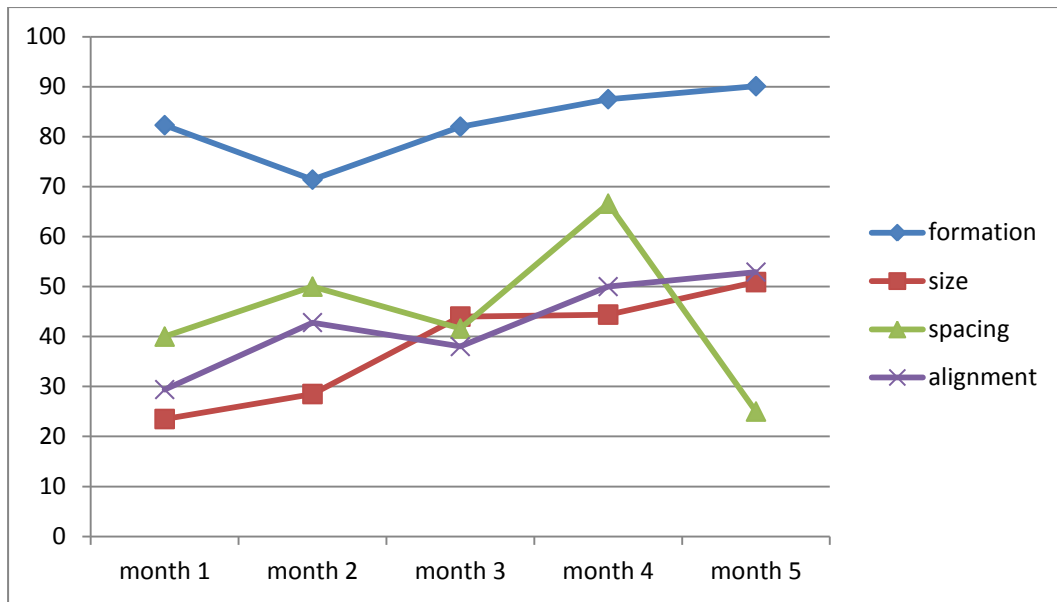
The four factors, paired two and two according to function, split to form two different partnerships in respect to percentage level of output. In this regard, spacing and formation are found at a higher range, and alignment and size are related to each other in a lower output range. Each pair continues to narrow the range of their interactions until, in month five, spacing and formation are separated by less than 5%, at 91.3% and 86.6% respectively. The factors of size and spacing have narrowed their range of output even more, to 48.3% and 45% respectively.

While primacy of interactions, whether range of output or developmental pattern, cannot be determined from the data, it is still interesting to note the divisions and interactions among the four elements according to these two distinctive expressions of the data. It may be that for this level of complexity, *Tɛnɛ* tends to learn by working with two elements in opposition until a certain level of mastery, perhaps over 80%, is reached, at which time those two elements act as connected growers, while the learner begins to focus more on the next two elements, again acting in opposition.



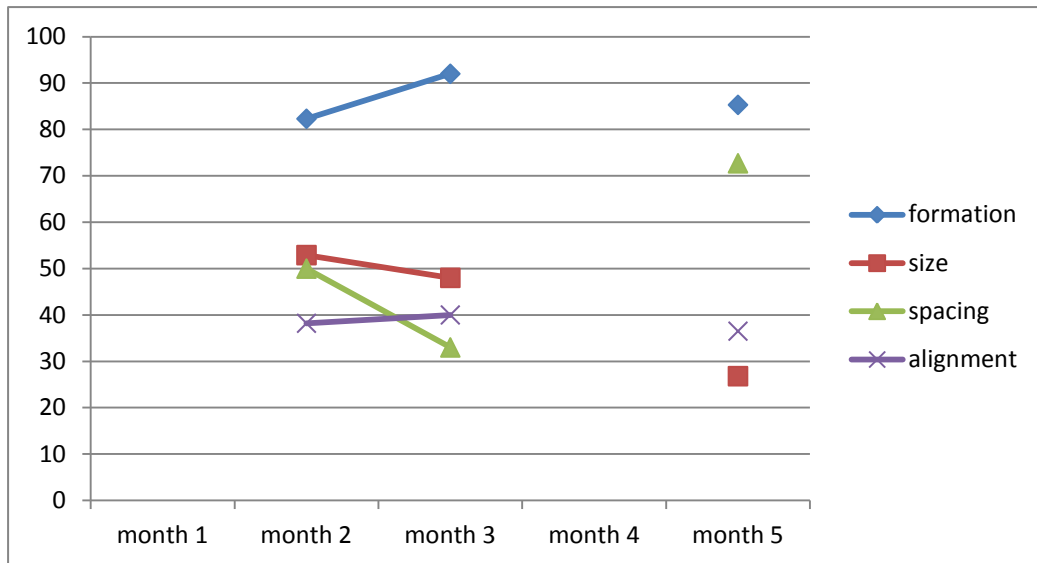
**Chart 52. Τελε, letter complexity level**

At the next level of complexity, that of copied text, letter formation is established as a precursor, but acting in opposition to spacing and alignment in months one to three. These two elements follow similar patterns through to month three, and are in opposition to size from months two to four. From months four to five, size and alignment act as connected growers, reflecting the same progression as letter formation but at a lower output. During the same period, spacing takes the role of competitor to the other three elements. So, each of the three elements has taken a turn as competitor to alignment during the five-month span. In such an interpretation, it is noted that alignment and letter formation are in a competitive relationship from month one to month three, after which they may be seen as connected growers, progressing in similar developmental patterns. Given the increasing progress of the factor of alignment, it is possible to see spacing and size as interacting in competition, while alignment and letter formation begin in competition, then shift to a connected grower relationship. This overall pattern among the four elements was seen at the previous complexity level in this learner, but with different factors fulfilling the various functions.



**Chart 53. Tene, copied text complexity level**

Tene's data contained writing samples for the complexity level of dictated text only for months two, three and five. The abbreviated patterns of interaction still show letter formation as a precursor and connected grower with alignment, as was the case at the letter complexity level. From month three to month five, the factor of size shifts functions to join letter formation and alignment as a connected grower, while spacing remains as a competitor. A similar shift occurs in the patterning of both of the other complexity levels in Tene's writing, roughly showing two factors in alignment, two in opposition until half-way through the learning period, at which point there is a shift in functions to have three factors as connected growers and one as competitor for the remaining period.



**Chart 54. Tene, dictated text complexity level**

Table 15 below shows a shift in pattern for Tene's learning across all three levels of complexity from one precursor, two connected growers and two competitors in the beginning of her learning to only one competitor in her later-developing pattern. The role of precursor is filled by spacing at the complexity level of letter and syllables rather than by letter formation, but the presence of the same three functions in this pattern over all three levels points to the fractal nature of language in the organized patterns of development of this learner.

**Table 15. Factor functions for letter, copied and dictated texts – Tene**

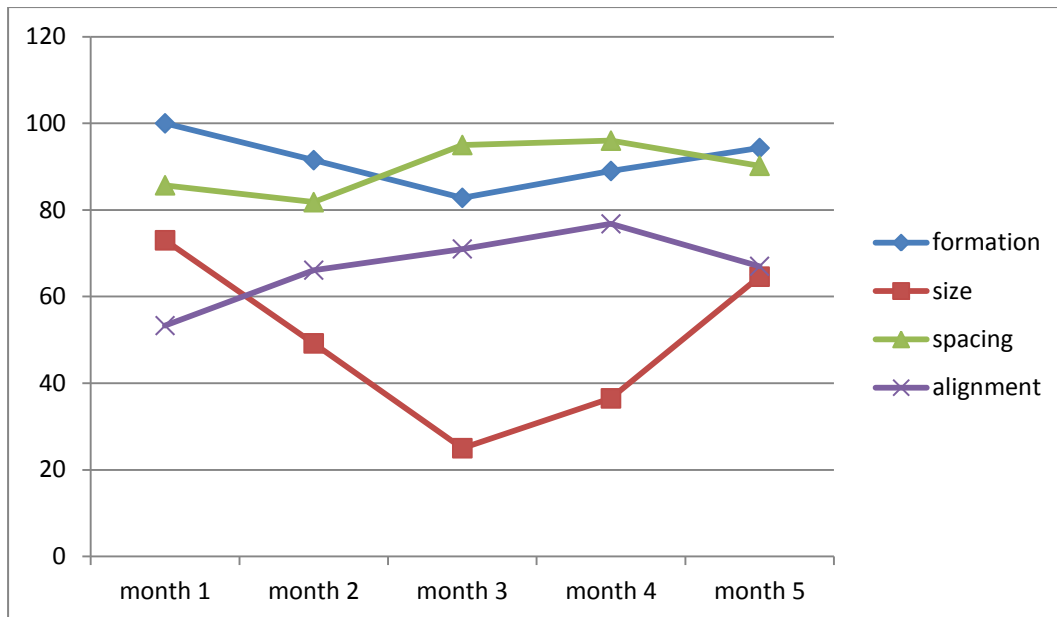
	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
19. Tene - letter								
formation		x				x		
size			x				x	
spacing	?		x		?	x		
alignment		x				x		
19. Tene - copied								
formation	x		?		x	?		
size		1-2	2-4			4-5		

spacing		x					4-5	
alignment		x				4-5		
19. Tene - dictation								
formation	x	?			x	?		
size			x			x		
spacing			x				x	
alignment		x				x		

#### 5.4.9 Kadjatou

In the six-month data from Kadjatou, there were no single letter or isolated syllable exercises for the sixth month, so that column is left blank in the data. In the data for letter complexity, we see a similarity with Tene's data in that the factors appear to pair off, with two in the higher range of the table and two reacting closer to mid-range, but the two elements which show the greatest similarity in pattern are not the two which are the closest to each other in output range.

From month one to month two, three factors, letter formation, spacing and size, show regression, while the factor of alignment progresses. From month two to month five, the factors of spacing and alignment display a similar developmental pattern in their output, in opposition to the patterns shown by letter formation and size, but size and letter formation are moving in similar patterns to each other. But when the range of output for each of the factors is considered, letter formation and spacing fall within the same range, above 80%, while alignment and size share the middle and lower portion of the chart. So again, we see a pattern of two higher-performing factors in opposition and two lower-performing factors in opposition. The fact that there are only two developmental patterns shown from month two to month five among the four elements, similar to what has been seen in other data, points to a possible tendency which may prove instructive to this research.



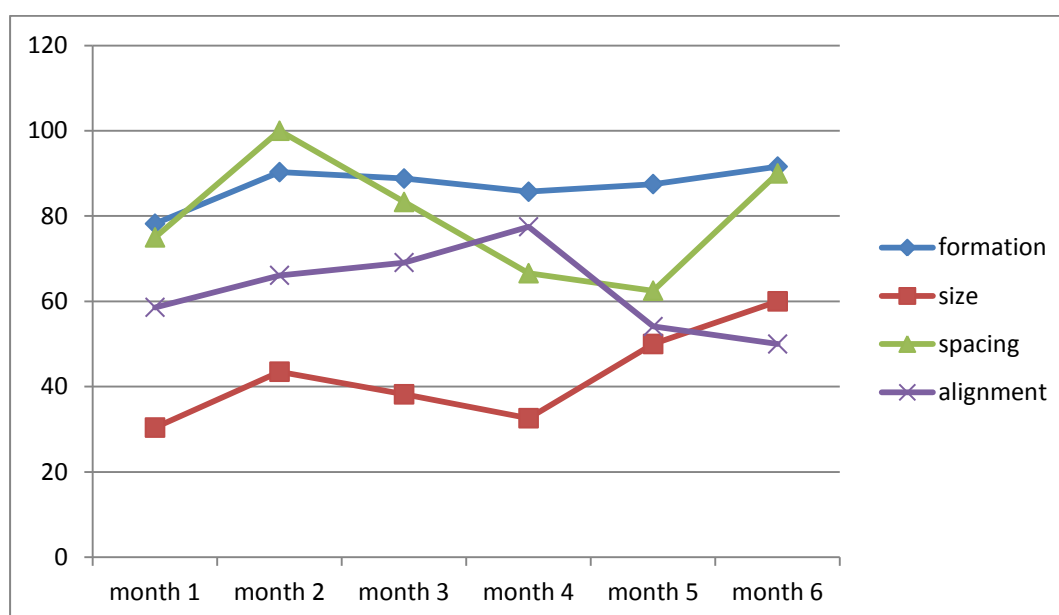
**Chart 55. Kadjatou, letter complexity level**

At the complexity level of copied text, Kadjatou's data show all four variables moving in a positive direction from month one to month two. From month two to month six, the factor of alignment breaks away to function as a competitor to letter formation and size. Spacing functions as a connected grower with letter formation and size from month one to month four, then transitions briefly into a competitor role from month four to month five before returning to a connected grower role. The two elements which are the most similar in developmental pattern are again the farthest apart in overall percentage of output, with letter formation performing in a range between 78.2% and 91.6% and size performing between 30.4% and 60%.

It is a matter open to interpretation whether it is better to characterize the factor of letter formation as a precursor and emphasize the development of spacing and alignment as the primary elements of the collective variable in focus, or to characterize letter formation and spacing as paired elements with the exception of the transition from month four to month five and the elements of alignment and size as the second pairing under development, moving in an overall competitive relationship. Both readings of the interactions are instructive. What has been seen in the data from both Kadjatou and Tene at other complexity levels suggests the second interpretation, while the divergence from linearity and pattern of both spacing and alignment support the first.

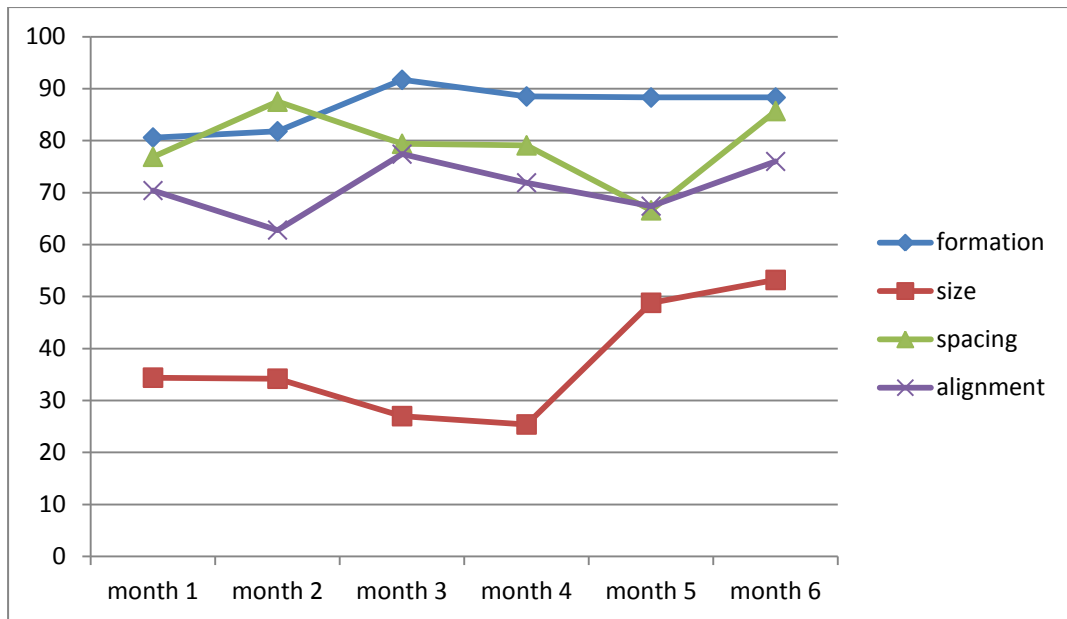


The factor of letter formation, once attaining a performance output of over 80%, exhibits a stability that is not seen in the factor of spacing. This instability would suggest that the factors of spacing and alignment are struggling between themselves for developmental stability. The transition phase from month four to month five shows the factor of size beginning to take a more prominent role, but at a cost to alignment performance, and to a lesser extent, to that of spacing. Size and alignment continue to interact closely and in opposition from month five to month six.



**Chart 56. Kadjatou, copied text complexity level**

In the data for dictated texts, Kadjatou's writing sample again shows the factors of letter formation and size at the extremes of the range of outputs, though the patterns are not as distinctly similar as has been seen at the other complexity levels. Spacing and alignment appear more closely connected here, acting in competition from month one to month four, then in tandem from month four to month six. The range of output for spacing falls between 87.5% and 66.6%, while the range of output for alignment reach a high of 77.4% and a low of 63.8%.



**Chart 57. Kadjatou, dictated text complexity level**

A summary of Kadjatou's patterns across all three complexity levels is seen in the table below. The overall pattern of functionality for the letter complexity level points to a two-and-two pattern of connected growers and competitors. The level of output previously seen in chart 55 also pointed to a two-and-two pattern, but of different factors. At the level of copied text, the pattern could be three-and-one, or one-two-one, with the function of precursor taken into consideration. The latter interpretation is reinforced when these data are viewed alongside those for Kadjatou's dictated texts. These data show similar interactions between the factors of spacing and alignment, with the factor of size reacting at a greater remove. As was seen with Tene's writing samples immediately preceding this discussion, Kadjatou's data illustrates the fractal nature of language as it appears in all three levels of complexity investigated.

**Table 16. Factor functions for letter**

	initial pattern				later-developing pattern			
	Precursors	Connected Growers	Competitors	Static	Precursors	Connected Growers	Competitors	Static
20. Kadjatou – letter								
formation	?	1-2					x	
size		1-2					x	

spacing		1-2				x		
alignment			1-2			x		
20. Kadjatou – copied								
formation	?	1-5			?	5-6		
size		1-5				5-6		
spacing		1-4	4-5			5-6		
alignment		1-2	3-5				5-6	
20. Kadjatou - dictation								
formation	x		2-4	1-2	x			4-6
size		2-4		1-2		5-6	4-5	
spacing		1-4				4-6		
alignment			1-4			4-6		

#### 5.4.10 Summary

In the functions of the collective variable of interest across the three levels of complexity investigated for the nine data sets, 53 patterns or shifts in pattern are seen. Four patterns for variable interactions emerge:

- 1-2-1 pattern, 37.75%: one precursor, two connected growers and one competitor, 20 times
- 2-2 pattern, 17%: two connected growers and two competitors, nine times
- 1-3 pattern, 37.75%: one precursor and three connected growers, 17 times; one competitor and three connected growers, three times
- all 4 pattern, 7.5%: all factors moving together, four times in the data.

In 22 of the 53 pattern examples, letter formation functions as a precursor. In another 14 instances, there is some evidence to indicate the role of precursor, but range of output and interaction with other variables allow other interpretations of role for that factor. The only other factor identified as fulfilling the function of precursor is that of spacing, in Tene's data for letter complexity level. In the same set of data for copied text level, it is letter formation that acts as precursor. From this, it can be said that the factor of letter formation performs as a precursor in the data of these nine participants between 41.5% and 68% of the time.

For the rest of the data, no one particular role could be determined for any of the factors. In the 1-2-1 pattern, the variables paired as connected growers were:

- size and alignment, 7 times
- spacing and alignment, 6 times
- size and spacing, 5 times
- formation and alignment, once
- formation and spacing, once.

In the 2-2 pattern, the factors paired as connected growers were:

- formation and alignment, twice
- formation and size, once
- size and space, twice
- size and alignment, twice
- spacing and alignment, twice

Once the strong role of letter formation as a precursor is taken into consideration, the functions of each of the factors appear to be evenly spread.

When we review the functions of the variables in the overall analyses from the three-month, four-month and five- and six-month data sets, we notice that the same four patterns occur. In the three-month data set with ten participants, there were ten patterns, all of which could be interpreted as a 1-2-1 pattern, but of those, two could also be seen as a 1-3 and a 4 respectively. In the summary table 17 which follows, these two interpretations are represented in parentheses. For these ten patterns, the factors identified as connected growers were size and alignment in five instances, size and spacing in four instances and spacing and alignment once. The factor of letter formation functions as a precursor in eight of the ten patterns, with a possible emerging precursor role in the other two cases. In the four-month data set with five participants, eight variations in factor interactions are shown: three are 1-2-1 pattern, three are 2-2 pattern, one is 1-3 pattern and one is 4 pattern. However, in the 1-3 pattern, spacing lags so far behind the other factors as to be interpreted as a 1-2-1 pattern. The 4 pattern, when taken over the four months as a whole, reveals a stronger interpretation as a 2-2 pattern.

Of the six variations which show two factors reacting as connected growers, two are letter formation and spacing, two are size and alignment, one is size and spacing, and one is size and alignment, again showing an even distribution of the functions among the four variables. The factor of letter formation functions as a precursor in four of the eight patterns for the four-month data and in eight of the

ten patterns in the five- and six-month data. In this latter data set (five participants), there are ten variations of factor interaction: eight are a 1-2-1 pattern, one is a 2-2 pattern, one is a 4 pattern. Of the nine patterns which show two connected growers, two are size and spacing, three are size and alignment and three are spacing and alignment. The following table compares the patterns of the different data sets:

**Table 17. Summary of patterns found in all data sets**

	<b>1-2-1 pattern</b>	<b>2-2 pattern</b>	<b>1-3 pattern</b>	<b>4 pattern</b>	<b>total</b>
three-month	10	-	(1)	(1)	<b>10</b>
four-month data	4	4	(1)	(1)	<b>8</b>
five- and six-month data	8	1	-	1	<b>10</b>
complexity level data	20	9	20	4	<b>53</b>
<b>total</b>	<b>40</b>	<b>14</b>	<b>22</b>	<b>5</b>	<b>81</b>

From the summary above, the 1-2-1 pattern is seen as the preferred developmental learning pattern, but the results for the 1-3 pattern and 2-2 pattern are not negligible in the complexity level data. The other matter of note in an overview of all of the data is the function of the factor of letter formation as a precursor in 61 of the 81 patterns overall.

With this view of the real data in hand, it is time to look at a possible model for the development of writing in adult Bambara women.

## Chapter 6.

### Proposed model of writing development in Bambara adults

[A]ny two different perspectives (or models) about a system will reveal truths regarding that system that are neither entirely independent nor entirely compatible ... for complex systems (by which I really mean any part of reality I care to examine) there exists an infinitude of equally valid, non-overlapping, potentially contradictory descriptions (Richardson, 2004a:76).

Modeling provides a visual representation of the interactions within the collective variable of interest. Within DST, a model reflects the non-linear, influencing relationships among the factors. The functions of each of the factors and their interactions may be expressed as an equation or as the graphic expression of the equation (Verspoor, De Bot & Lowie, 2011:100). Modeling is used to represent quantitative information in ways that reveal which variables most strongly affect development. It should be remembered, however, that the relationships among factors considered in a DST analysis are not directly causal: “The fact that modeling is a quantitative enterprise obscures the fact that it is as much an art as a science” (Beckner *et al.*, 2009:13).

The graphs of data presented thus far have been expressions of the observed, but they are not necessarily predictive of what may yet develop. The dynamic systems of the type addressed in this study are by nature open and non-linear, rendering their behavior unpredictable (Tesson, 2006:49). By isolating a subset of factors within the system for the purpose of analysis, a closed system is created, which points out a distinct gap between what can be demonstrated and what actually occurs (Richardson, 2005:109). In addition, the complex systems concepts of the Darkness Principle, i.e. that no complex system can be completely known, and incompressibility, i.e. that a complex system can only be represented by itself, introduce confounding factors. The very act of analyzing the functions of particular variables within the system creates an artificially closed system and misrepresents the system as a whole (Richardson, 2004b:77).

Therefore, the value in modeling in DST is not to predict an outcome, but to explain what has occurred within a set of data and to compare occurrences within and among individual learners in a stochastic, nonlinear visual representation. The variability in the data, when viewed as “a series of patterns evolving and dissolving over time, and, at any point in time, possessing particular degrees of stability” (Thelen & Smith, 2006:276), can open windows illuminating certain aspects of the development of the process (De Bot *et al.*, 2012:199).

The challenge before us now is to examine the data in the study to discover if there is indeed enough of a generalization evident to suggest an overall model of development in the writing acquisition in Bambara women. This section will examine the data with a view toward model development, first giving a review of pattern development within individuals at different complexity levels and then moving to an overview among all study participants.

### ***6.1 Pattern development within the individual at different complexity levels***

The question is, how can we generalize our findings to the population (a basic question in social science) given we have only so few cases? Such generalization is possible if every single case is conceived of as a separate study. ... It is our firm belief that the starting point of developmental studies should be studies of individual trajectories (Van Geert & Van Dijk, 2002:369-370).

The strength and intent of DST is the investigation of variability within an individual system. In an initial step toward identifying a useful model of the phenomena present in the data in this study, the analysis for different complexity levels within individual study participants is reconsidered. For the purpose of modeling, only the five sets of data containing enough information to form complete patterns at the three levels of complexity considered are included. These are: Assan and Mai from the three-month sets, Minata from the four-month set, and Ramatulaye and Kadjatou from the five- and six-month set. Each of these five data sets has been examined for the interactions among the complexity levels with the principle questions being: do the learners display the same developmental patterns at each level of writing acquisition, reflecting a consistency within the individual acting according to the fractal nature of language, or is the self-

organizing nature of dynamic systems more responsive to the variability of the demands of the specific learning task?

#### *6.1.1 Assan*

In the initial analysis of Assan's overall pattern of writing development, the data show a 1-2-1 pattern, with letter formation as a precursor, and with size and alignment progressing as connected growers and spacing in a regressive state (see chapter 5, three-month samples, chart 1). A later analysis of Assan's data at complexity levels for individual letters, copied texts and dictated texts reveals a different pattern of interactions concurrent at the differing complexity levels (see chapter 5, intra-individual performance at varying task-complexity levels, charts 31, 32 and 33). Although the patterns of interaction change as the complexity level increases, the output levels of all four variables continue to indicate that Assan is concentrating on two variables at a time in her learning process, with one variable acting as a precursor, and the fourth variable lagging behind in development.

#### *6.1.2 Mai*

In the first consideration of Mai's data, the cohesive factor appears to be the output levels, which suggests a 1-2-1 pattern of letter formation as a precursor, spacing and alignment as competitive growers and size lagging behind as the last factor to develop (see chapter 5, three-month samples, chart 4). In the subsequent analysis of Mai's data for complexity level, output level is again informative, with letter formation a consistent precursor at all levels of complexity. The patterning of the remaining three factors continues to indicate a 1-2-1 pattern of interaction, but is inconsistent as to which of the factors relate at any given level. The factor of spacing performs with high variability among the different levels (see chapter five, intra-individual performance at varying task-complexity levels, charts 34, 35 and 36).

#### *6.1.3 Minata*

The general consideration of Minata's output reveals factors grouped by output in a 2-2 pattern (see chapter 5, three-month samples, chart 12). Letter formation may still be interpreted as a precursor, which would change the pattern to a 1-2-1. The useful aspect of the patterning that is consistent with the preceding two cases is the focus on two variables at any given time. This set of data differs in that there



is frequently a ‘top two’ and a ‘bottom two’ instead of two factors at mid-range of output with one factor lagging distinctly behind. In reexamining Minata’s data for complexity level, different patterns again emerge within a single individual. Size and alignment appear to be closely linked at all levels, but with variance in both the range of output and the functions of the two factors. As was seen in Mai’s data, spacing is the most highly variable of the factors as the complexity level changes. At letter complexity level, the factors are clearly paired 2-2 by output, but at copied and dictated text levels, letter formation appears to develop as a precursor element, which continues to interact with all three remaining factors in a similar range of focus. The variable which moves to create this change in pattern is spacing, which increases in complexity as it shifts from spacing between individual letters to reflect meaningful groupings of words in copied and dictated texts (see chapter five, intra-individual performance at varying task-complexity levels, charts 37, 38 and 39).

#### *6.1.4 Ramatulaye*

In the first analysis of Ramatulaye’s data, letter formation is a precursor throughout the five-month period, and by the same determination of output, spacing is the element lagging behind. This interpretation leaves the elements of size and alignment, sometimes as connected growers and sometimes as competitors, as the two elements in focus by the learner in a 1-2-1 pattern (see chapter five, three-month samples, chart 23). Intriguingly, once Ramatulaye’s data are broken down according to complexity level, the outputs are seen as much more wide-ranging, and letter formation no longer functions as a precursor. This phenomenon points out again the masking effect of averaging or generalizing data. Within this learner’s production, at single letter production level, a 1-2-1 pattern is still discernible, but with a different factor acting as precursor. At copied text level, data patterns vary between 2-2 interactions among varying factors, with a 3-1 transition period from month three to month four. In dictated texts, the factors reveal a pattern of two connected growers and two competitors until month three, and then there is a transition to a 1-2-1 pattern, with letter formation stabilizing into a precursor role (see chapter five, intra-individual performance at varying task-complexity levels, charts 46, 47 and 48).

### 6.1.5 *Kadjatou*

In the six-month data from Kadjatou, an overall 1-2-1 pattern is in evidence by output and by function, although the roles of each of the factors change over the time span (see chapter five, three-month samples, chart 26). In the analysis of the data by complexity level, different interactions among the factors emerge at each level, but a discernible 1-2-1 pattern is apparent. Letter formation performance remains consistently high, but is at times outperformed by spacing at the single letter complexity level. By output level, the 1-2-1 pattern is reinforced by the consistently lagging performance of the factor of size, leaving spacing and alignment at mid-range. The 1-2-1 pattern is also in evidence by function, but the roles within the patterns are again not consistent (see chapter five, intra-individual performance at varying task-complexity levels, charts 55, 56 and 57).

The preceding cases underline the distinctive, individualized nature of learning patterns, reinforcing the characteristic of incompressibility in the data. “[B]ecause levels and processes are mutually interactive, it is impossible to assign one level as the ultimate causation. Descriptions of change of many components are needed so that multilevel processes and their mutual interactions can be fully integrated” (Thelen & Smith, 2006:281). The patterning that describes change in this data is clear and variable, not only among the different learners, but within each individual at different complexity levels as well. It is of note for the samples of data examined that the overriding importance for each individual is the re-patterning of variables to meet the challenges of the complexity of the learning task, not a preferred pattern of development of the variables at each complexity level within each individual.

It is significant that in every case, and with each new pattern established, two of the four factors appear to be in focus. These factors are not static, but change over time. For one factor to progress, attention must be taken from another factor, with a resulting regression in the output of that variable. Yet because the roles of each of the variables are not static, but continue to change over time within the variable of interest, it remains to be determined what may be generalized as a model which would be informative beyond the study of a specific individual.

## 6.2 Toward a generalized model among all participants

[T]rade-off may be a feature of any individual performance, as well as a feature of developmental processes: Substantial progress for one feature may lead to another feature being put 'on hold'. This possibility of both individual and developmental influences raises the question of whether there is a limited set of learning trajectories focusing on a particular configuration of target features while significant gains in other sets of features are delayed (Verheyden *et al.*, 2012:10-11).

To respond to the question of generalization of findings, the output levels of all 20 participants were examined for percentage of output of each of the four factors, for pattern of development for each of the factors and for function describing the interactions of each of the factors within the variable of interest. The order in which each of the factors progressed was also taken into consideration in the comparison among the participants.

For the comparison, data were re-grouped according to the pairing of functions of the factors in each pattern. As seen in table 18 below, the 1-2-1 patterns and 2-2 patterns in the data for all time spans were separated according to the connected growers of size and alignment, with 14 examples, size and spacing, with eight examples, and spacing and alignment, with five examples. These three groupings account for all but one of the data sets. The one remaining data set is a 4-pattern, with all four factors progressing and regressing in the same patterns.

**Table 18. Patterns according to factor function among all 20 participants**

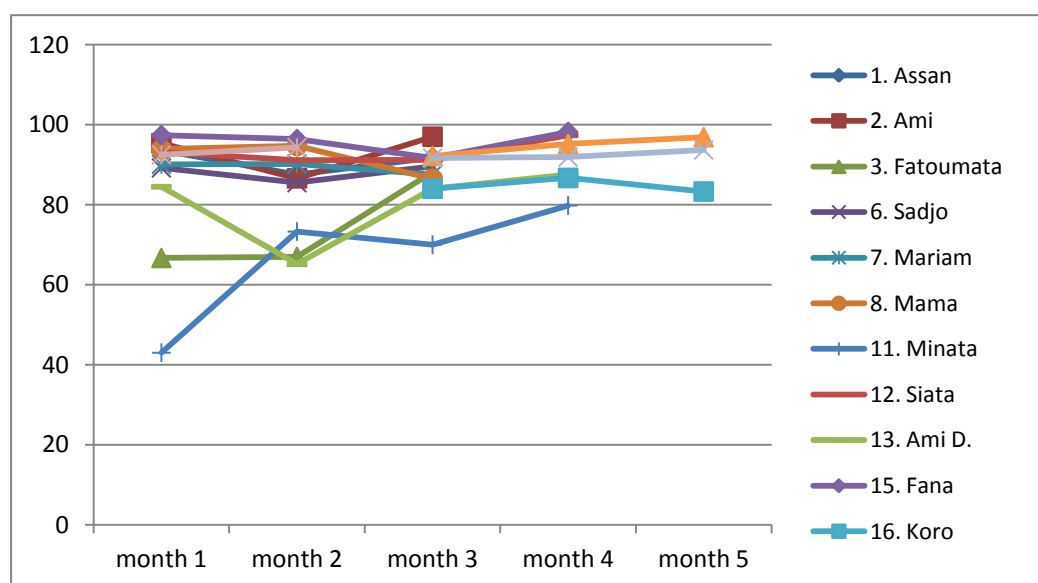
	1-2-1 patterns & 2-2 patterns			4 pattern	total
	size- alignment	size- spacing	spacing- alignment		
three-month	6	3	1		<b>10</b>
four-month data	4	3	1		<b>8</b>
five- and six- month data	4	2	3	1	<b>10</b>
<b>total</b>	<b>14</b>	<b>8</b>	<b>5</b>	<b>1</b>	<b>28</b>

The data in each of the above categories were then plotted on graphs for each of the four factors, to compare the pairings of functions with percentage of output and progression/regression patterning. While all four factors in the 4-pattern set do clearly react in tandem throughout the time span, letter formation is once again

the highest-performing factor, and could thus also be characterized as a precursor, heavily influenced by the movements of the other three factors. Size lags slightly in performance, leaving spacing and alignment acting and reacting most closely among the four factors. For these reasons, the 4-pattern data is added to the data in the category of spacing and alignment connected growers.

### 6.2.1 Data with size and alignment as connected growers

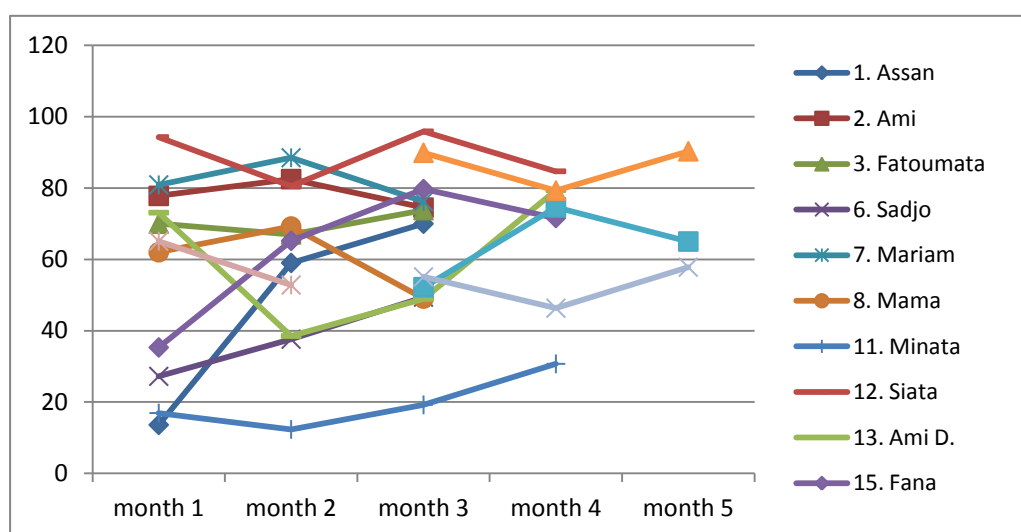
Charts 58, 59, 60 and 61 graph the groupings of data for letter formation, size, spacing and alignment respectively for the category of data in which size and alignment act as connected growers in a 1-2-1 or a 2-2 pattern. Chart 58 demonstrates the strength of letter formation in the role of precursor. Even the lowest-performing outputs for that factor seen in Minata's data present a clear case for the precursor function in relation to the other three factors within the specific set of data.



**Chart 58. Letter formation in 1-2-1 and 2-2 patterns with size and alignment connected growers**

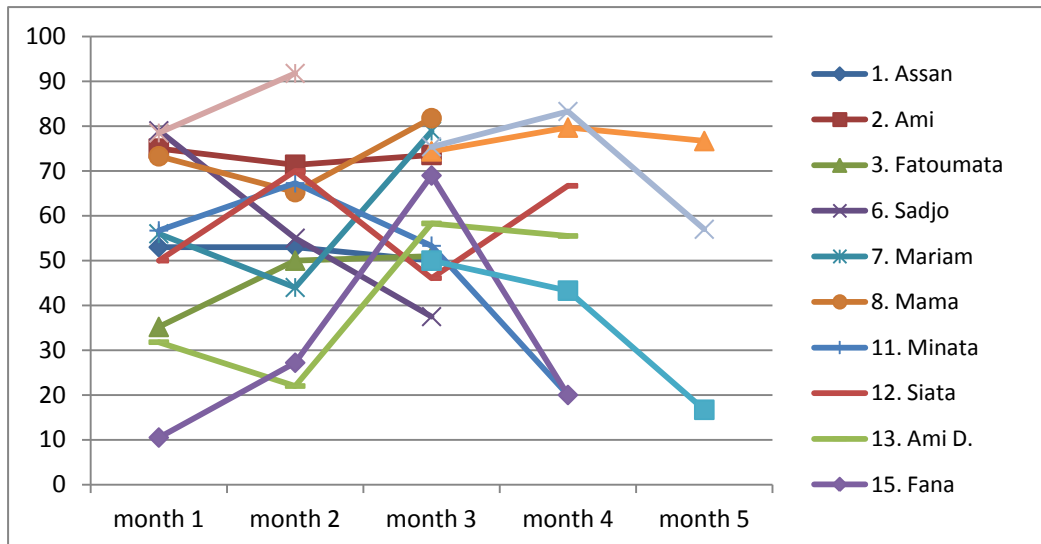
Charts 59, 60 and 61 are less helpful in that the minimum to maximum range of output for each of the factors was so wide as to negate a correlation within the function of the specific factor in each graph. Because the charting reflects only that part of the data that corresponds to the data in which size and alignment act as connected growers, some of the patterns give a false impression of being incomplete.

In chart 59 below, the minimum-maximum range of output of just the factor of size for the data sets of this category fall between 13.6% and 94.3% in the first month, 12.3% and 88.5% in month two, and 48.9% and 95.8% in month three. Although the range is diminishing over time, it is too broad to be informative. Another characteristic of the data which is less helpful at this point is the pattern of progression/regression for this factor among all of the data sets. A different way of representing the data must be sought to visualize the similarities found in the data.



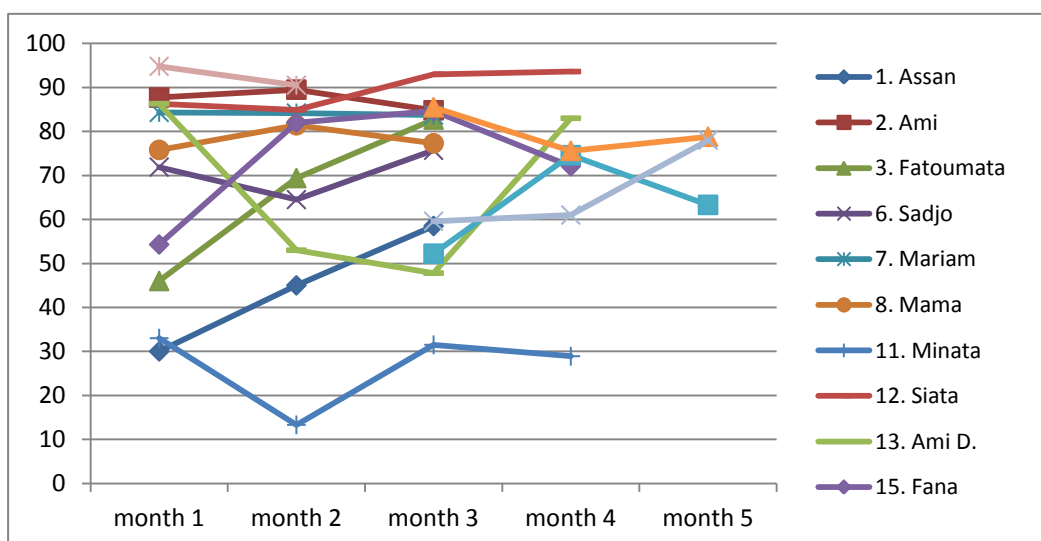
**Chart 59. Size factor in 1-2-1 and 2-2 patterns with size and alignment connected growers**

Chart 60, below, represents the factor of spacing for the category of size and alignment connected growers. As was seen for size, the minimum-maximum range outputs for this factor are very broad, falling between 10.5% and 78.5% in month one, 22% and 91.8% in month two, narrowing to 37.5% and 81.8% in month three, but broadening again to between 20% and 83.3% in month four before finishing between 16.7% and 76.7% in month five. As before, the progression-regression pattern is not evident for this factor.



**Chart 60. Spacing factor in 1-2-1 and 2-2 patterns with size and alignment connected growers**

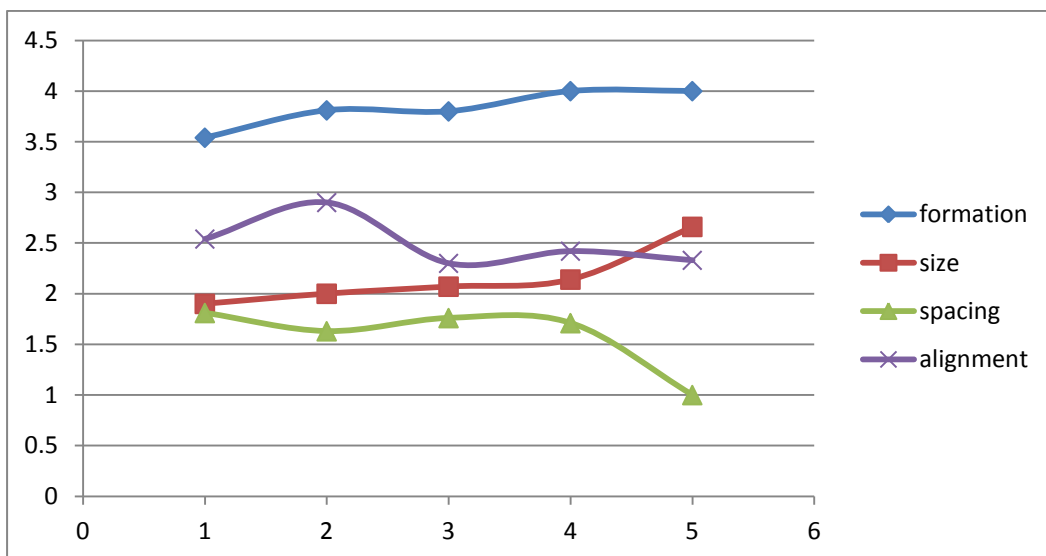
In chart 61, the alignment factor for the data sets in this category displays a range of output between 30% and 94.8% in month one, 13.3% and 90.5% in month two, 31.5% and 93% in month three and 28.9% and 93.6% in month four. Only three sets of data displayed the 1-2-1 or 2-2 pattern with size and alignment as connected growers in month five in this category. Again, the patterning of progression and regression among the data sets is not informative to the development of a model at this juncture.



**Chart 61. Alignment factor in 1-2-1 and 2-2 patterns with size and alignment connected growers**

Given the uninformative nature of the foregoing charts, the data were examined again, eliminating the characteristic of the range of output by assigning a simple

level of one to four to the order of development of each of the factors in the data set, with four being the highest level of output among the factors for the given month. In cases where the output percentage was identical between two factors for a particular month, both were assigned the same number. The resulting graph, as shown in chart 62, does not produce an image of size and alignment as connected growers, but it does show formation as a precursor and a relatively regular order of development among the remaining three factors. Without regard to progression/regression patterning, the order of development among the factors in this category is consistently: letter formation, alignment, size, and then spacing until month five, when size and alignment switch order. This view when combined with the same information from the other categories of collaborative grower pairing may bring us a step closer to a visual generalization of what has occurred in the data.



**Chart 62. Order of factor development for size-alignment grower data set**

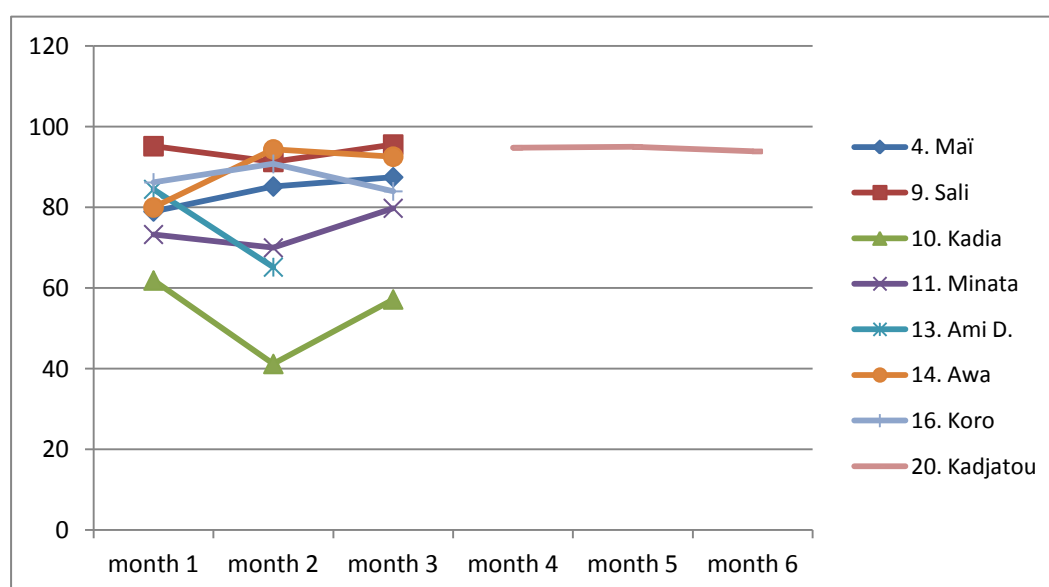
### ***6.2.2 Data with size and spacing as connected growers***

The same procedures were then followed for the eight patterns in the data categorized as having size and spacing as connected growers. As with the previous data sets, only that part of the data displaying the relevant pairing patterns is included in charts 63-66, which summarize the data for each of the four factors.

Again in chart 63, letter formation is performing as a precursor, albeit with a wide range of outputs. The minimum-maximum output ranges between 61.9% and

95.2% in month one, 41.2% and 94.4% in month two and 57/2% and 95.6% in month three. It is an interesting anomaly in the data that this pairing of growers does not occur after month three except in one data set between months four, five and six.

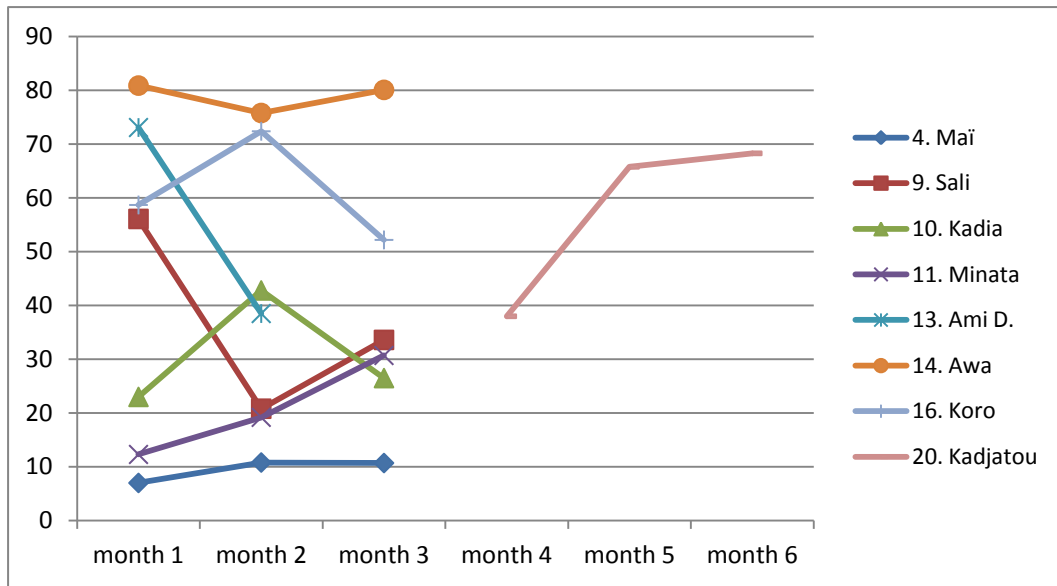
As was seen in the previous category of data, range of output creating progression-regression patterns does not suggest an observable generalization of pattern which could inform the development of a model.



**Chart 63. Letter formation in 1-2-1 and 2-2 patterns with size and spacing connected growers**

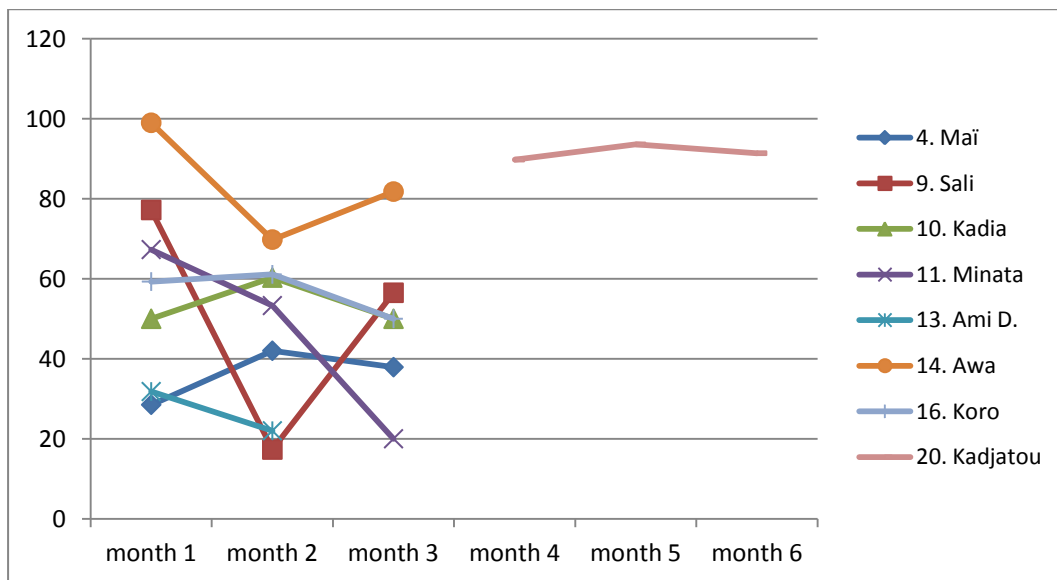
Chart 64 shows the wide range of output in the size factor for the data with size and spacing connected growers with the range of responses varying between 7% and 80.9% in month one, 10.8% and 75.8% in month two and 10.7% and 89.1% in month three. Progression-regression patterning is also inconsistent with an overall generalization.





**Chart 64. Size factor in 1-2-1 and 2-2 patterns with size and spacing connected growers**

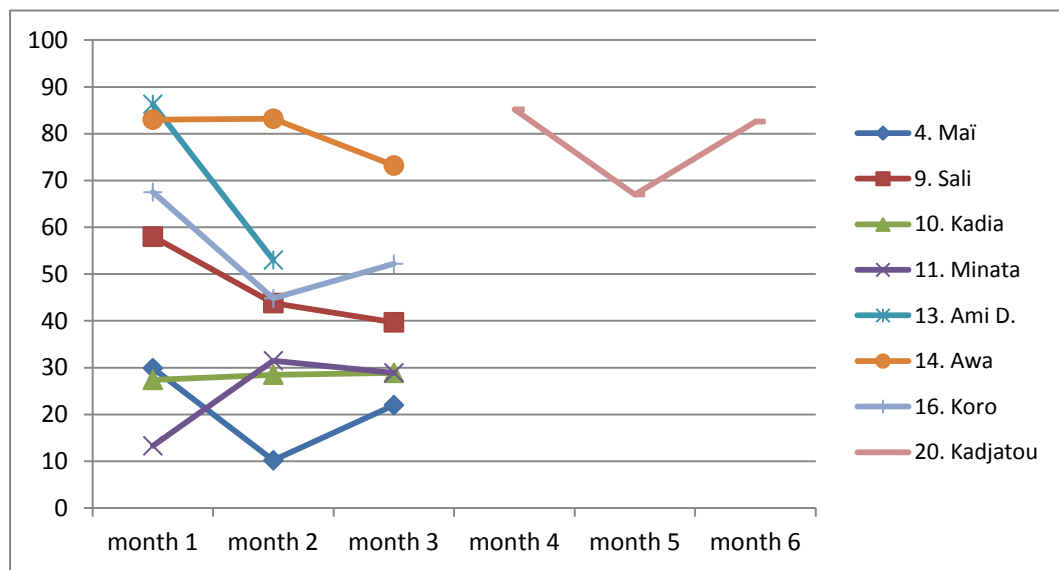
The range and patterning for the factor of spacing is seen in chart 65. The range is again wide, between 28.5% and 99% in month one, 17.3% and 69.8% in month two and 20% and 81.8% in month three. Progression-regression patterning is again inconsistent with generalization.



**Chart 65. Spacing factor in 1-2-1 and 2-2 patterns with size and spacing connected growers**

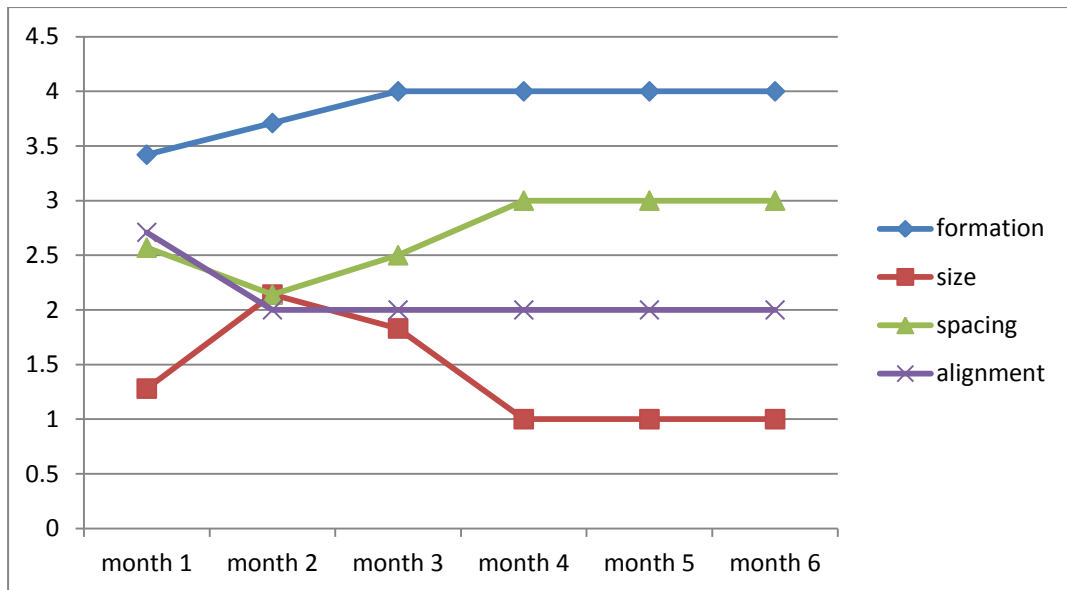
Chart 66 reflects the output of alignment for the data patterns with size and spacing connected growers. Alignment output ranges from 13.3% to 86.3% in month one, from 10.2% to 83.2% in month two and from 22% to 73.2% in month

three, again displaying a wide discrepancy in both range of output and progression-regression patterning.



**Chart 66. Alignment factor in 1-2-1 and 2-2 patterns with size and spacing connected growers**

As was done for the data for size and alignment connected growers, each factor in this category was then re-evaluated on a scale of one to four to determine developmental order as separate from the minimum-maximum output range. It is again interesting to note that the two connected growers do not emerge as connected in this interpretation of the data, but formation is clearly a precursor. As seen in chart 67 below, the order of development of each of the factors begins in month one as: letter formation, alignment, spacing, and then size. In month two, letter formation remains in the top position, while all three other factors converge, before re-organizing into a stable order of letter formation, spacing, alignment then size for months three, four, five and six. The order shown is not consistent with the order shown in chart 62 for data of the size and alignment connected growers. What appears to emerge in the analysis of the data is that the pattern of interaction, or patterns of functions, among the factors is of overriding significance to the order of development of each of the individual factors.

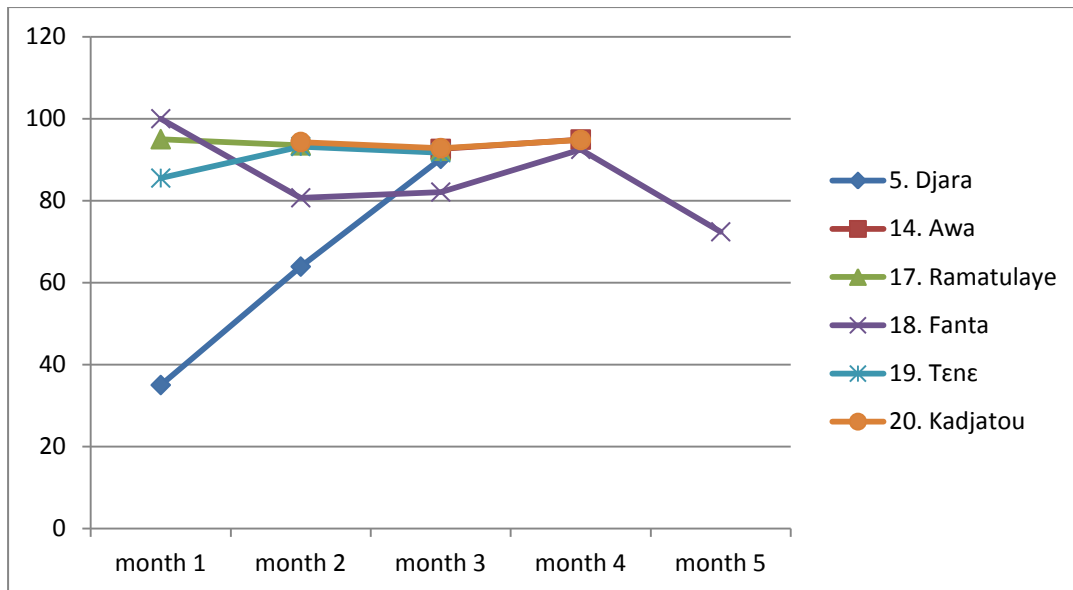


**Chart 67. Order of factor development for size-spacing grower data set**

### ***6.2.3 Data with spacing and alignment as connected growers***

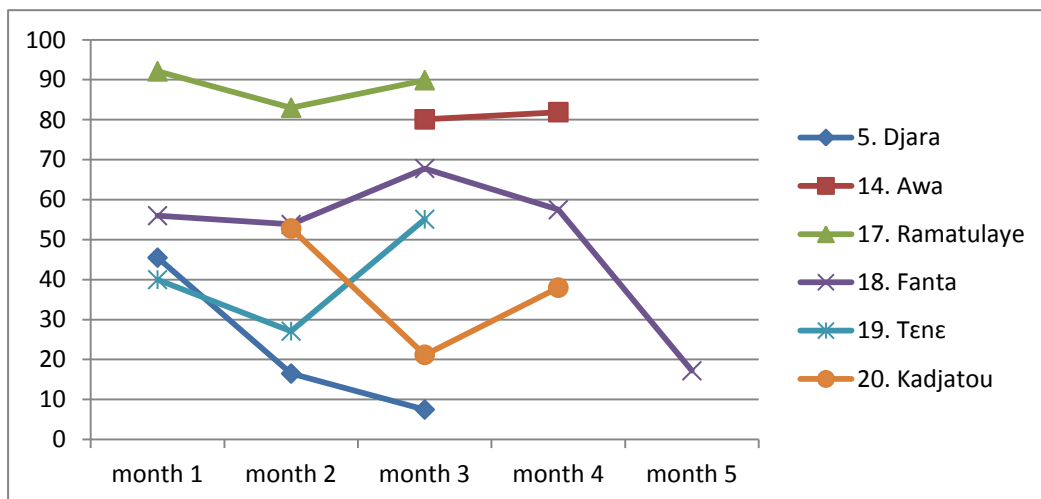
The third and final category of patterns focuses on spacing and alignment as connected growers. As was recognized earlier, one set of data only showed a 4 pattern. When that pattern is considered for performance levels in addition to function, letter formation is again the precursor, and size is the element which lags in performance, leaving spacing and alignment as the mid-performing factors in the pattern. For this reason, data from the one set of a 4 pattern is included in the calculations for this category, so that all of the data observed are considered.

As with the previous two categories of patterns, the data in which spacing and alignment act as connected growers is graphed to compare the pairings of functions with percentage of output and progression-regression patterning. Once more, letter formation is seen to act as a precursor. Care must be taken to consider the range of output in each individual set of data to avoid the risk of misinterpretation of function. In this case, letter formation for Djara in the early months and Fanta in the last month might appear to be something other than precursor, but within the data sets of these particular individuals, after the first month, letter formation is indeed functioning as a precursor. (Note: the similarity in output for this factor causes an overlapping in the graph, most markedly in the data from Awa, Kadjatou and Tene in months two, three and four.)



**Chart 68. Letter formation in 1-2-1 and 2-2 patterns with spacing and alignment connected growers**

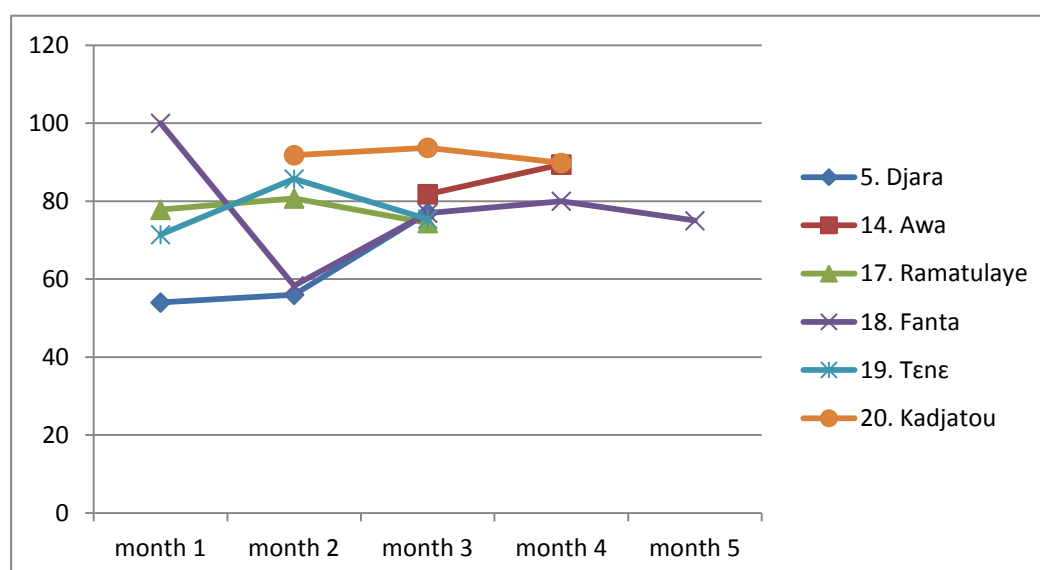
Chart 69 below shows that the factor of size, functioning in these patterns as a competitor, does not appear to have any correlation across participants. The significance of the function is seen more cogently within each individual data set. From this, it is reconfirmed that the order of development of factor functions is not universal in nature and cannot be generalized inter-individually.



**Chart 69. Size factor in 1-2-1 and 2-2 patterns with spacing and alignment connected growers**

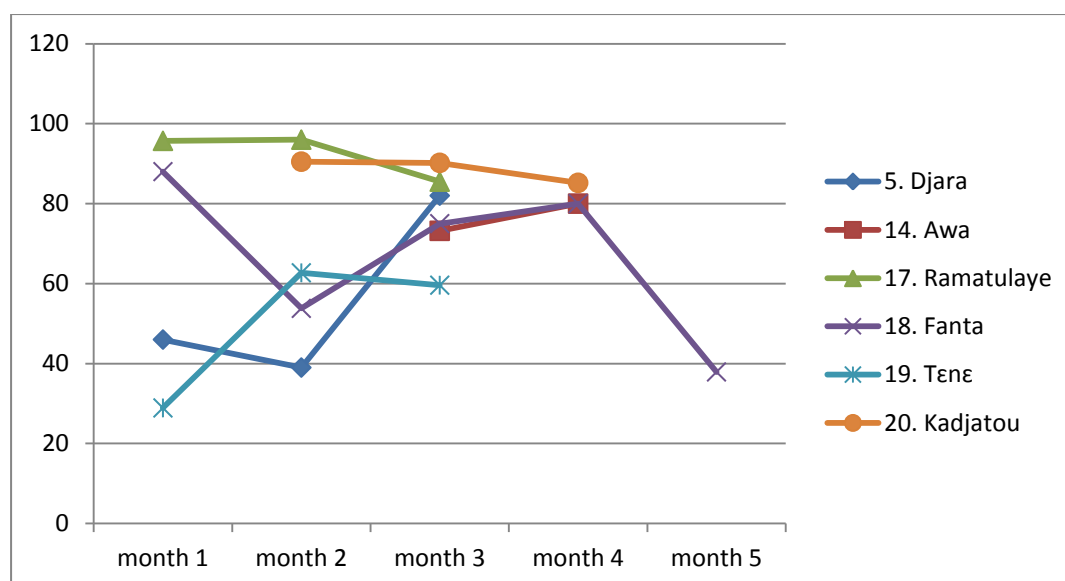
Chart 70 represents the factor of spacing in the spacing and alignment pattern category. No overall pattern of progression and regression can be ascertained for inter-individual generalization. The range of responses is large, from 54% in month one of Djara's data to 100% in Fanta's data for the same month. In

isolating the particular patterns of connected growers, the data for pattern development is truncated and does not reveal a uniformity of development across all the participant data.



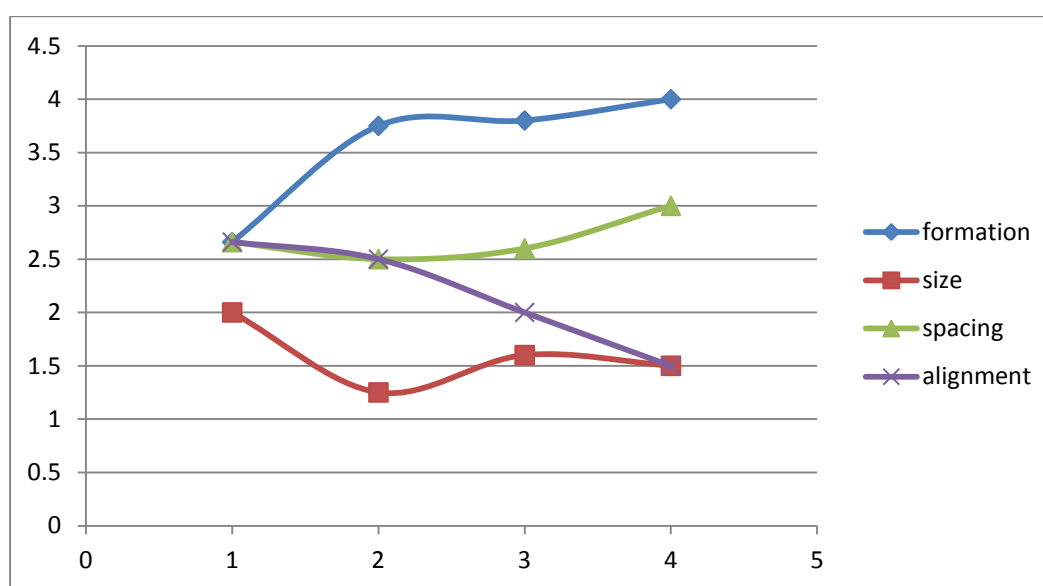
**Chart 70. Spacing factor in 1-2-1 and 2-2 patterns with spacing and alignment connected growers**

Chart 71 shows the isolated patterns for alignment, the second connected grower in this category. The range of responses is even greater than it was for spacing, going from Tene's 28.9% to Ramatulaye's 95.7% in month one. As in previous categories and factors, the progression/regression among all participants is inconsistent with a generalized pattern.



**Chart 71. Alignment factor in 1-2-1 and 2-2 patterns with spacing and alignment connected growers**

As was done in the preceding two categories of patterns, the data for the spacing and alignment connected grower patterns were then re-evaluated on a scale of one to four, with four as the highest, to determine developmental order of the factors as separate from the output range. Again, in this configuration of the data as shown in chart 72 below, the function of connected growers is no longer evident. The order in which the factors appears to develop when the aspect of order is isolated is consistent within this category, in that letter formation remains at the top throughout the time span and size remains at the bottom, spacing and alignment perform equally in months one and two, then spacing progresses while alignment regresses in months three and four.



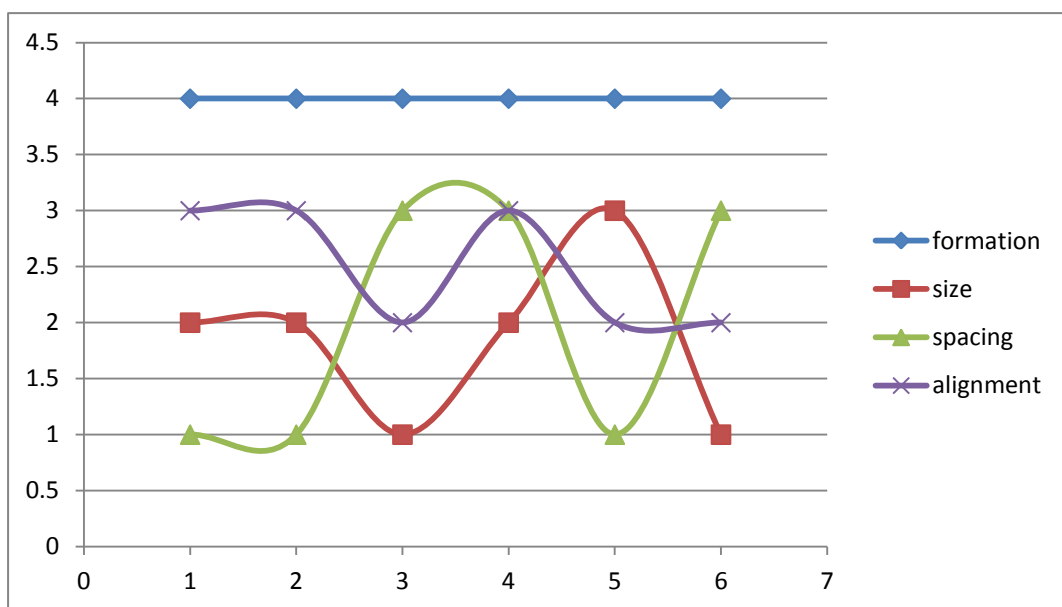
**Chart 72. Order of factor development for spacing-alignment grower data set**

“The graphs vividly display the unpredictability of the output: The different variables behave in a whimsical way across the occasions” (Verheyden *et al.*, 2012:20). To consider the order of factor development across all of the data, we first compare the results of the charting of the levels of each of the categories of factor function. In doing so, we see that letter formation is consistent throughout as a precursor element, affecting both the function and the order of development of the factors. For the remaining three factors in the variable of interest, the order of development is recorded in table 19 below. Alignment is the second factor to develop in month one across all categories, but at this stage the data do not permit a further reduction of the pattern to a more simplified model.

**Table 19. Comparison of order of factor development by category of growers**

<b>connected growers:</b>	<b>month 1</b>	<b>month 2</b>	<b>month 3</b>	<b>month 4 (-6)</b>
<b>size-alignment</b>	alignment – size – spacing		alignment – size – spacing	size – alignment – spacing
<b>size-spacing</b>	alignment – spacing – size	spacing/size – alignment	spacing – alignment – size (order remains consistent through month 6)	
<b>spacing-alignment</b>	alignment /spacing – size		spacing – alignment – size	spacing – alignment/size

In a final look at all of the three-month, four-month and five- and six-month data sets, all of the one-to-four rankings of the data from all categories of connected growers were combined in order to ascertain the patterns in the order of development and function of each of the four factors in the variable of interest. A percentage of the occurrence of the four levels for each month was calculated for each of the four factors. The factor with the highest percentage of rankings at a given level for each month was then assigned that overall ranking, the results of which are seen in chart 73:



**Chart 73. Generalized order of factor development by percentage**

By eliminating the confounding factor of minimum-maximum range of data, we isolate the order of development among the factors according to the category of connected growers. This representation confirms the role of letter formation as

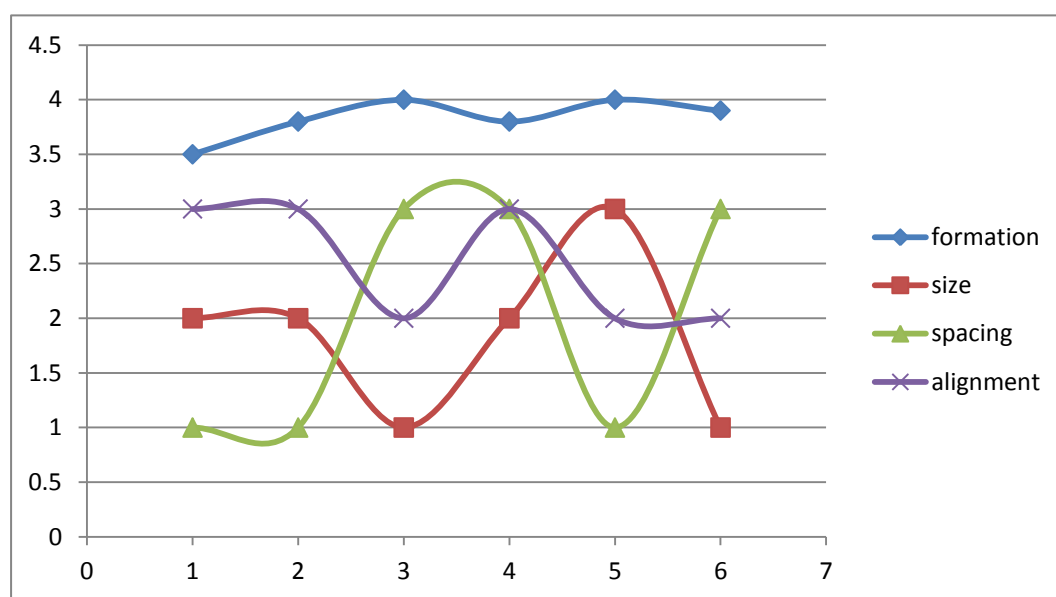
precursor, as well as demonstrating the interaction among the remaining three elements in respect to function and order of development. It must be noted that this representation does not prescribe a particular order of development among the factors other than that of letter formation, nor does it reflect the precise movements of progression and regression of all the data. What it does reveal is the importance of the interactions of the function or role played by each of the factors at any given time in the learning process.

Function is the unifying aspect with the greatest cross-participant consistency in the data, not only in the specific role of each factor, but also in their interactions as described by the function and reflected in the resulting pattern. Chart 73 above provides a highly simplified rendition of what occurs in the data: the variable of letter formation acts as a precursor, while the other three variables interact, self-organize, re-group and reform into new patterns of interaction as a basis to the learning process for writing development. At any given stage, there may be stability, but in order for one factor to increase, there must be a decrease in the other two factors or stability in one factor and decrease in one factor. In the model above, this is exemplified in the stage from month two to month three, when spacing makes a dramatic increase, but alignment and spacing both show a dip. This phase is followed by a period of recovery, from month three to month four, when spacing establishes stability and size and alignment recover to their previous levels. A similar situation is seen from month four to month five, but the roles have reorganized so that while size shows an increase, both spacing and alignment decrease in output; alignment remains stable at level two from month five to month six, while size and spacing exchange levels, with spacing progressing and size declining.

Such an oversimplification of the process to four discrete levels is not able to reflect the continued variability in the output of letter formation, which does continue to dip, recover, and stabilize in the data according to the influence of the other factors while maintaining a high output level. According to the patterns established by the functions and interactions of each element in the variable of interest, a predominant 1-2-1 pattern in which letter formation acts as a precursor but continues to be influenced by the other variables is representative of the data. This influence creates a secondary pattern, usually read as a 2-2, but it is possible



for the precursor to align itself with the connected growers so that a secondary 3-1 pattern is discernible. For the remaining elements, there is no defined order for development or range of output that may be generalized from the data, but from the pattern formations it is possible to say that in global terms, in order for one element to progress, the remaining two regress or stabilize. This pattern is represented in chart 74 which follows.



**Chart 74. Generalized model of interactions within the variable of interest**

This reduced representation of the process revealed in the data clarifies certain aspects of the learning process, which carry implications for both the instruction and assessment of writing. Of primary interest are function and number of interacting factors – one precursor, which continues to be influenced, two factors operating at mid-range developmental output, and one which lags behind. The two mid-range factors may interact as connected growers or, less frequently, as competitors, but in general terms, the functions of precursor, two connected growers, and one competitor is seen in the variable of interest. Which of the variables fulfils the functions may change at each state, but the functions themselves are relatively stable in the learning process.

As shown in the model, for one element to progress, two generally display a dip in performance. This phenomenon speaks to the idea of regression as evidence of learning. For example, a teacher might understandably show concern when in month five a student's assessment shows a drop in spacing such as that seen in the

model above. In such a case, the teacher must then take into account the concurrent advancement in letter size, which had been lagging previously. Thus, assessments need to measure more than one aspect of development and should be taken at several points throughout the learning period, with a clear understanding that a high score in one particular skill or concept in any given assessment period does not indicate the attainment or mastery of that skill. Instruction should include frequent review of basic skills to support the recovery periods of factors experiencing dips in performance. It is posited that a certain level of over-learning, or automaticity, in basic skills should be targeted to achieve stability and so reduce the need for regression as other aspects develop. This last point is an application drawn from the model, but has not been tested in the data. The model implies a learning process in which the concept of comprehension or skills development is akin to a tapestry, each of the threads of which are continually being woven together to produce a whole pattern that is the learning achievement.

## Chapter 7.

### Conclusion

[S]ince language growth does not follow a linear path, a complexity theory explanation can readily provide an interpretation for a phenomenon that many teachers will attest to. How is it, one often hears language teachers ask, that learners sometimes ‘unlearn’ or simply fail to learn elements of the target language that they should, by linear expectations, already have possessed or acquired? (Weideman, 2009a:69)

Learning to write is not a linear process through which a student, whether child or adult, moves from strength to strength, first acquiring one skill then moving on to the next. It is rather a “crooked” path of different interacting factors moving forward and backward to create a pattern of development as writing skills develop. This study investigates the developmental processes involved in emergent writing skills of 20 previously illiterate Bambara women. The writing samples are gathered not for the purpose of prescription, in the sense of diagnosis of disability to determine any need of educational remediation, nor for proscription, to grade and correct to an acceptable or approved form, but rather to describe and compare the development of writing in previously illiterate individuals who speak a language which has only relatively recently been developed in written form.

In order to investigate several developmental aspects of writing concurrently, a model of analysis able to address multiple factors emerging over time in a non-linear, self-organizing, open system that would reflect periods of stability and change is necessary. Thus, Dynamic Systems Theory is employed in this study to assess monthly writing samples collected from Bambara women attending basic literacy classes to ascertain developing patterns in a variable of interest consisting of letter formation, alignment, size and spacing. The study begins with four specific questions:

- Are there distinct patterns in the learning of writing skills in this language?

- Do illiterate adults in this language group develop handwriting skills according to the same developmental steps as has been documented in children?
- If patterns are evident, are they the same intra-individually, or is each adult learning sequence unique?
- What can be learned from the seeming regression, or “dips in developmental progress,” for teaching and evaluation?

Each of these questions is considered in light of the analysis of the data, before returning to the application of DST to the study and practice of writing instruction and assessment.

### ***7.1 Are there distinct patterns in the learning of writing skills in this language?***

Stated differently, are there interactions of various influencing factors in writing skills development that come together at thresholds of learning that could inform researchers as to the nature of the process of learning to write in the Bambara language? This question was formulated with a specific language in focus, because, if there is a discernible pattern for this language, it is not known whether such a pattern would be generalizable to other languages. However, the findings of the research indicate not one overall pattern for the study, but separate and distinct patterns in each learner.

So the answer to this first question is both “Yes” and “No.” Patterns which emerged in the participants’ data were evident and often striking, indicating that there are distinct patterns in the learning of writing skills. But the patterns varied from one individual to the next, meaning that there are no complete, overall patterns expressing all aspects of the data which may be characterized as distinct to this language. The implication of these distinct individual patterns for classroom instruction and evaluation is perhaps obvious, reinforcing what is observed and gained from other avenues of study: learners assimilate new information in different ways and in different time-frames. A broad range of teaching methods with frequent review and reinforcement will allow for the needs of different individual styles. This variation in methodology is perhaps the most

significant finding from an applied linguistic perspective that asks how instructional designs may be informed by analysis (Weideman, 2009a:61, 65). Equally, different methods of assessment of learning progress to measure various aspects of the skills to be acquired, taken at frequent intervals throughout the period of instruction, will provide a clearer, more accurate evaluation of what is being learned and may also further inform instructional design.

## ***7.2 Do illiterate adults in this language develop handwriting skills according to the same developmental steps as has been documented in children?***

As was discussed in chapter one, illiterate adult learners approach their new learning task differently than do children. First, adults have a fully developed capacity for oral expression and comprehension in the language, whereas children's oral and aural language abilities are still developing. Adults also have a more clearly defined motivation to learn to read and write and must intentionally choose to join a class, while children go to school and are presented with learning tasks not of their own volition but through an established program of study. In child learners, basic fine motor skills for pencil manipulation are being developed as a part of their learning. Adult literacy learners may never have needed to develop these fine motor skills, to which sometimes may be added the challenges of stiffening joints and diminishing eyesight.

In the Bambara language context, even adult learners do not have consistent contact with written or printed Bambara in a standardized form. There are some billboard advertisements and newssheets which use Bambara, but not in a consistent written form. The choice of letter symbols for some sounds, word breaks, and spellings are heavily influenced by French, the official language in the country, and by the judgment of the individual writer. Thus the new literacy student cannot draw on a context that is rich in a stabilized form of examples of the written language to reinforce and encourage reading and writing skills.

Given this particular context, it was expected that adult learners' writing skills would develop much along the same lines as has been described in children's writing development. The early stages of scribbling, if at all present in the adult,

were not observed in the data, but the writing samples were taken from non-formal literacy classes which gave specific instruction in letter formation. However, the concepts of sound-symbol correspondence, linearity of copied symbols, minimum quantity of letters per word and internal qualitative variation of different letters within words, all included in Ferreiro's first level of acquisition of literacy in children (as discussed in chapter 2, Writing development), were seen to develop across the course of this study in adult learners. One difference between Ferreiro's levels for children and this study of adult writing development was the association of meaning with writing. In children, this connection between written symbols and meaning does not begin to emerge until Ferreiro's second level of literacy acquisition, as children begin to associate the number of letters with the size of the concept represented, before moving to a syllabic-alphabetic hypothesis in level three, by which one letter may represent a sound or a whole word. The adult learners in this study appeared to telescope levels one and two, in the sense that from the beginning, there was a greater, though imperfect, understanding of writing to communicate meaning. This understanding was stronger for written words in isolation and in dictated sentences than it was for phrases, such as the date, copied directly from the board. This phenomenon was particularly notable in the learners' use of spacing to separate words.

In chapter 5, where five-and six-month data are discussed, Fanta's writing sample provides a beautiful example of the emergence of the syllabic-alphabetic hypothesis with her use of "d" and "k" seeming to represent meaningful units. This same sample also reflects the fifth stage in Deford's proposed flexible framework (see discussion in chapter 2, Writing development), during which letters are used in combinations and with some spacing as the concept of meaningful units (words and phrases) develops, but letter-sound correspondence may not remain consistent. This "dip" in letter-sound correspondence as another concept emerges, in this case that of use of spacing to indicate word boundaries, is consistent with the findings throughout the data and will be discussed in the response to question four.

Given the flexibility of patterns of development among individual learners, it may be said that the data in this study support the proposition that illiterate adults in a non-literate context pass through the same stages of development in the writing

process as do children. While the manner of communicating information to adults rather than children may change due to the adults' increased language ability, reasoning capacity and their different motivations and understandings in electing to attend literacy classes, the concepts foundational to writing skills, such as basic directionality and linearity of text, word spacing and letter formation, must still be given a chance to develop in each new adult writer.

### ***7.3 If patterns are evident, are they the same intra-individual, or is each adult learning sequence unique?***

As with the findings for the first research question, the response here is mixed. The patterns in the data of each individual are unique in

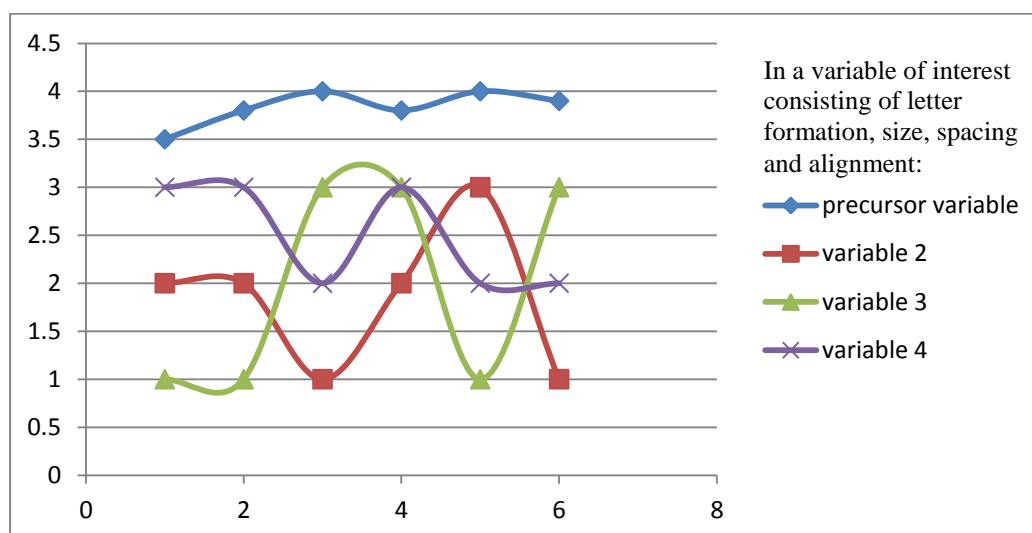
- the percentage and range of correct output shown in the data, as the work of high and low achievers in any learning situation will reveal;
- the order in which each element of the variable of interest develops;
- the progression and regression of each element, as seen in the dips and progressions of each factor and in the interaction of each factor with other elements.

From the data, it is not possible to predict for a particular individual or to generalize for the population as a whole which factors will act in concert or in competition. The patterns evident in the data are not the same intra-individually.

While the patterns produced are definitely not "one size fits all," some generalities which may be useful were proposed in chapter five and are repeated here in a more generic form in chart 75. For the proposed model, the elements which varied intra-individually were separated from the generalities that were consistent across the data. This consistency was evident in the types of patterns formed by the roles or functions expressed by each of the elements in the variable of interest. So while the data cannot indicate a particular order of development or interaction among the elements, they do indicate specific roles and functions that will be evident within the variable of interest at any given point. The most common pattern of functions in the data can be characterized as a 1-2-1 pattern, with one element acting in the role of precursor, two elements regressing or progressing together as connected growers, and one element moving in the opposite direction

to the connected growers as a competitor. The concentration of a learner's effort on one or two elements instead of all four concurrently in equal measure implies again the need for teachers who are aware of the different elements involved, who reinforce previous learning and who are willing to look more broadly at overall performance of all elements to interpret a regression in one element. Because all four elements in the variable of interest continue to interact and influence each other, it is possible to interpret other patterns in the data as well; different elements shift into the roles of connected grower and competitor at different stages, as is reflected in the generalized model.

So the findings in respect to the third research question are also that certain aspects of the data, but not all, are consistent intra-individually and are represented in the proposed model.



**Chart 75. Proposed model of writing development in Bambara women**

#### ***7.4 What can be learned from the seeming regression, or “dips in developmental progress”, for teaching and evaluation?***

Perhaps the most important concept illustrated by this study is that of regression in performance as a positive indicator of learning. In the model, as indeed in the graphs of the individual data sets, it is seen that when one element makes a huge gain in output, two others show a concurrent regression in performance. This downward trend is subsequently recovered, creating “dips” in the graphic representation of the data which may cause a teacher to wonder what happened to those skills that the student had already demonstrated as having acquired. Armed



with the understanding provided by DST, the same teacher might look again at the student's work to ascertain the area in which the student was making a leap in progress to explain the poorer performance in other areas. This notion of failure-as-progress has implications for the areas of teaching and assessment.

First in teaching, these learning patterns indicate that it may be useful to scaffold and revise even those elements in which students have already demonstrated some level of attainment. Over-learning to the point of automaticity in the acquisition of basic writing skills may lessen the cognitive load on the new writer, causing fewer dips in progress and perhaps greater stability. While this would necessitate more drills and exercises being incorporated into the handwriting instruction, they should never be separated from the idea of writing for meaning, to aid the learner in transitioning to higher level operations without sacrificing accuracy in basic skills.

The fact that these dips in performance are evidenced at different points for each learner underscores the individuality of the learning process. A balance must constantly be negotiated between whole class and individualized instruction to respond to the needs of the different learners. Again, an increase in exercises of different types, employing different learning preferences and addressing specific skills, should be incorporated to aid each of the learners to achieve their learning goals. Incorporating this practice into the design of a language course responds to the design principle of having “an appropriately and adequately differentiated course” (Weideman, 2014:17) – one of the principles of course design that predictably finds support in the theoretical rationales for courses (and language tests) that are supported by analyses arising from a DST perspective.

In evaluation, the dips in performance as seen in this model of writing development advocate in favor of continuous, or at least frequent, assessment of learners' progress as well as careful consideration of what is included in the scope of assessment. The model demonstrates the various states of skills acquisition at each stage of development. If evaluations are made at only a few points during the learning period, the picture of the learner's acquisition is incomplete and could be misleading. Caution should be exercised to ensure that no one assessment of a learner's performance is seen as being definitive of skill attainment, because the different elements continue to interact and influence each other throughout the

learning period, even after an element has achieved a consistently high degree of output. In addition, if different aspects of the learning process are interacting to influence each other as demonstrated in the model, then all of these aspects need to be considered in the content of the evaluation, in order to ascertain that the learner is indeed progressing in some aspect of the subject matter and is not, in fact, losing their way altogether. If different aspects of writing are not included in the evaluation, there would be no means of determining if the learner is progressing in one area while struggling in another or is simply struggling on all fronts.

### ***7.5 Why is a dynamic systems analysis of writing useful?***

Let me close, however, with an obvious caveat. None of the work described here qualifies as a full model of language use. The range of phenomena illustrated is suggestive, but limited. As any linguist will note, there are many, many questions which remain unanswered. .... These networks are input/output devices. Given an input, they produce the output which is appropriate for that training regime. ... Put most bluntly, these are networks that do not think! (Elman, 1995:219)

Dynamic Systems Theory is employed in this study not to refute or replace the research methods used traditionally, but to add to what can be known and discussed about writing development, adding another arrow in the quiver of understanding of the processes involved in learning and language development. In DST, the model expresses the patterns of complexity, self-organization and emergence of new interactions within the framework of the whole (Thelen & Smith, 2006:271). The usefulness of the model is in the visual representation of the process, reminding literacy facilitators of the variable nature of writing acquisition and addressing the recurring question of competence versus performance, or from a DST perspective, the issue of regression and progression in the availability of resources: why does a learner do well in the performance of one task but then less well at a later stage at a similar task (ibid.:278)?

The development of writing skills was defined at the beginning of this study as the formation of letters and spatial and directional orientation of symbols reproduced manually on a page by previously illiterate adults, which provides a mechanism to support self-expression. A greater understanding of the inner workings of this

mechanism will facilitate the instruction of new writers' capacity to convey their thoughts in written form without the hindrance or distraction of imperfectly mastered technical skills, as well as allowing new writers the freedom to regress without being labeled a failure. Thus, a study of emergent patterns in early writing skills provides a foundation to understanding which should precede study of writing development at the compositional level. If, as studies have shown (see chapter 2, Handwriting in adults), the act of transcription interrupts or delays the process of recording thought, then the development of writing skills from their inception need a better description and understanding before the study of compositional skills can be most fruitfully examined. In addition, a study of this process in newly literate adults, with their different motivations, different language development/oral communication level, and different perception of reading and writing, is sadly lacking in the literature.

Beyond the models, beyond the theories, it is fundamental to the study of language development at any level to have a basic awareness of the range of patterns of development in order to know when variance goes beyond the bounds of normal, indicating a need for further intervention. The definition of such a range is rendered more complex by the recursive nature of the learning process, i.e. the way in which learners seem to forget or regress, then make subsequent leaps of progress. The implications of this phenomenon for assessment and instruction should influence the support given in skills acquisition as well as the timing, frequency and focus of evaluation of progress. Attentiveness to the interactions of various factors influencing the learning process may more effectively facilitate movement from one level of attainment to another, even to the point of redefining regression as overall progress in the course of skills acquisition.

As is underscored by Elman at the beginning of this section, the range of elements under consideration in a given study is by nature limited. Only a handful of variables have been in focus for this study, while there are of course many more influencing factors affecting language development and learning. Language development is an open system unique to each individual. As such, it cannot be fully known or completely described by a set of phenomena common to all across the board. But the fractal nature of language does give indications of tendencies

which illuminate certain aspects of the mechanisms emerging at different levels of language development. These mechanisms, or skills, need an elaborated base, an explanation of how the foundations of lower-level writing skills emerge in adult learners, in order to better inform instructional and interventional practice. To that end, the results of this study are offered as a baseline for further investigation into the development of writing skills in adults.

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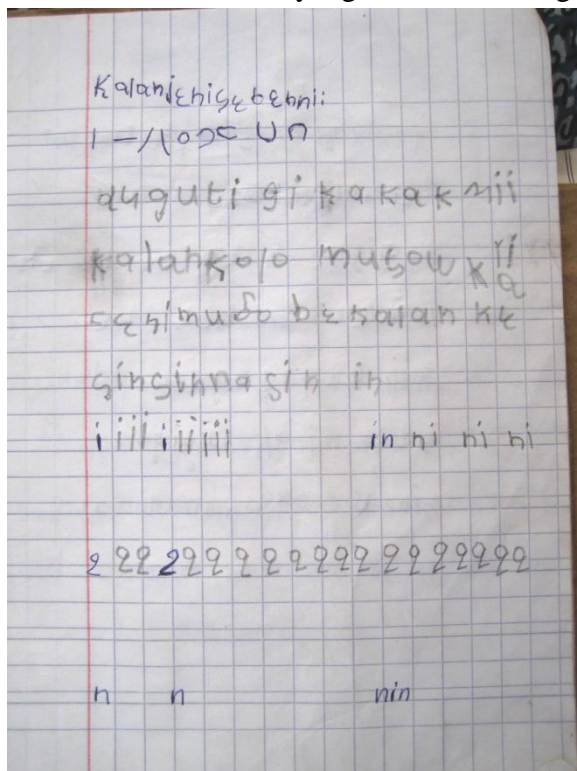
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## Appendix A. Writing samples over a three-month span

### 1. Assan Coulibaly, age 23, Diallobougou (6 samples, 3 months)



(month 1) symbols: 95 (numbers excluded)

formation: 6/95 variance, 93.6%

size: poor alignment interferes. 13.6%

spacing: 9/17 word break variance, 52%

alignment: 56/95 variance, plus word order and letter order: 'in' as 'ni' 30%

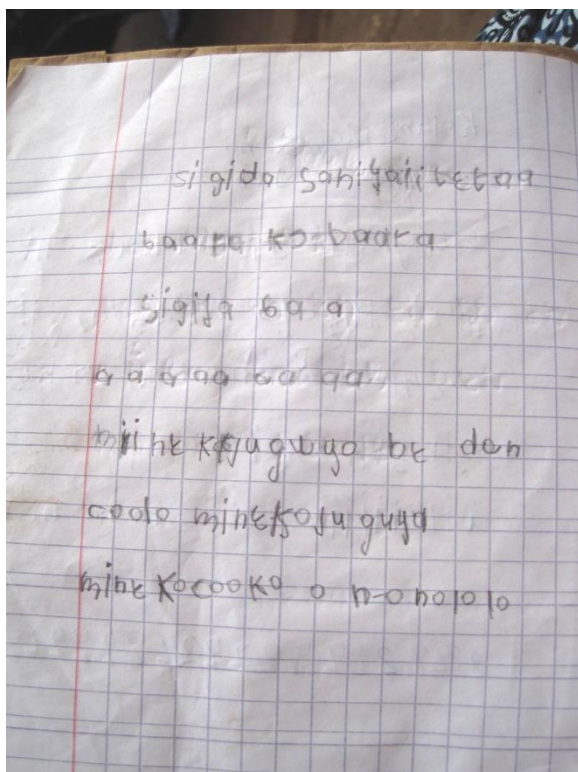
sentence to be copied:

"dugutigi ka kan ka miiri musow ka kalan ko la." (the village chief must think about [the subject of] women's study)

duguti gi ka ka mii kalankolo musowka (ĩi – may be the missing 'ri' from 'miiri')

Dictation: "Cε ni muso be kalan ke sinsinni." (the man and woman persevere in study)

cenimuso be kalan ke sinsinna si n in



## (month 2)

symbols: 104

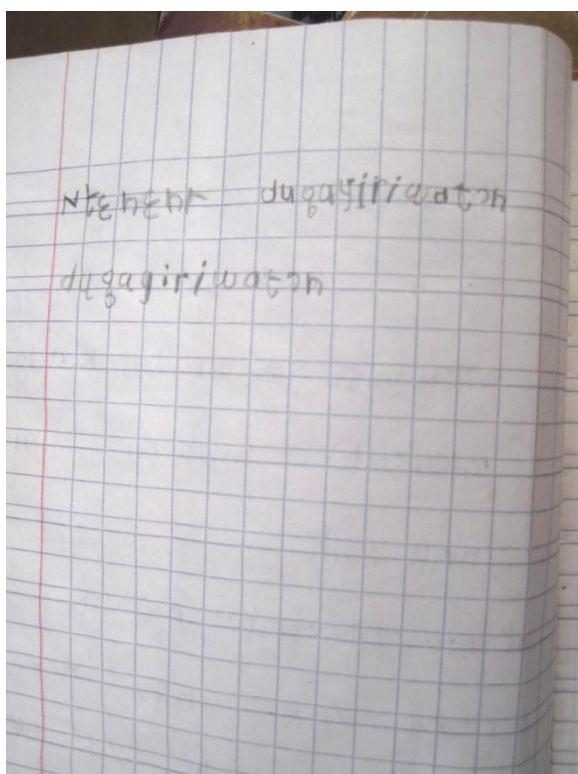
formation: 13/104 variance, 87.5 %

size: 42/104 variance, 59%

spacing: 7/15 word break variant 53%

alignment: 57/104 variance, 45%

awareness of words, but difficulty in getting a whole word without error



## Monday,

dugu yiriwa ton (village development association)

symbols: 33

formation: 4/33 variance, 12%

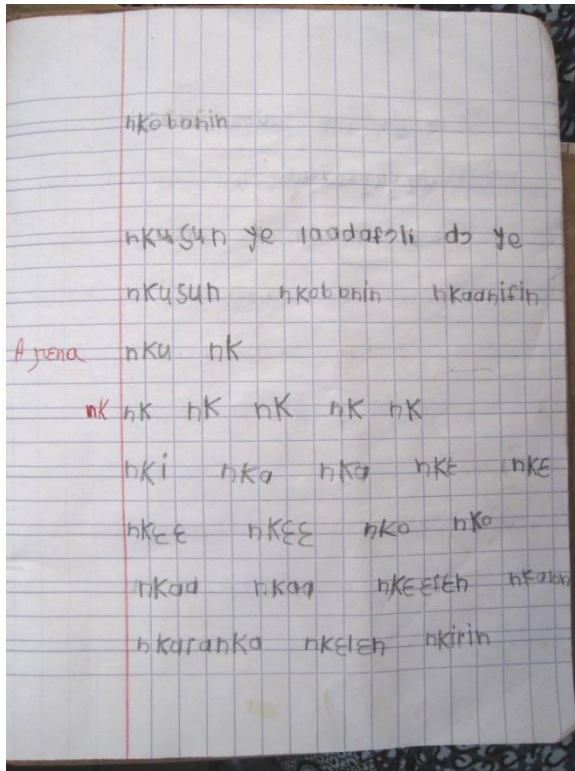
size: 13/33 variant

spacing: (see above)

alignment: 18/33 variance, 54%

spacing success due to paucity of data, but the three words were spaced appropriately.





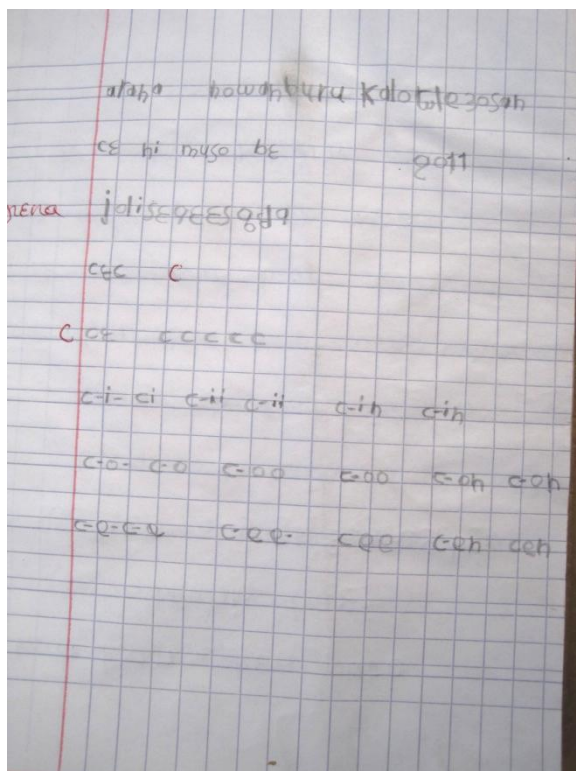
symbols: 138

formation: 12/138 variant

size: 39/138 variant

spacing: (see above)

alignment: 45/138 variance, 32.6%



(month 3)

Wednesday, November 30, 2011

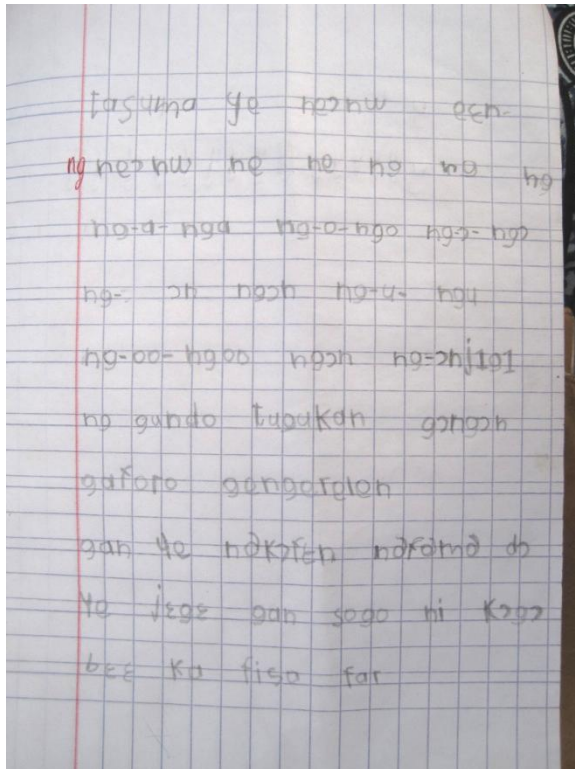
symbols: 111

formation: 9/111 variance, 91.8%

size: 33/111 variance, 70%

spacing: 5/10 word break variance, 50%

alignment: 46/111 variance, 58.5%



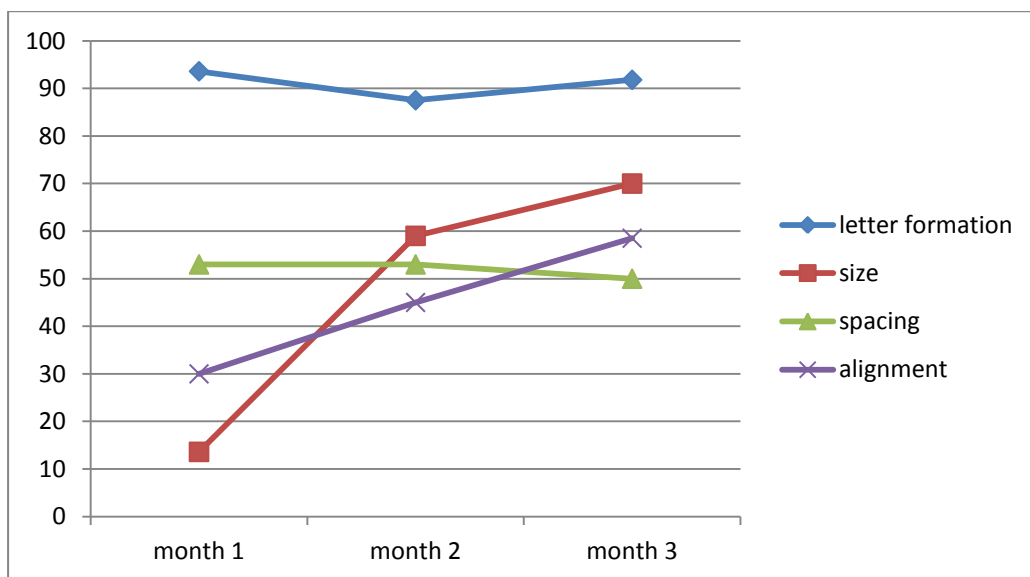
symbols: 171

formation: 15/171 variant

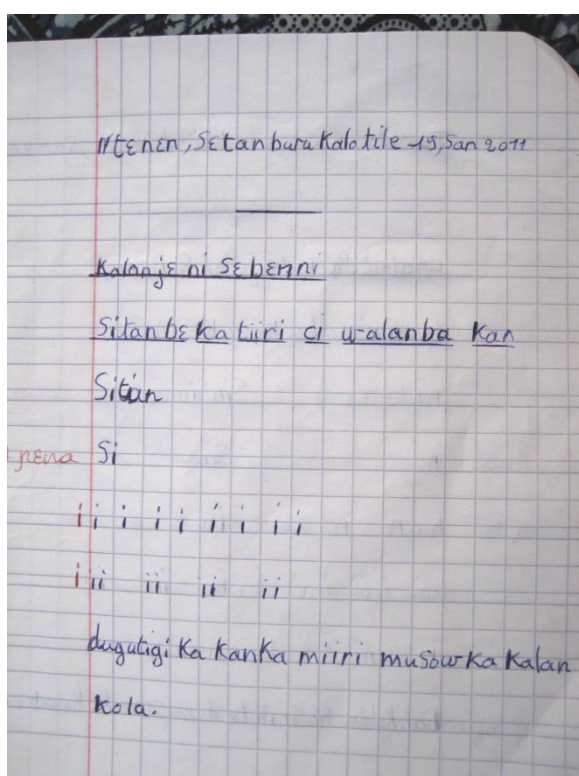
size: 45/171 variance, 26%

spacing: (see above)

alignment: 37/171 variant



## 2. Ami Sanogo, age 26, Diallobougou (4 samples, 3 mo)



ntenen, setanburu kalo tile 15, san 2011  
Monday, September month day 15, year 2011  
kalanje ni sebenni – reading and writing

### (month 1)

Sitanbe ka tiiri ci walanbe kan.

Sitanbe must trace the lines on the board.

symbols: 131

formation: 6/131

variance, 95.4%

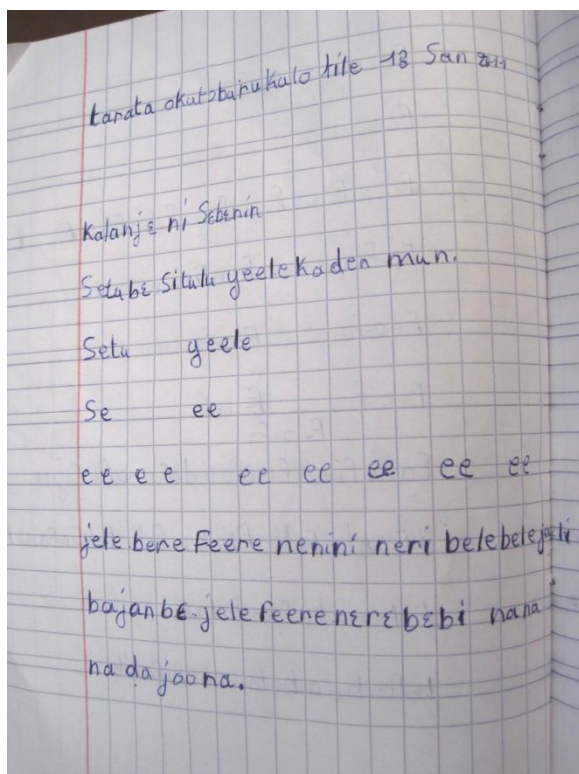
size: 29/131 variance, 77.8%

spacing: 5/20 word break variance, 75%

alignment: 16/131 variance, 87.7%

Dugutigi ka kan ka miiri musow ka kalanko la.

The village chief must think about (the subject of ) women's study.



### (month 2)

symbols: 172

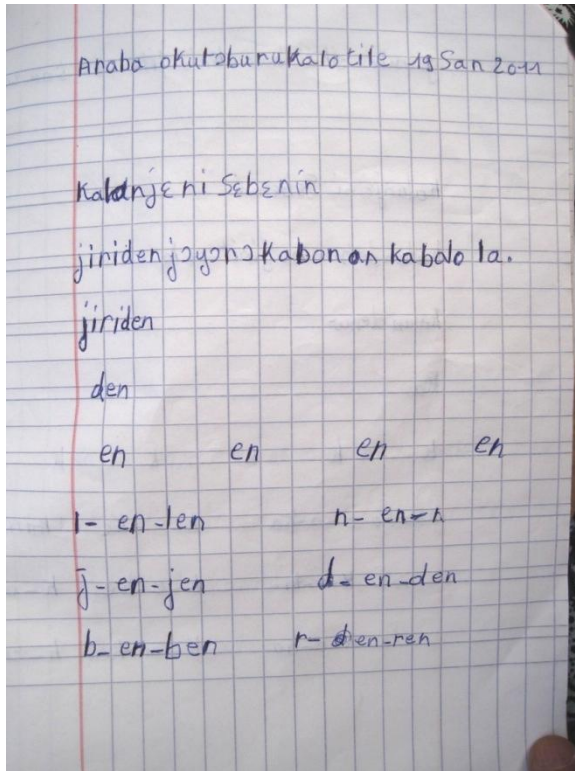
formation: 23/172

variance, 86.6%

size: 30/172 variance, 82.5 %

spacing: 10/35 variance, 71.4%

alignment: 18/172 variance, 89.5%



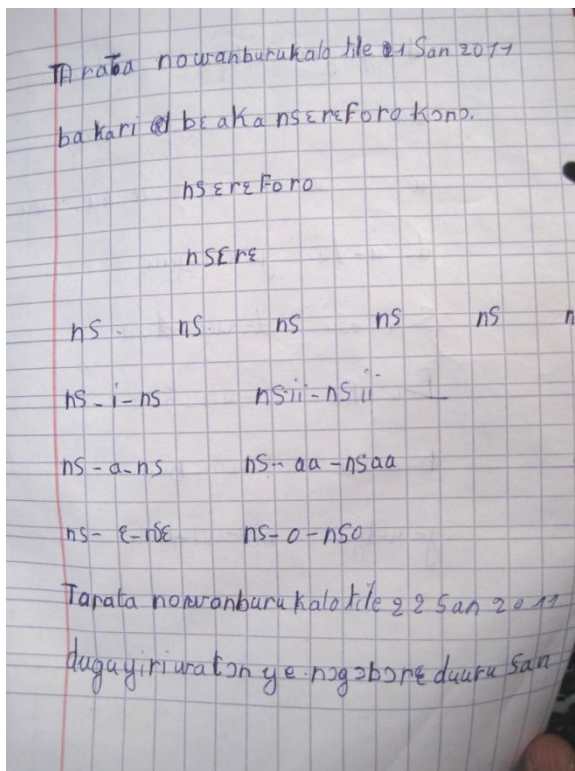
symbols: 128

formation: 6/128 variant

size: 22/128 variant

spacing: 6/13 word break  
variant

alignment: 21/128 variant



(month 3)

symbols: 185

formation: 5/185

variance, 97%

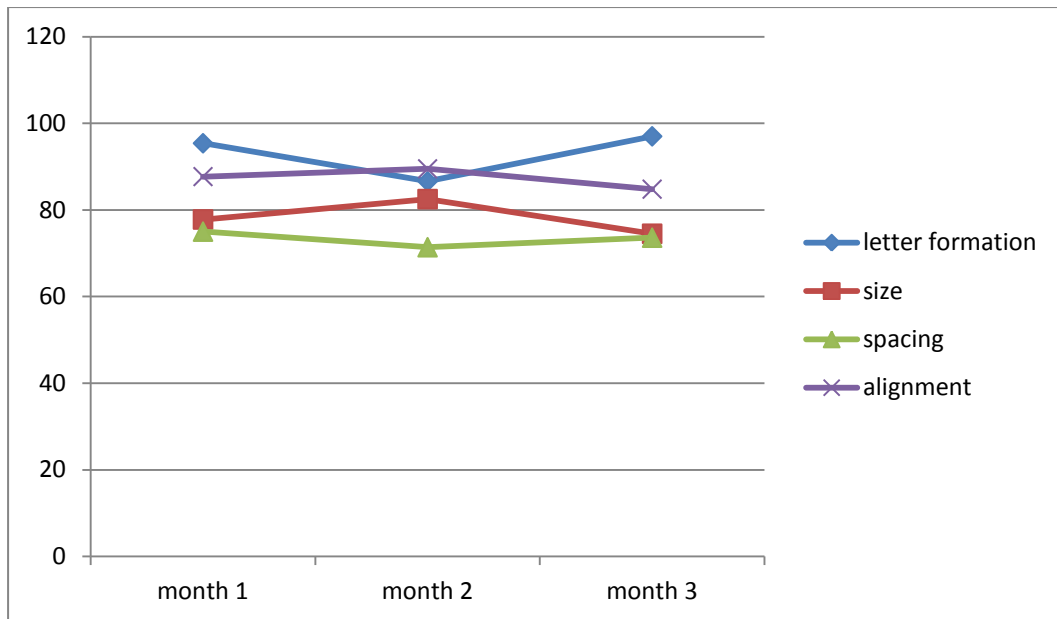
size: 47/185 variance,  
74.5%

spacing: 5/19 word break  
variance, 73.6%

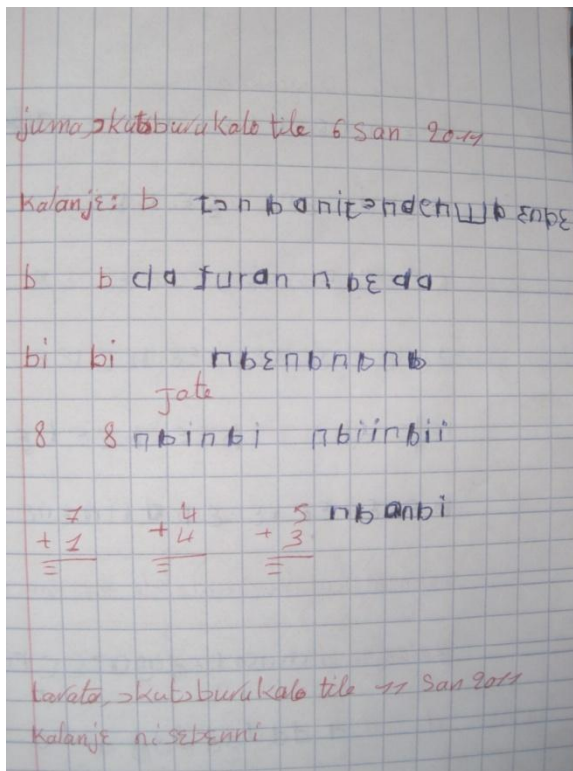
alignment: 28/185

variance, 84.8%





### 3. Fatoumata Barité, age 28, Centre Netaa (6 samples, 3 mo)



#### (month 1)

(Text in red provided by the instructor)

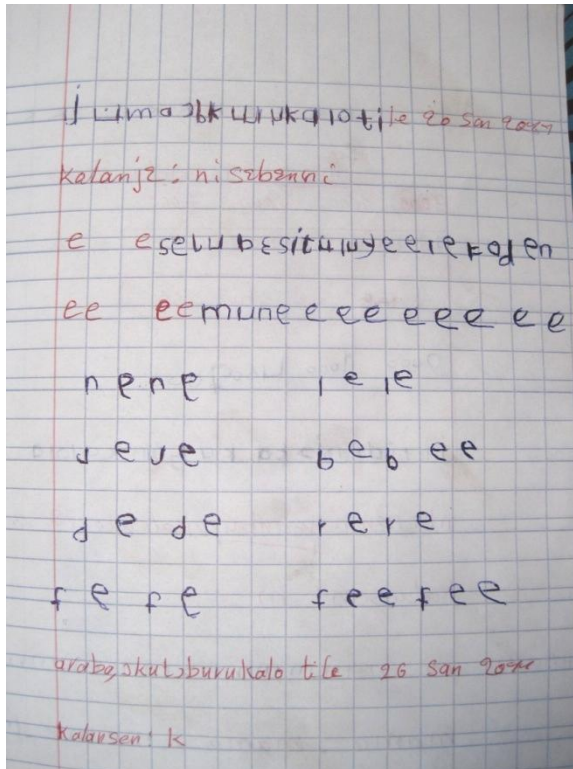
symbols: 60

formation: 20/60 variance, 66.7%

size: 18/60 variance, 70%

spacing: 11/17 variance, 35.2%

alignment: 28/60 variance, 46%



symbols: 84

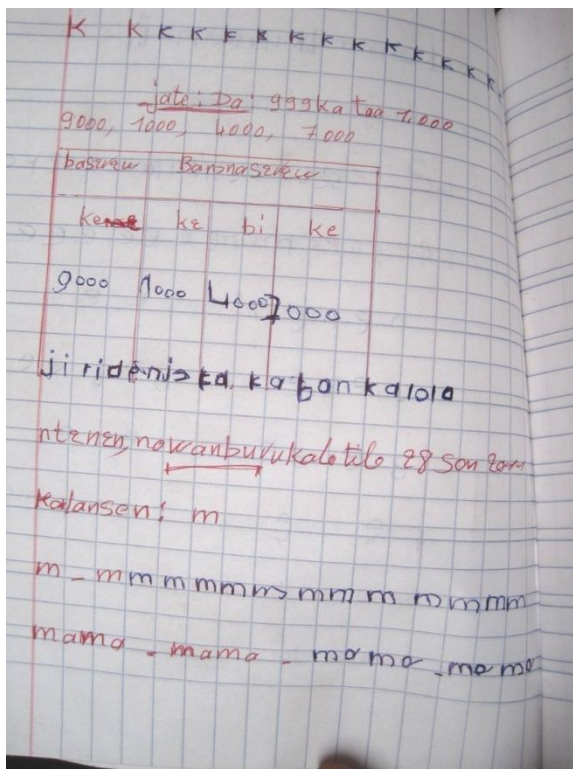
formation: 15/84 variance, 18%

size: 56/84 variance, 67%

spacing: between letters  
inconsistent, 5/9 word break  
variance, 55.5%

alignment: 59/84 variance, 70%

(Setu be situlu yeele ka den mun.)



symbols: 54 (numbers excluded)

formation: 4 (15/54 variance,  
28%)

size: 4 (21/54 variance, 38%)

spacing: 2 (letters yes, words no)

alignment: 4 (15/54, 28%)

(month 2)

Combined 28 & 30 Nov:

symbols: 85

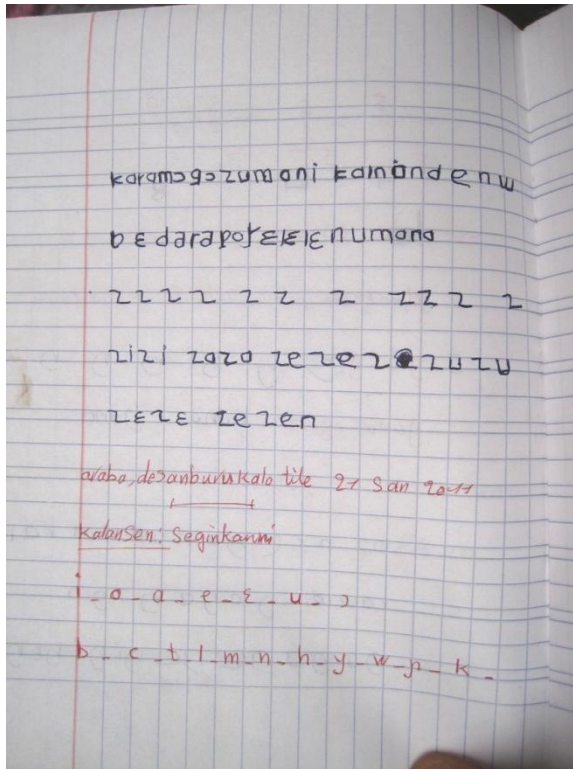
formation: 28/85 variance, 67%

size: 28/85 variance, 67%

spacing: 50%

alignment: 26/85 variance, 69.4%





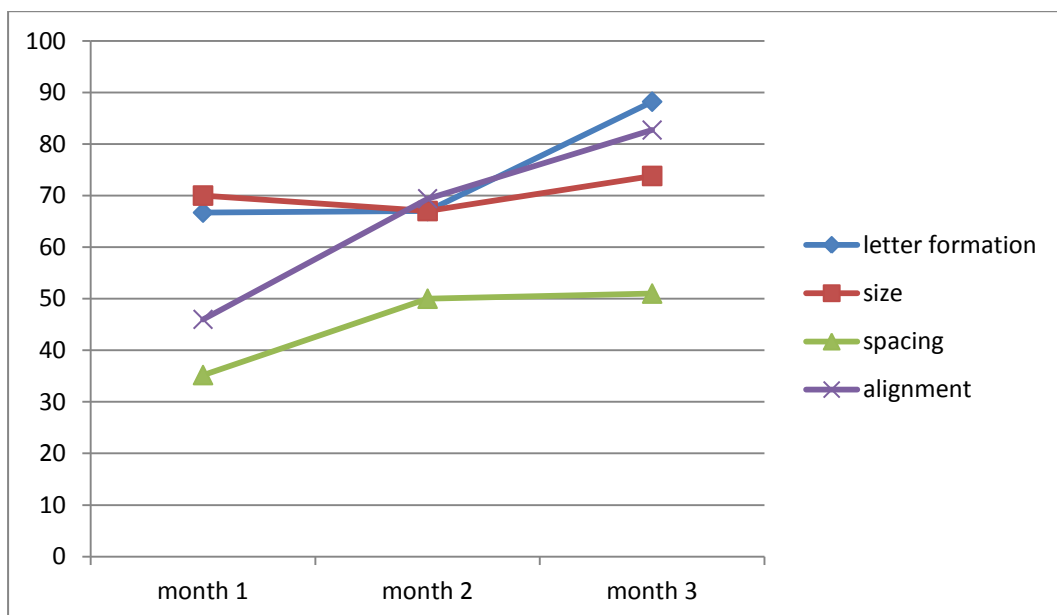
symbols: 83

formation: 5/83 variant

size: 16/83 variant

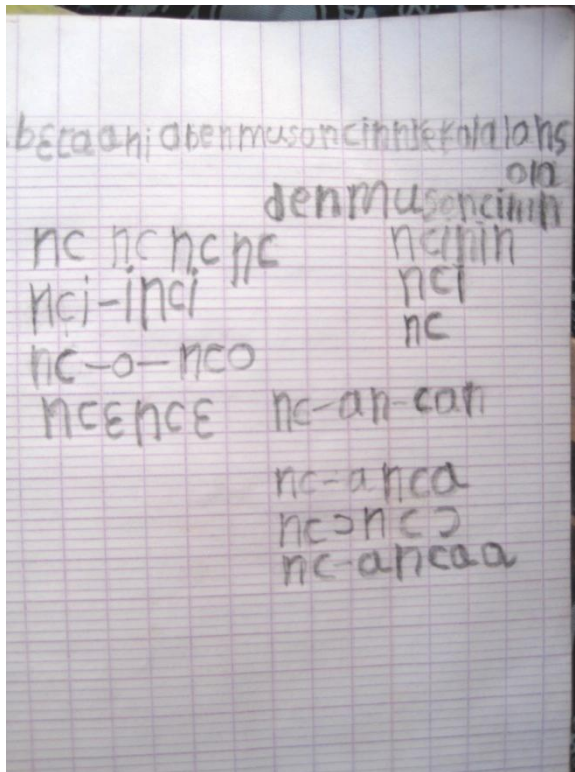
spacing: 11/21 variant

alignment: 12/83 variant





4. Maï Danté, age 35, Dialloubougou (5 samples, 3 mo, debutant example)



symbols: 110

formation: 17/110 variant

size: 103/110 variant

spacing: 12/16 variant

alignment: 86/110 variant

**(month 1)**

Combined:

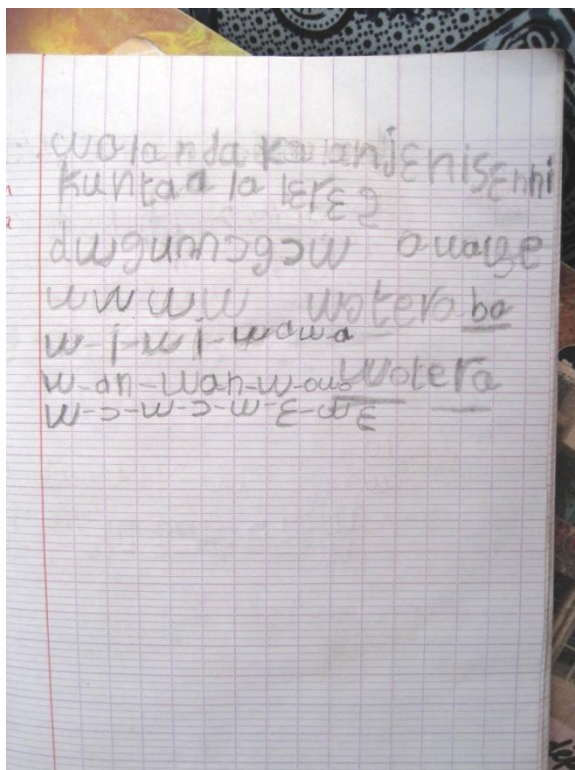
symbols: 201

formation: 42/201 variance, 79%

size: 187/201 variance, 7%

spacing: 20/28 variance, 28.5%

alignment: 161/201, 29.9%



symbols: 91

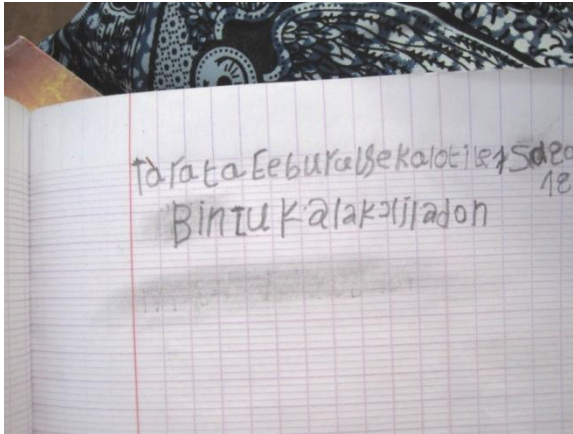
formation: 25/91 variant

size: 84/91 variant

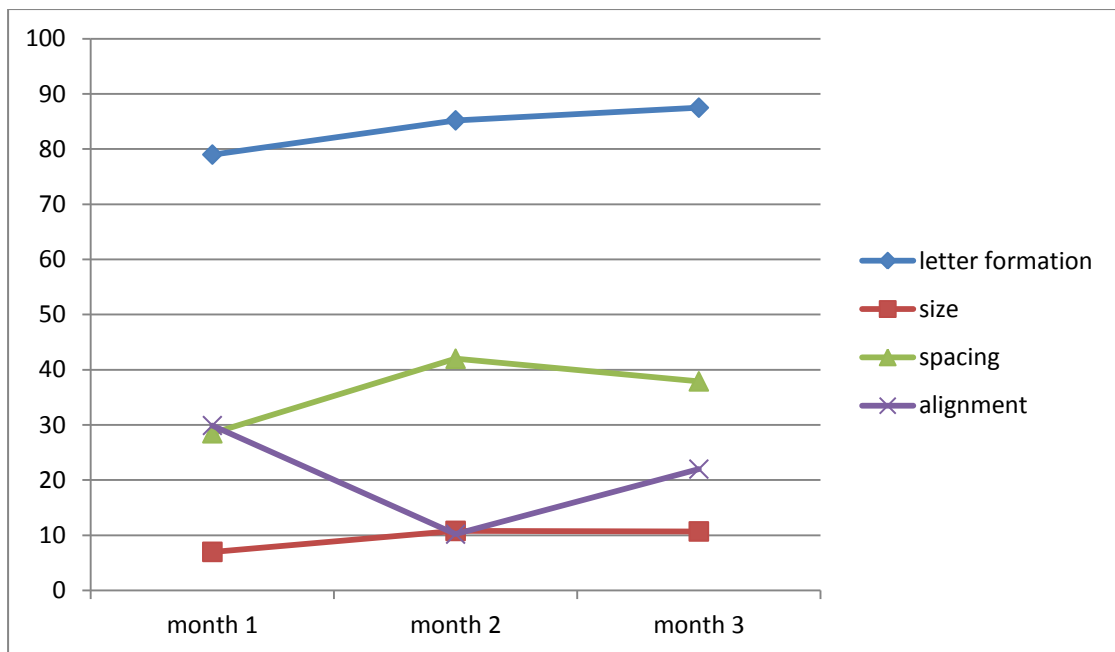
spacing: 8/12 variant

alignment: 75/91

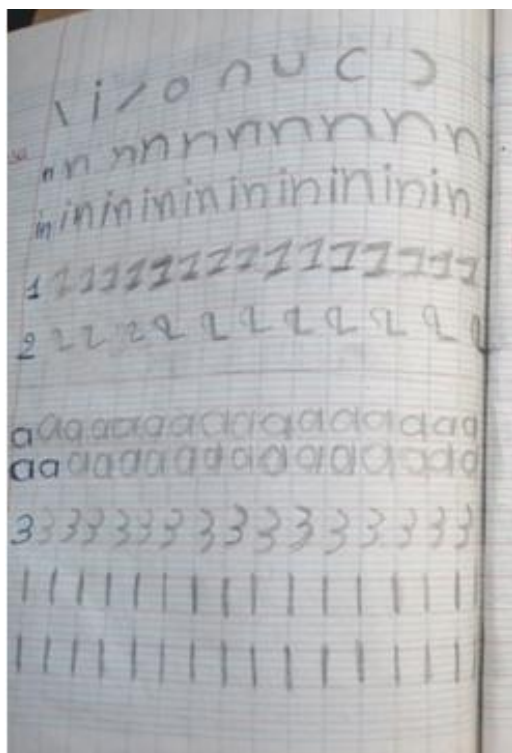




symbols: 47  
 formation: 11/47 variant  
 size: 41/47 variant  
 spacing: 7/9 variant  
 alignment: 36/47 variance, 77%



5. Djara Coulibaly, age 39, Diallobougou (5 samples, 3 mo.)



symbols: 56 letters

formation: 19/56 variance, 34% note heavy tracing over each line, denotes 'drawing' instead of 'writing'

size: 47/56 variance, 84%

spacing: 17/37(following columns on page)

alignment: 32/56 variance, 57%

**(month 1)**

combined:

symbols: 222

formation: 144/222 variance, 35%

size: 121/222 variance, 45.5%

spacing: 94/205 variance, 54%

alignment: 119/222 variance, 46%



symbols: 166

formation: 95/166 variance, 57%, if re-tracing over the form is counted as 'drawing' variant

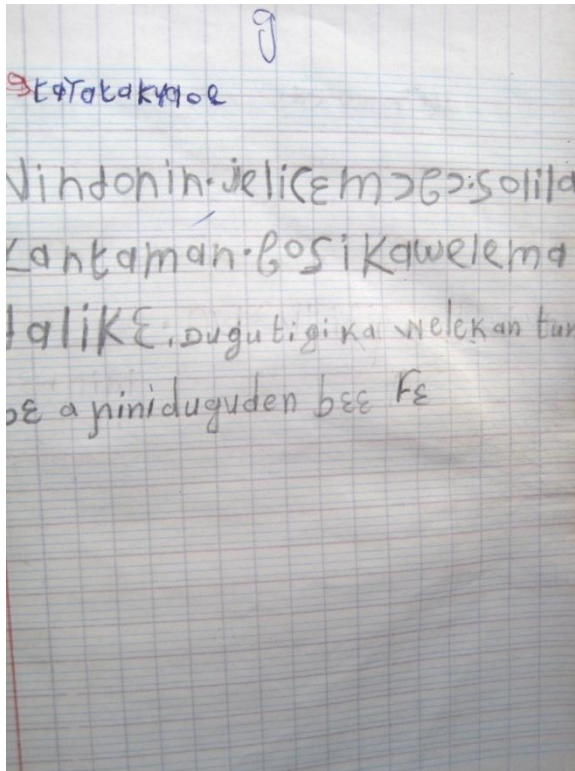
size: 74/166 variance, 44%

spacing: 77/168 variant (spaces between 'ii')

alignment: 87/166 variance, 53%







(connected text writing sample)

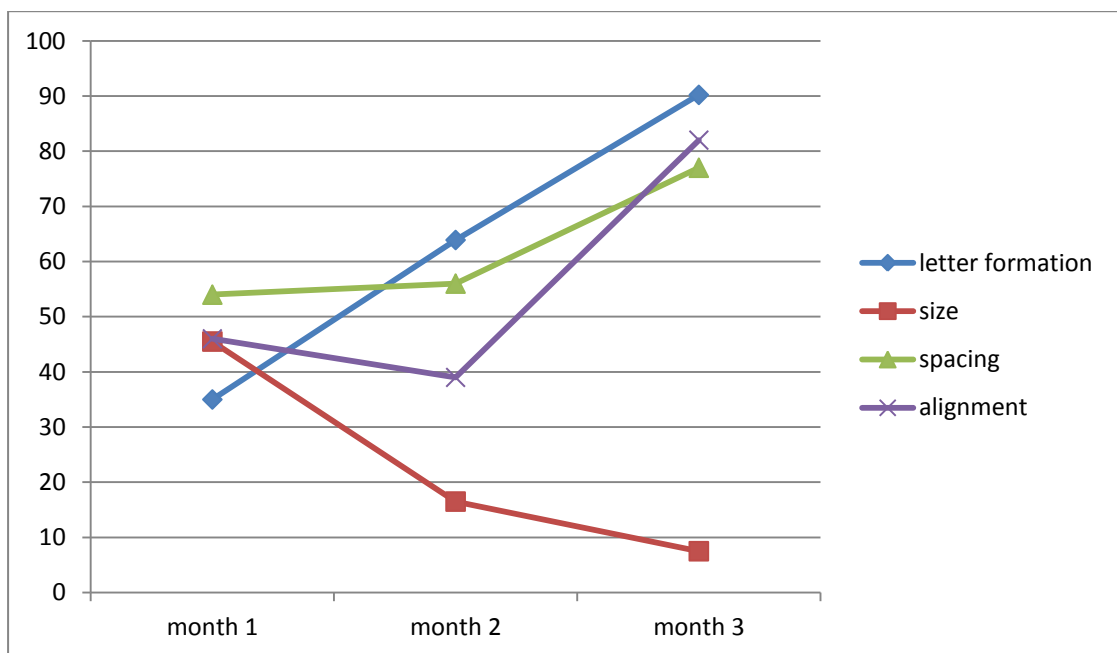
symbols: 102

formation: 13/102, inverted 'g'

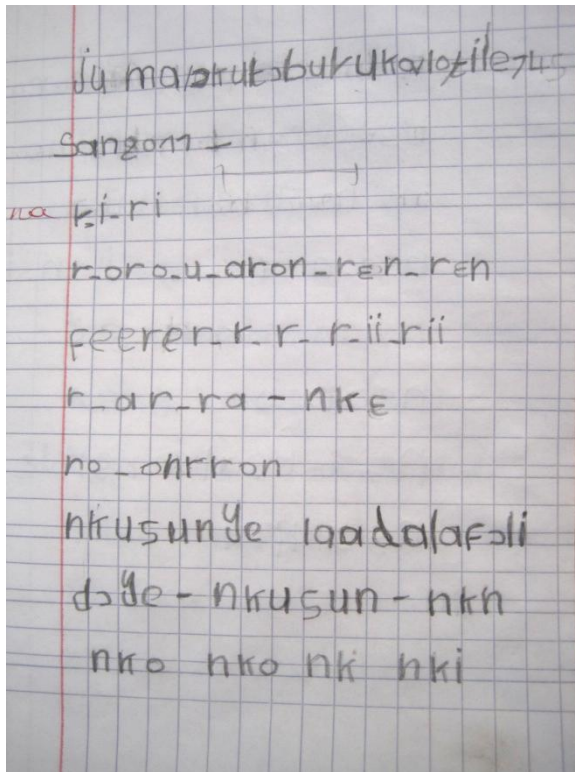
size:

spacing:

alignment: 66/102 variance, 64%



6. Sadjo Doumbia, age 40, Diallobougou (5 samples, 3 mo)



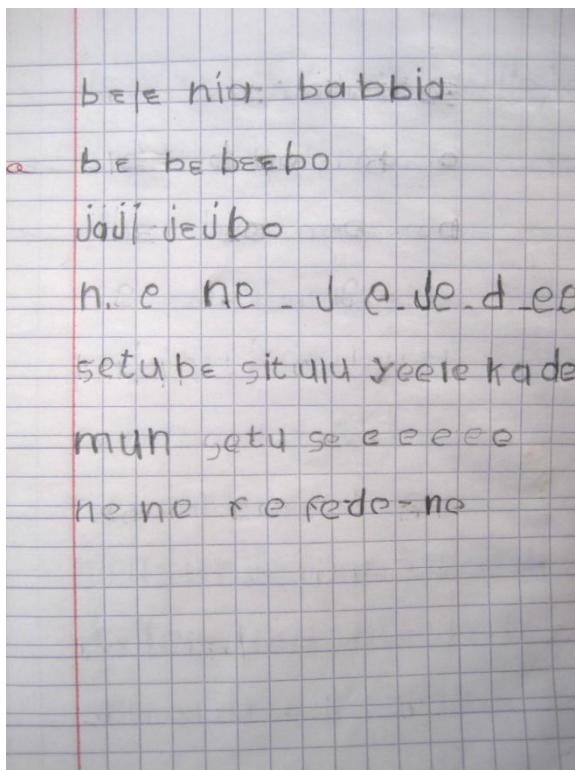
symbols: 121

formation: 13/121 variance, 89.2%

size: 88/121 variance, 27.2%

spacing: 16/79 variance, 79%

alignment: 34/121 variance, 71.9%



symbols: 88

formation: 18/88 variant

size: 57/88 variance, 64%

spacing: 7/15 variance, 53.3%

alignment: 35/88 variance, 40%

(month 2)

combined:

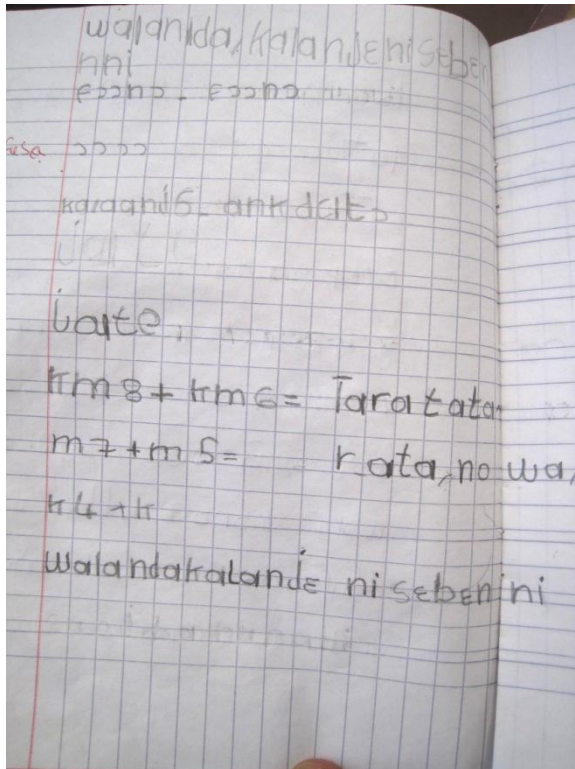
symbols: 186

formation: 27/186 variance, 85.4%

size: 116/186 variance, 37.6%

spacing: 45/100 variance, 55%

alignment: 66/186 variance, 64.5%



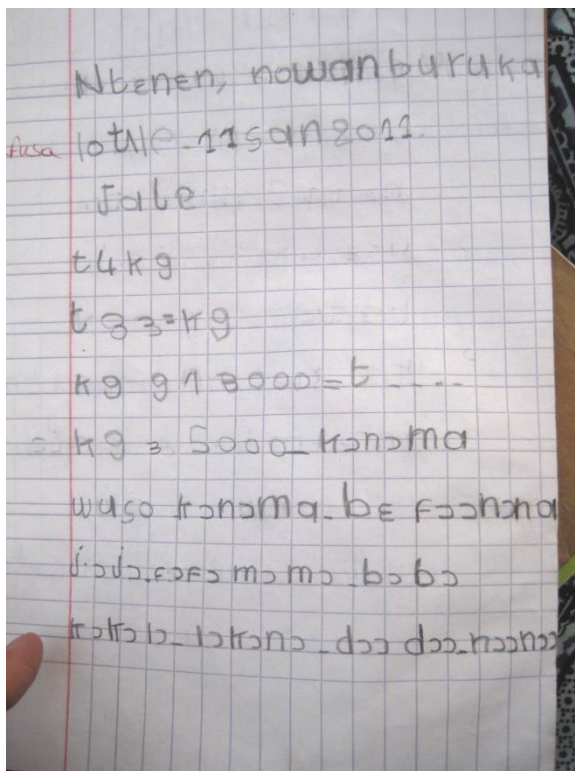
symbols: 98 (math excluded)

formation: 9/98 variant

size: 59/98 variant

spacing: 10/12 variant

alignment: 31/98 variant



symbols: 95 (math excluded)

formation: 11/95 variant

size: 40/95 variance, 42%

spacing: 6/10 variance, 40%

alignment: 19/95 variant

### (month 3)

combined:

symbols: 194

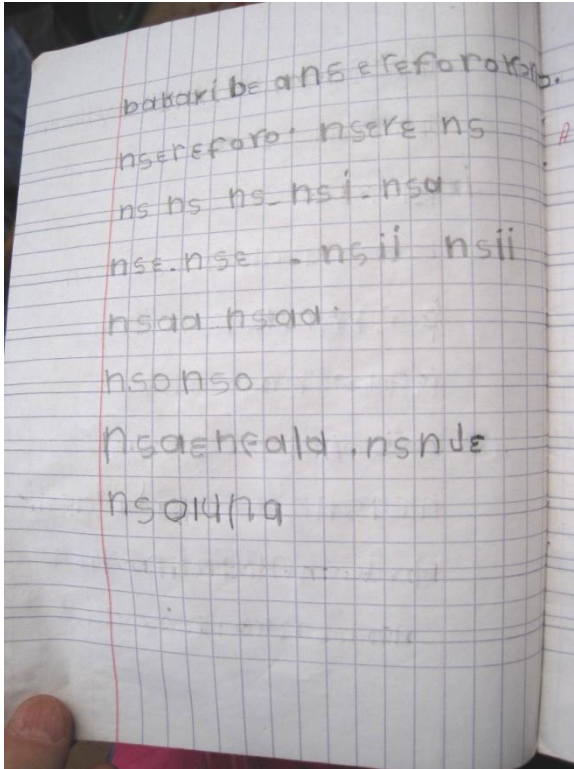
formation: 20/194 variance, 89.6%

size: 98/194 variance, 49.4%

spacing: 10/16 variance, 37.5%

alignment: 47/194 variance, 75.7%





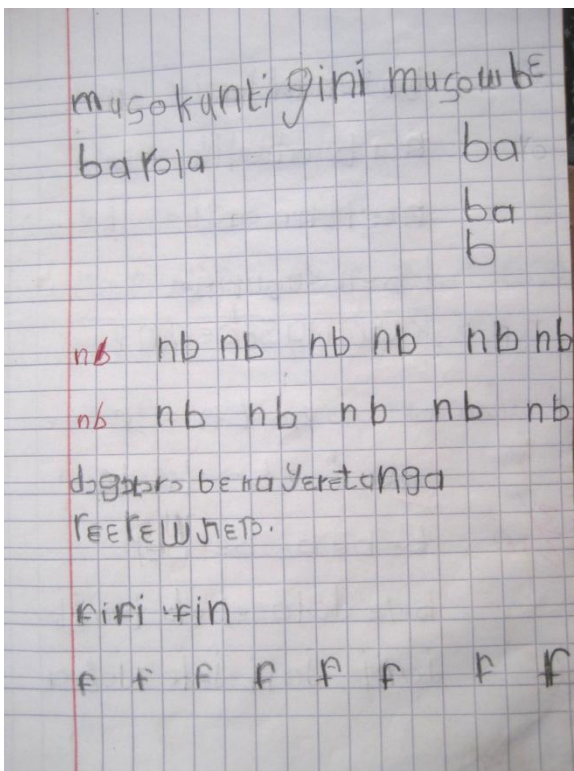
symbols: 99

formation: 9/99 variant

size: 58/99 variant

spacing: 4/6 (2 word breaks correct)

alignment: 28/99 variance, 28%



(sample of connected text writing)

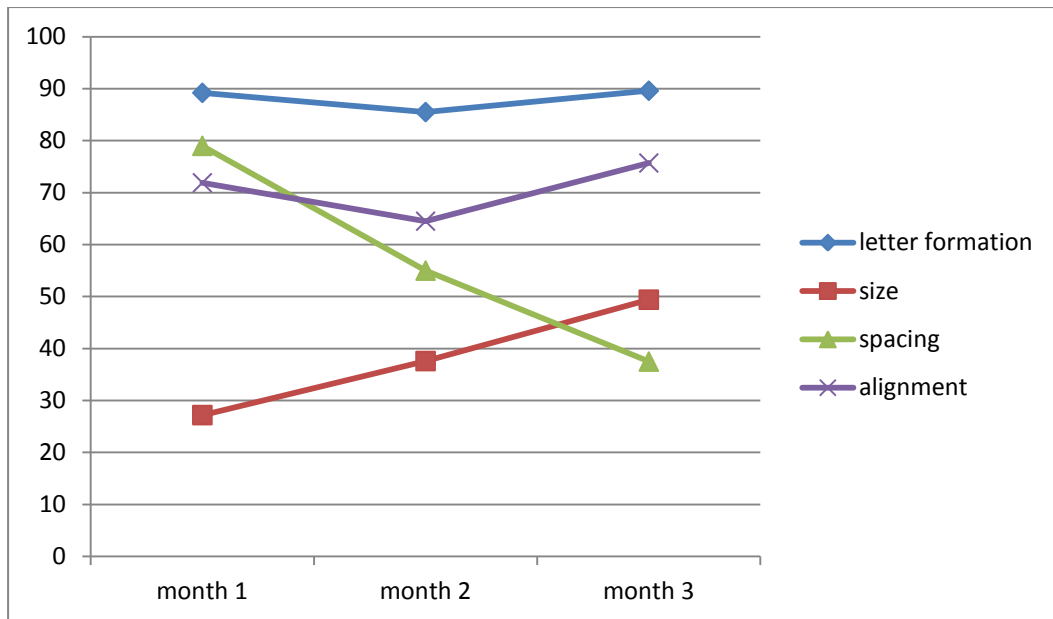
symbols: 99

formation: 4 (10/99)

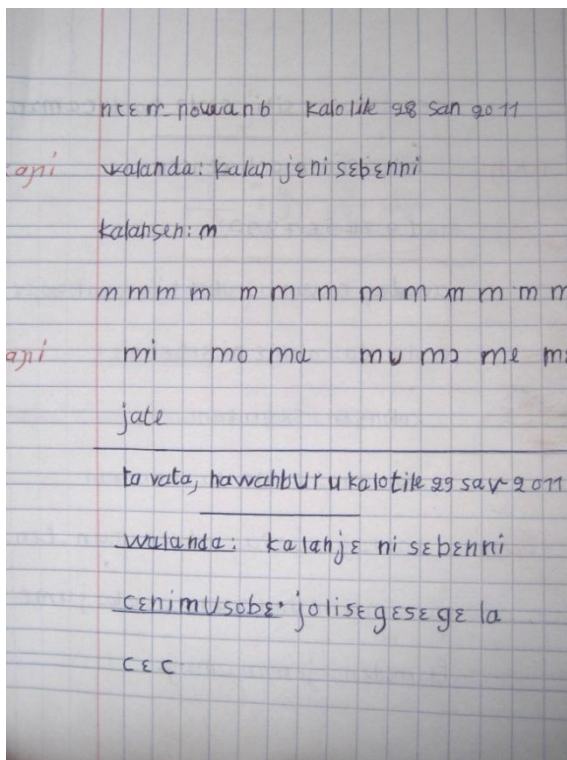
size: 2 (71/99 variance, 71%)

spacing: 0

alignment: 3 (45/99 variance, 45%)



7. Mariam Bah, age 41, Centre Netaa (6 samples, 3 mo)



(month 1)

symbols: 173

formation: 17/173 variance, 90.1%

size: 33/173 variance, 80.9%

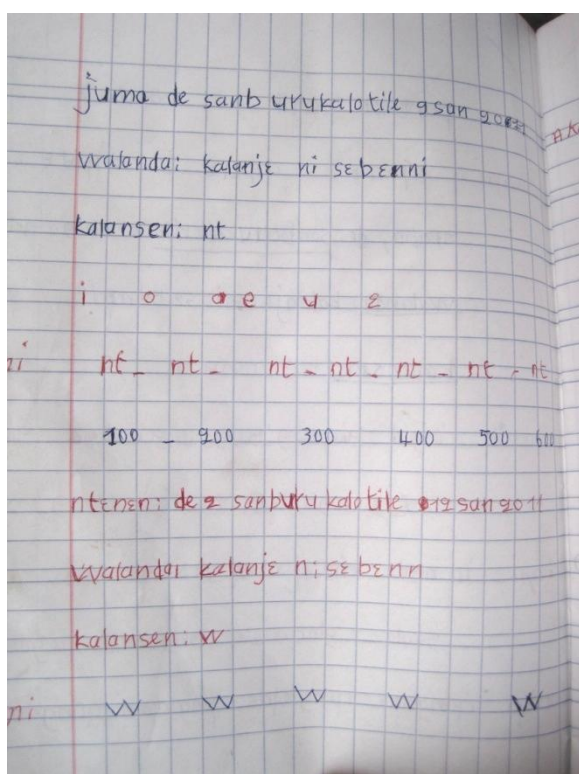
spacing: 11/25 variance, 56%

alignment: 27/173 variance, 84.3%

ce ni muso be joli segesegela  
man and woman pred how-much exam  
post

What were the man's and woman's  
exam results?

cenimusobe jolise gesegela



symbols: 153 (numbers excluded)

formation: 4 (15/153 variant)

size: 4 (29/153 variant)

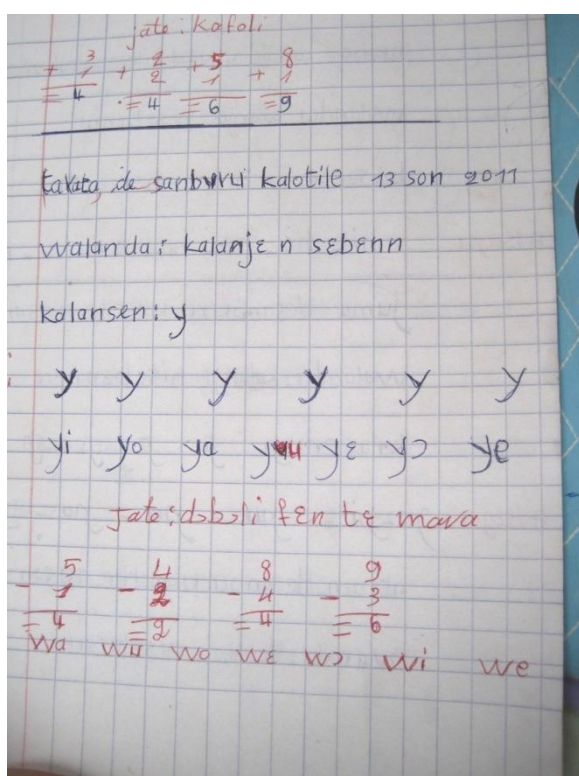
spacing: 1 (6 breaks within words, 5 word breaks omitted)

alignment: 4 (28/153 variant)

kalanje ni se b enni (first instance)

kalanje nise be nn (second instance)

line substituted for colon after second instance of walanda (blackboard)



Tuesday, December 13, 2011

symbols: 112 (excluding math)

formation: 4 (14/112 variant)

size: 4 (33/112 variant)

spacing: 3 (2/10 breaks within the word, 2/8 word breaks omitted)

alignment: 4 (25/ 112 variant)

tarata, desanburu kalo tile 13 san 2011

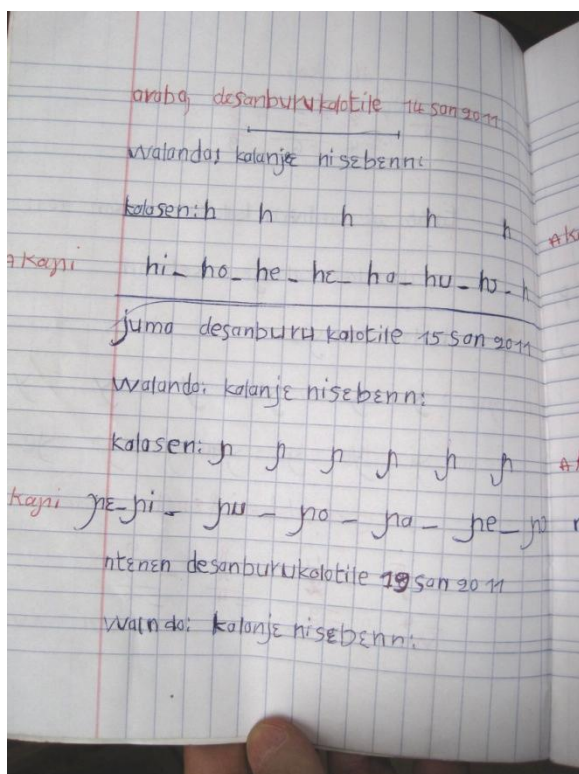
Tuesday December month day 13  
year 2011

tarata de sanburu kalotile 13 son 2011

walanda : kalanje ni sebenni

blackboard : reading and writing

walan da : kalanje n sebenn



Wednesday, December 14, 2011 and

Friday [sic], December 15, 2011

symbols: 215

formation: 4 (30/215 variant)

size: 4 (58/215 variant)

spacing: 4 (6/23 word breaks omitted, none added)

alignment: 4 (42/215 variant)

Monday, December 19, 2011

walanda: kalanje ni sebenni

blackboard : reading and writing

walndo: kolonje ni sebenni

(month 2)

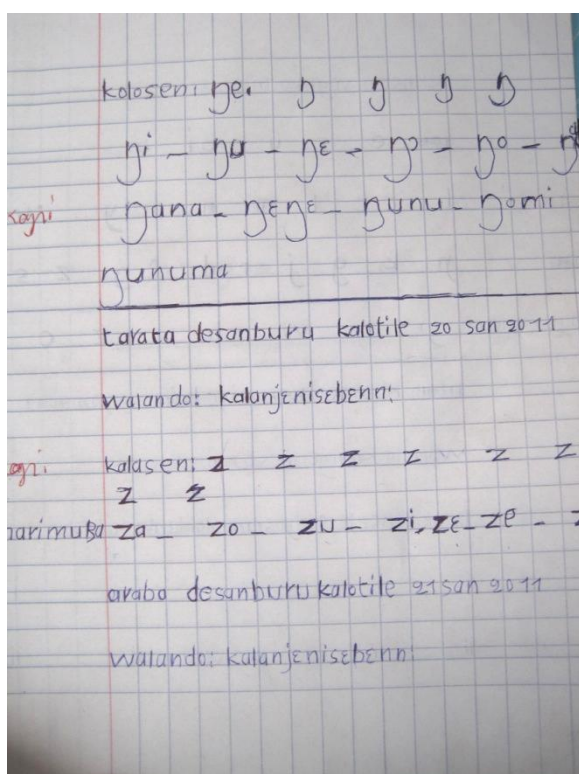
symbols: 184

formation: 18/184 variance, 90.2%

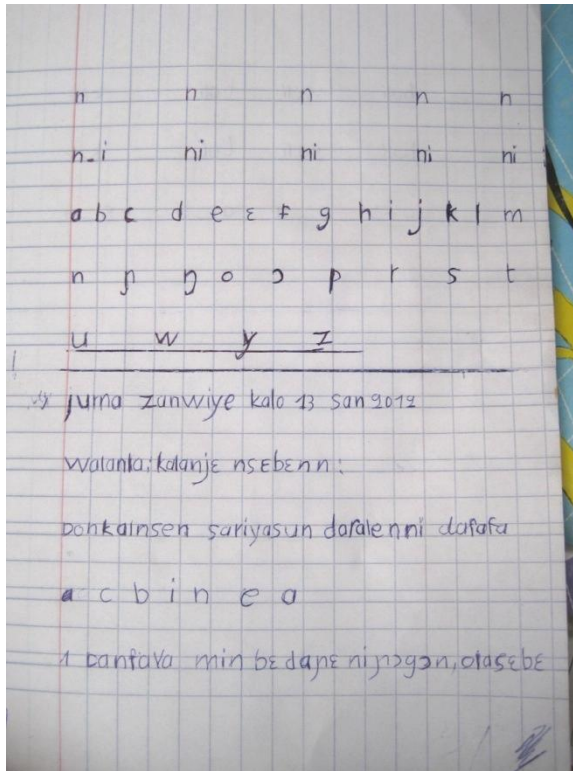
size: 21/184 variance, 88.5%

spacing: 7/16 word breaks omitted, 44%

alignment: 29/184 variance, 84.2%







### (month 3)

symbols: 160

formation: 20/160 variance, 87.5%

'tile' omitted from date

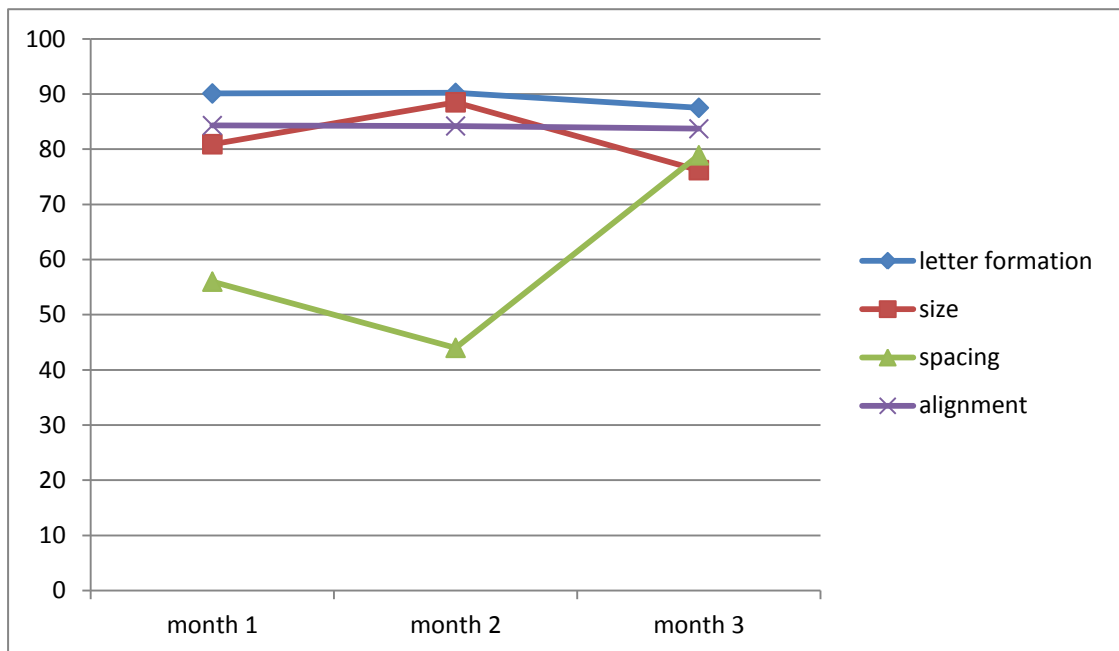
size: 38/160 variance, 76.2%

spacing: 4/19 variance, 78.9%

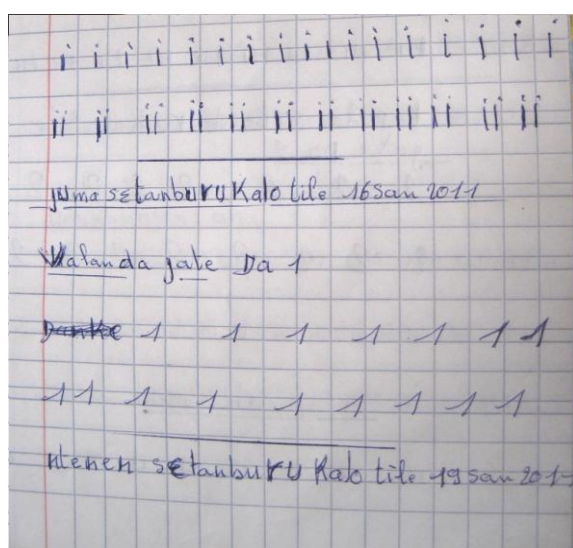
alignment: 26/160 variance, 83.7%

Donkalsen sariyasun daralen ni dafafa  
don kalansen? law fast ? spit and  
complete+intensifier?

Danfara min be dape ni jagon, olu sebe  
separation which word and another  
dem-pl write

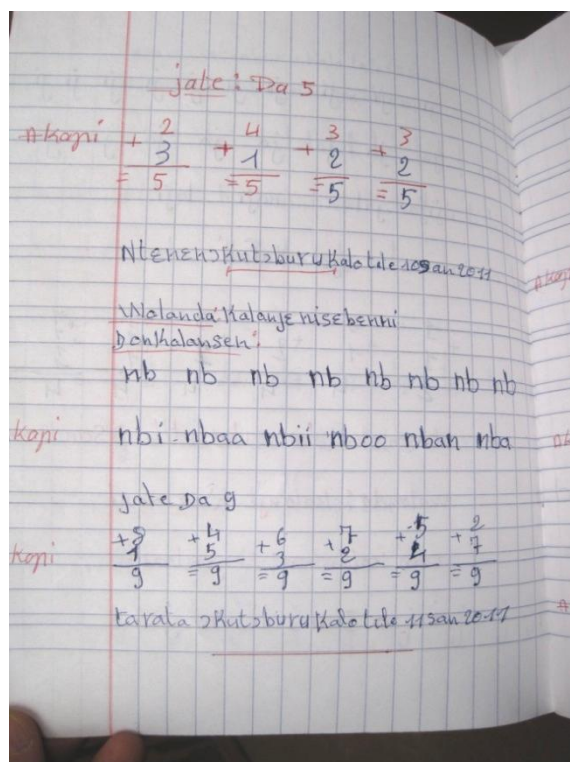


8. Mama Koné, age 48, Centre Netaa (4 samples, 3 mo)



(month 1)

symbols: 116 (math omitted)  
 formation: 7/116 variance, 93.9%  
 size: 72/116 variance, 62%  
 spacing: 4/15 variance, 73.3%  
 alignment: 28/116 variance, 75.8%  
 da (number)

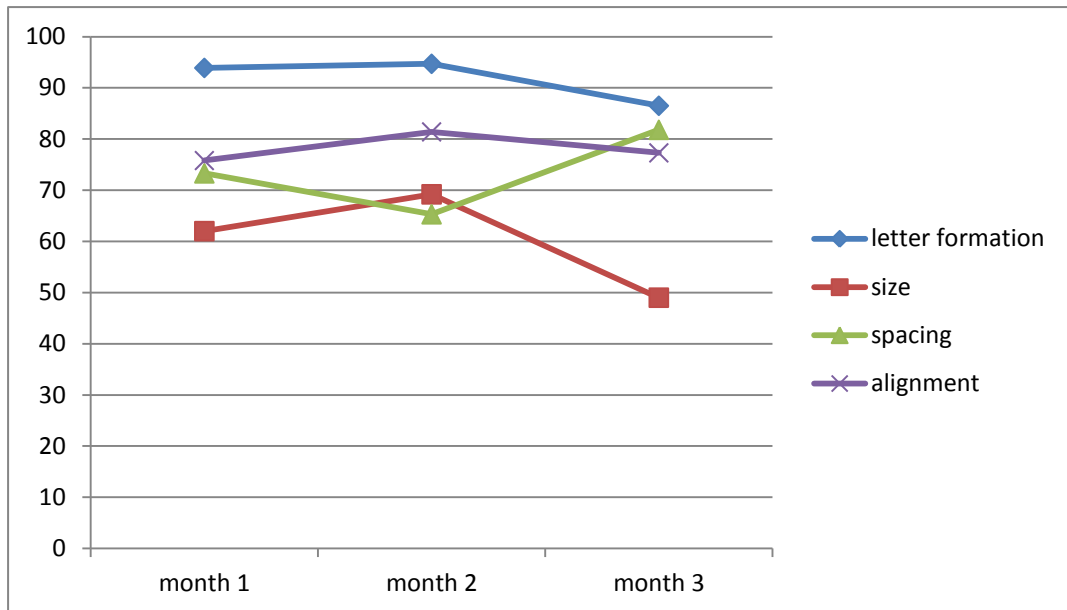


symbols: 104 (math excluded)  
 formation: 8/104 variant  
 size: 34/104 variant  
 spacing: 8/10 variant  
 alignment: 20/104 variant

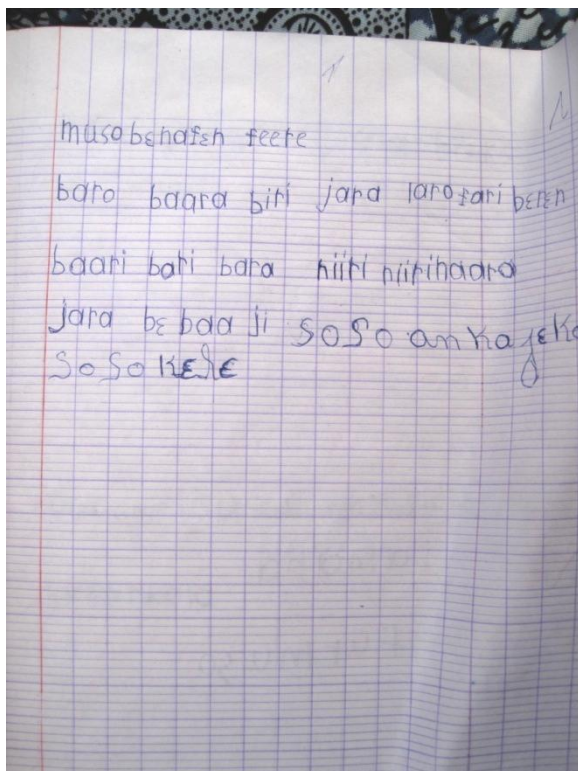
(month 2)

combined:  
 symbols: 286  
 formation: 15/286 variance, 94.7%  
 size: 88/286 variance, 69.2%  
 spacing: 9/26 variance, 65.3%  
 alignment: 53/286 variance, 81.4%





9. Sali Dembélé, age 50, Diallobougou (3 samples, 3 months)



symbols: 105

formation: 5/105

variance, 95.2%

size: 46/105

variance, 56.1%

spacing: 5/22

variance, 77.2%

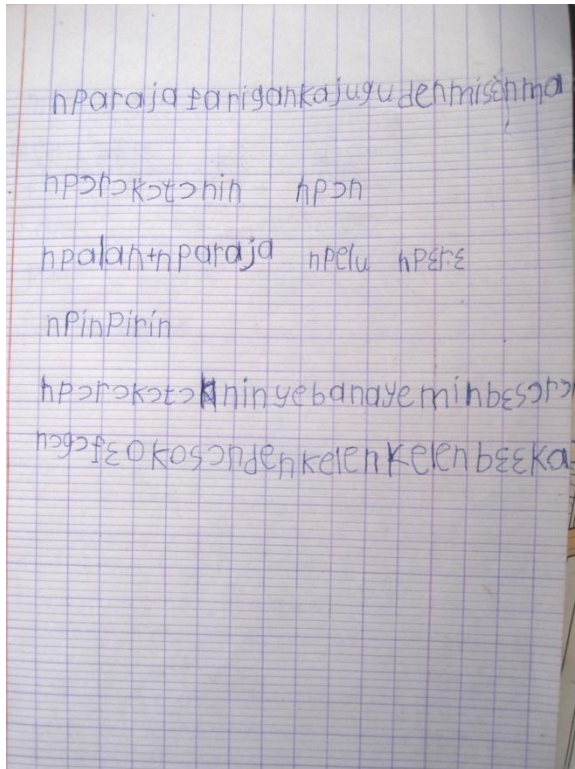
alignment: 44/105

variance, 58%

muso be nafen  
feere

The woman sells  
ingredients for  
sauce.





symbols: 139

formation: 12/139 variance, 91.3%

size: 110/139 variance, 20.8%

spacing: 19/23 variance, 17.3%

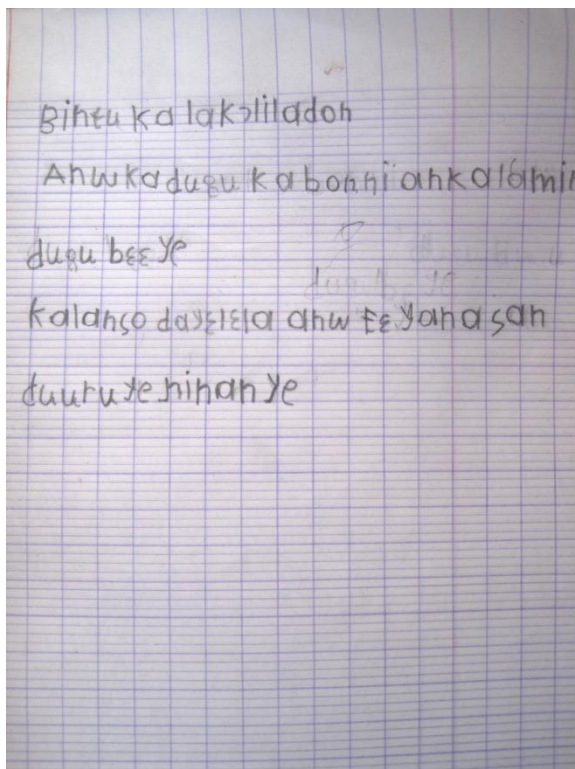
alignment: 78/139 variance, 43.8%

nparaja farigan ka jugu den misen ma

Chickenpox fever is difficult for children.

npɔrɔkɔtɔnin ye bana ye min be sɔrɔ nɔɔ fɛ o kɔsɔn den kelen kelen bɛɛ ka

The smallest thing is an illness which is found with dirt. Because of that, every child must (incomplete phrase)



symbols: 93

formation: 4/93 variance, 95.6%

size: 65/98 variance, 33.6%

spacing: 10/23 word breaks omitted, 56.5%

alignment: 52/93 variance, 39.7%

Bintu ka lakoli ladon.

Bintu must welcome school.

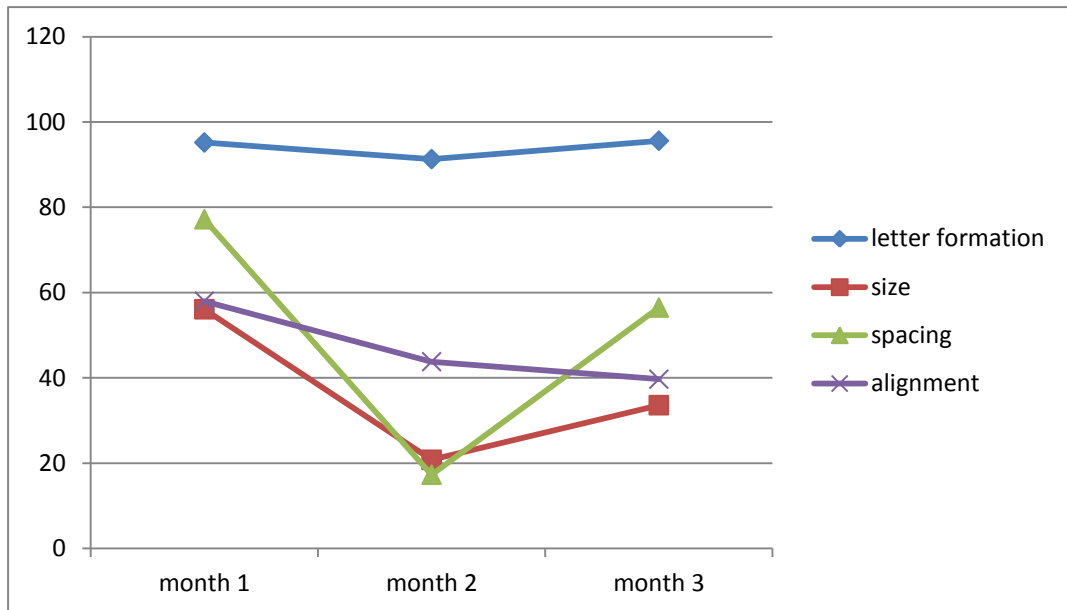
Anw ka susu ka bon ni an ka lamin

dusu bɛɛ ye.

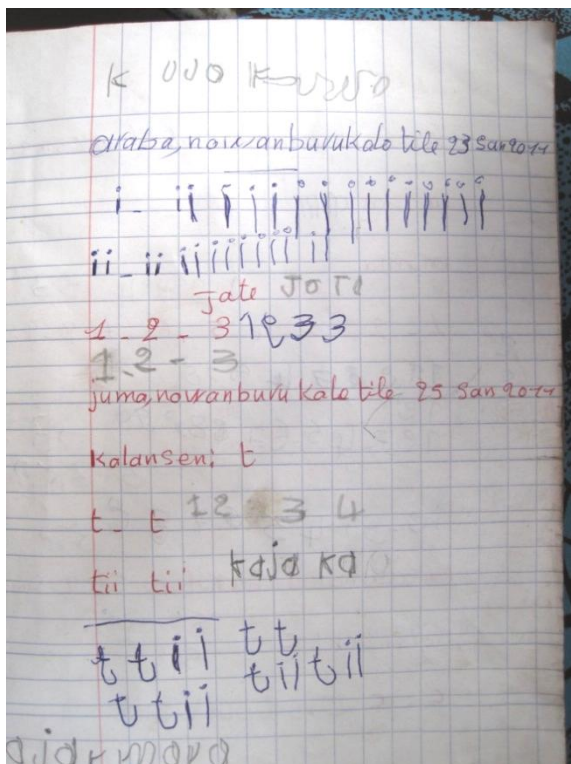
Our pounding [grain] is big and we must drink with our whole heart.

Kalanso dayele la anw fɛ yana a san duuru ye ninan ye.

The classroom was opened to us this year is the fifth year.



10. Kadia Camara, age 50, Centre Netaa (7 samples, 3 mo)



symbols: 51 (dates, numbers, marginal text and red text omitted)

formation: 22/51 variance, 43 %

size: 42/51 variance,

spacing: 11/24 variant

alignment: 46/51 variant

**(month 1)**

combined:

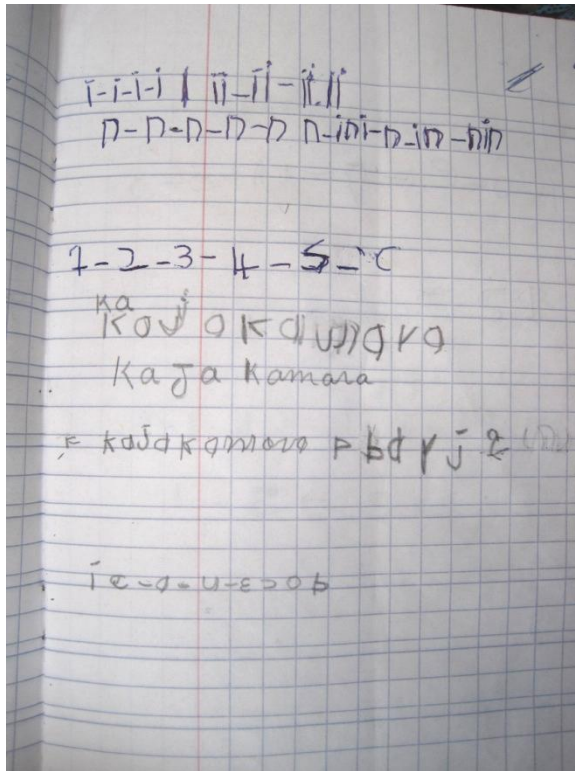
symbols: 113

formation: 43/113 variance, 61.9%

size: 87/113 variance, 23%

spacing: 22/44 variance, 50%

alignment: 82/113 variance, 27.4%



symbols: 62 (name model excluded)

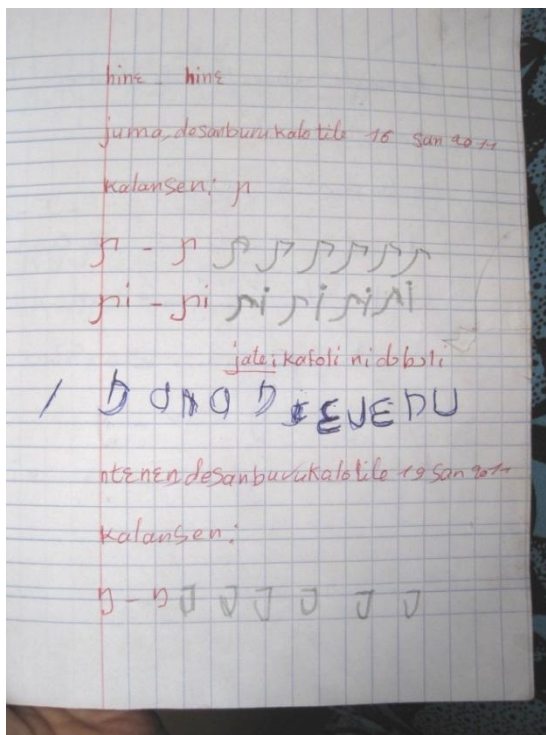
formation: 21/62 variance,

size: 45/62 variance, 72%

spacing: 11/20 variance,

(inconsistent, but some effort/awareness shown)

alignment: 36/62 variant



symbols: 32 (instructor's writing in red excluded)

formation: 17/32 variance, 53%  
(can distinguish some letters, some substitution)

size: 17/32 variance, 53 %

spacing: 13/32 variance, 40.6 %

alignment: 23/32 variance, 72%

**(month 2)**

combined:

symbols: 63

formation: 37/63 variance, 41.2%

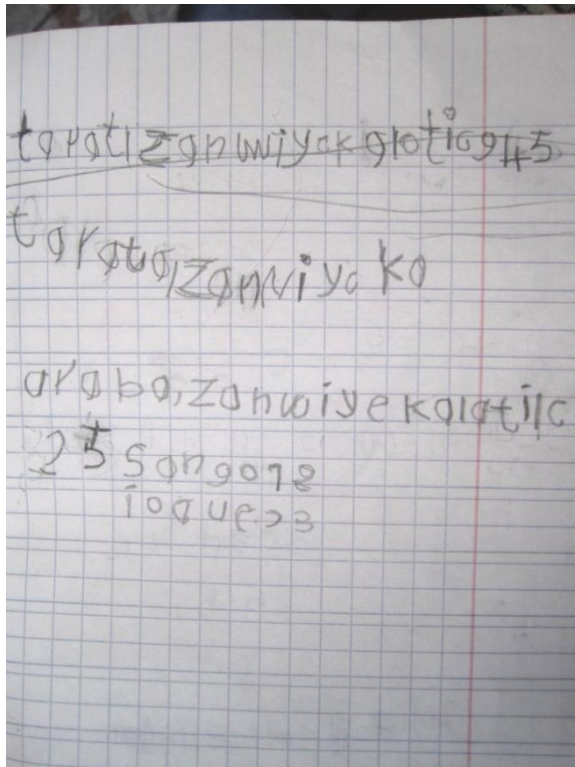
size: 36/63 variance, 42.8%

spacing: 25/63 variance, 60.3%

alignment: 45/63 variance, 28.5%







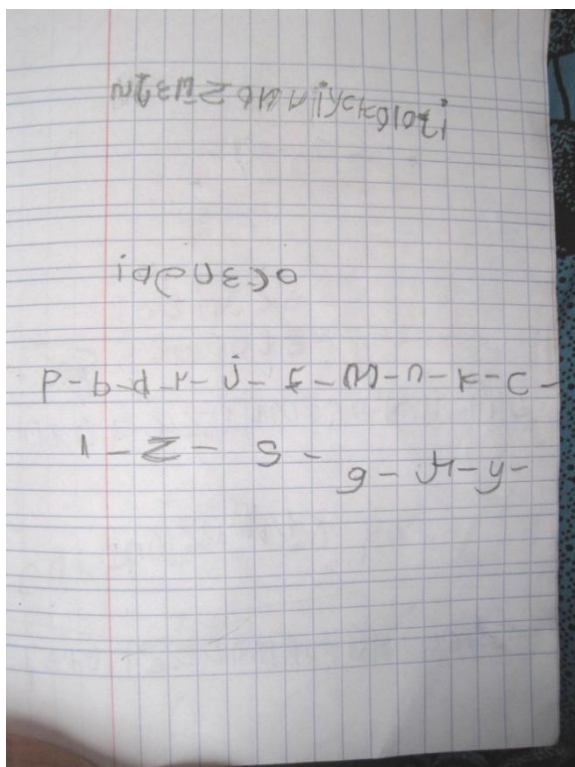
symbols: 75

formation: 32/75 variance, 41%

size: 56/75 variance, 75%

spacing: 9/11 variance,

alignment: 57/75 variance, 76%



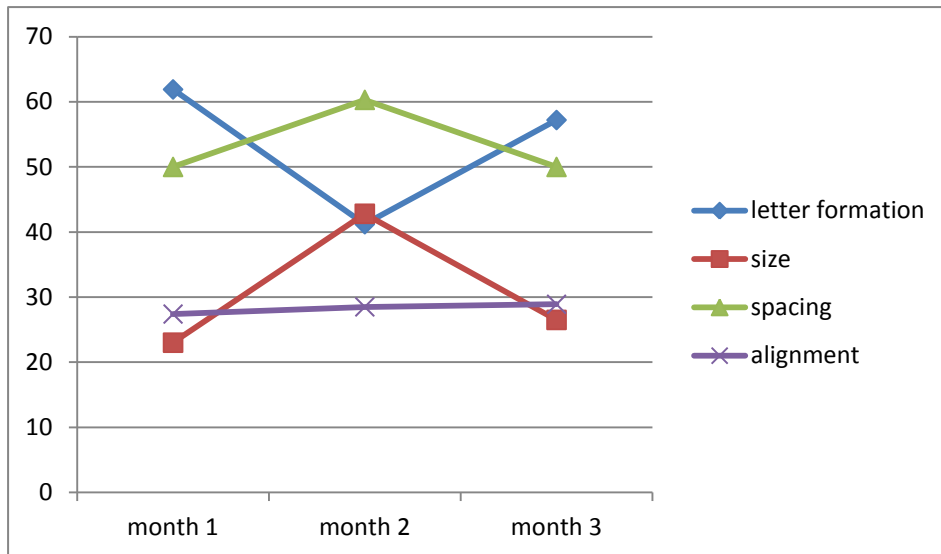
symbols: 40

formation: 17/40 variance, 43%

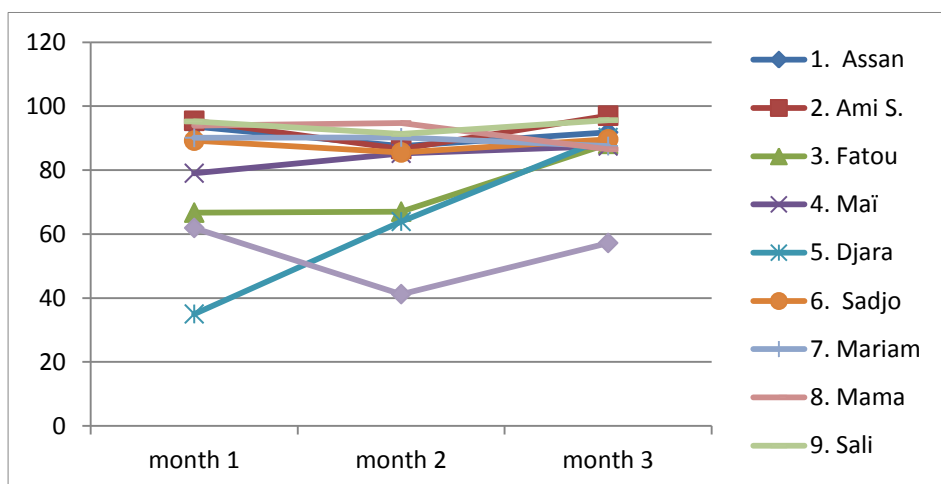
size: 37/40 variance, 7.5%

spacing: 3/3 variant

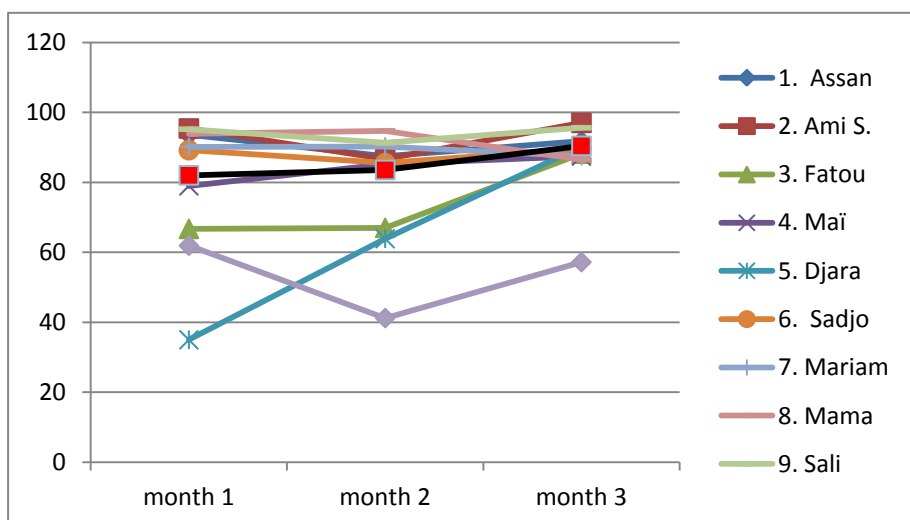
alignment: 33/40 variance, 83%



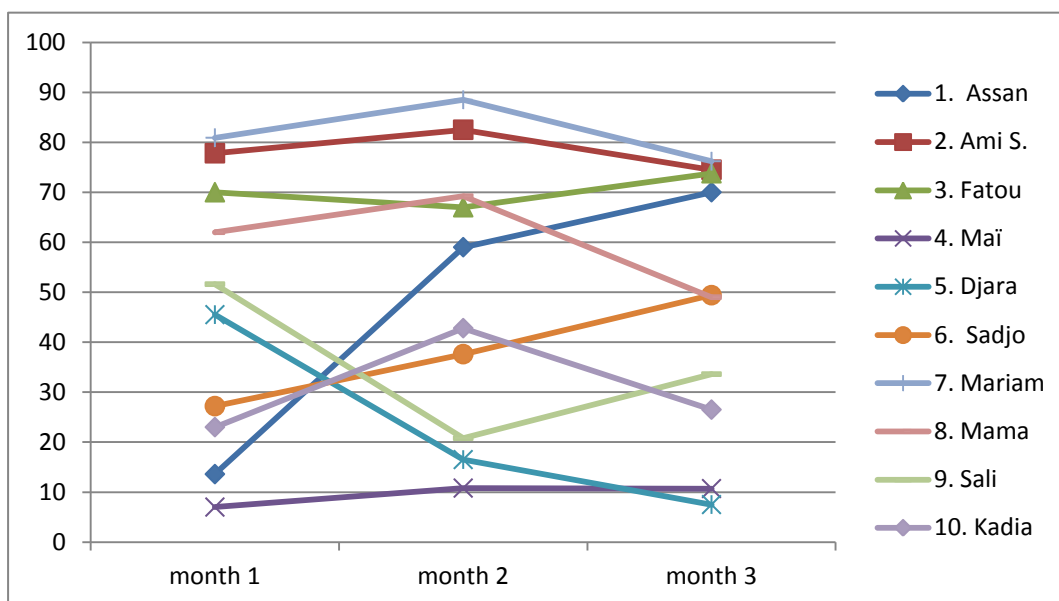
#### all ten, formation



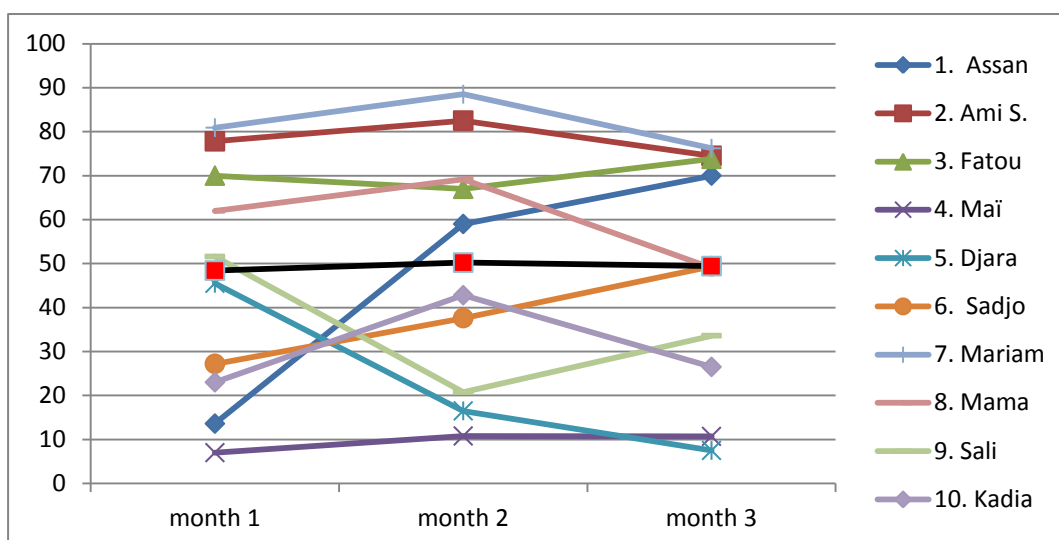
#### letter formation with average



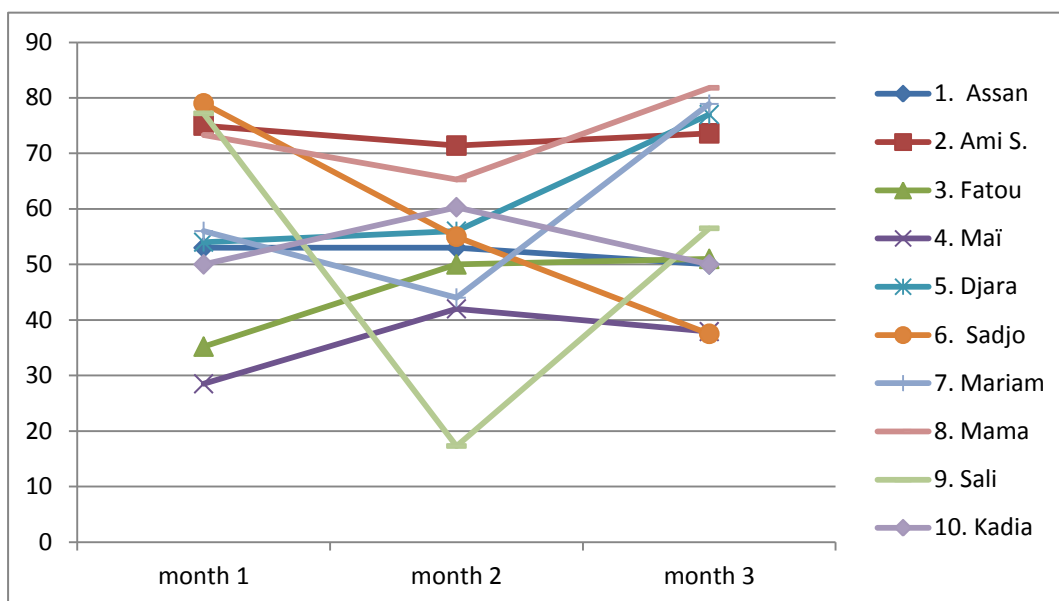
all ten, size



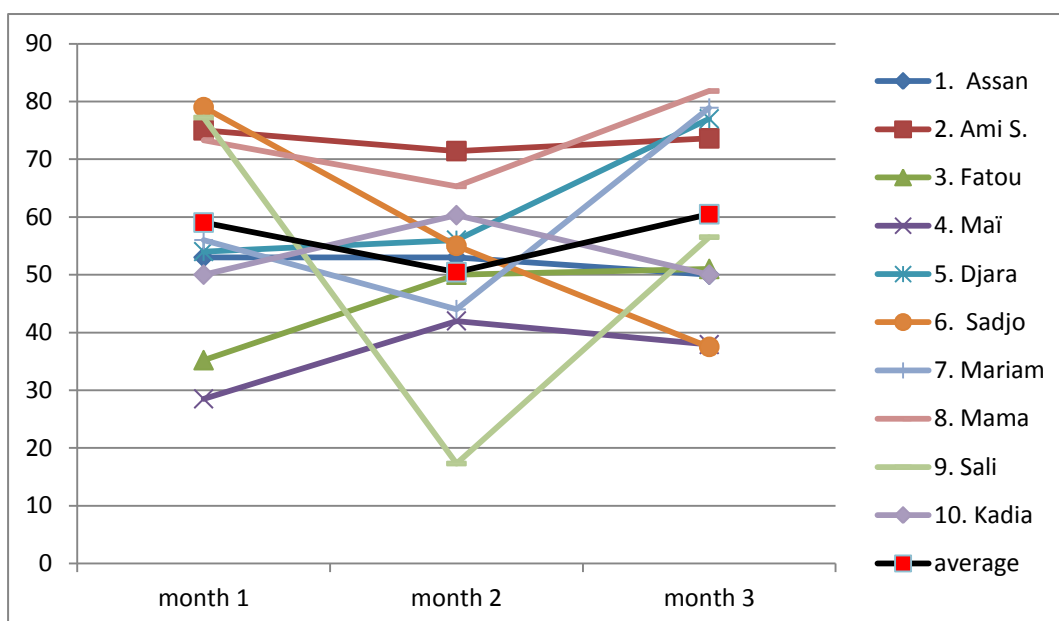
size with average



all ten, spacing

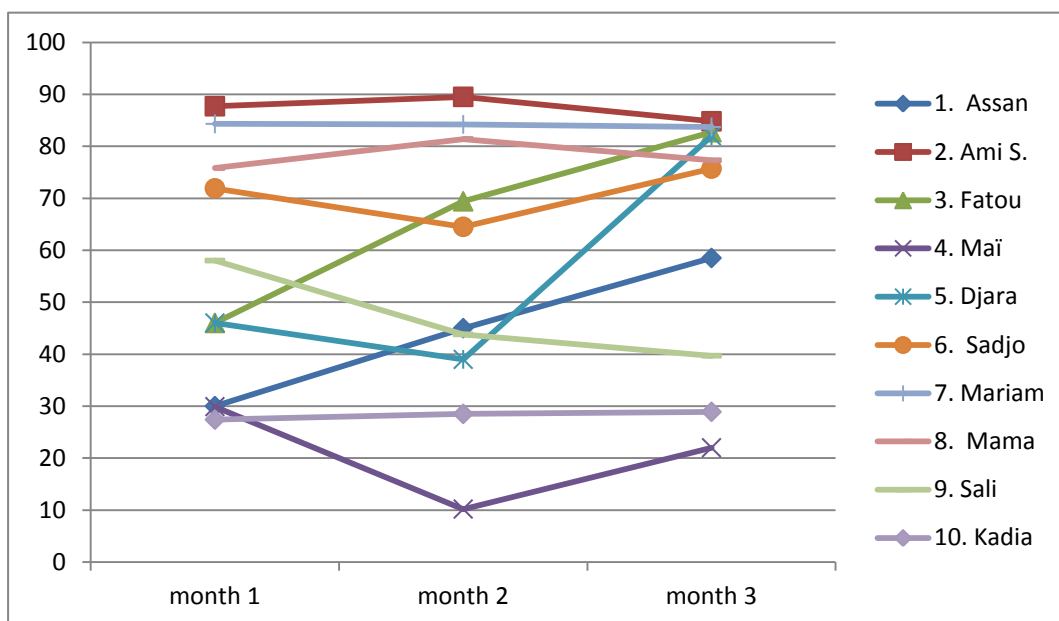


spacing with average

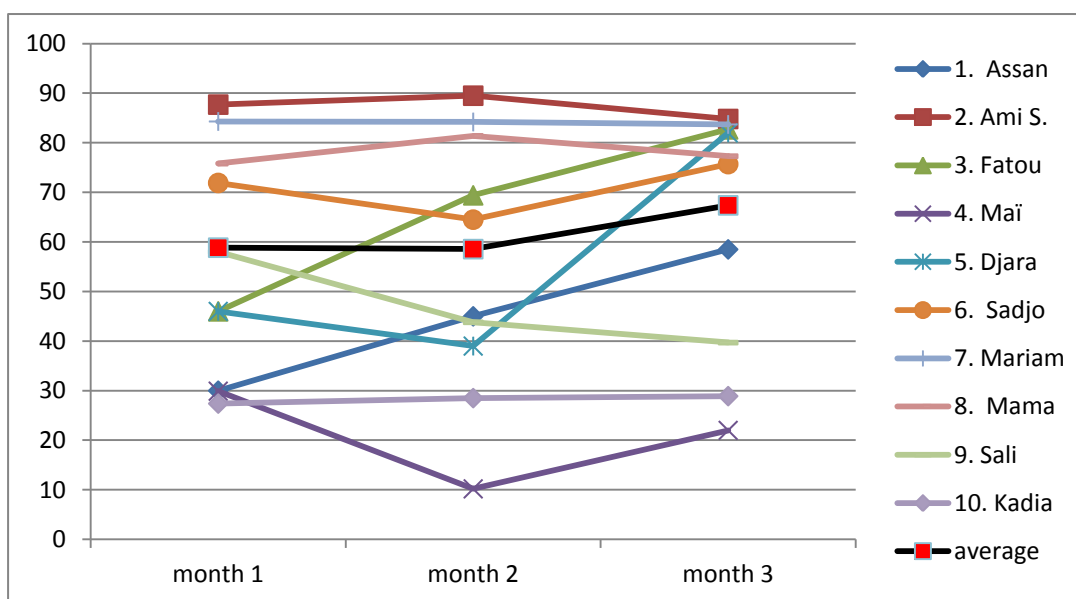




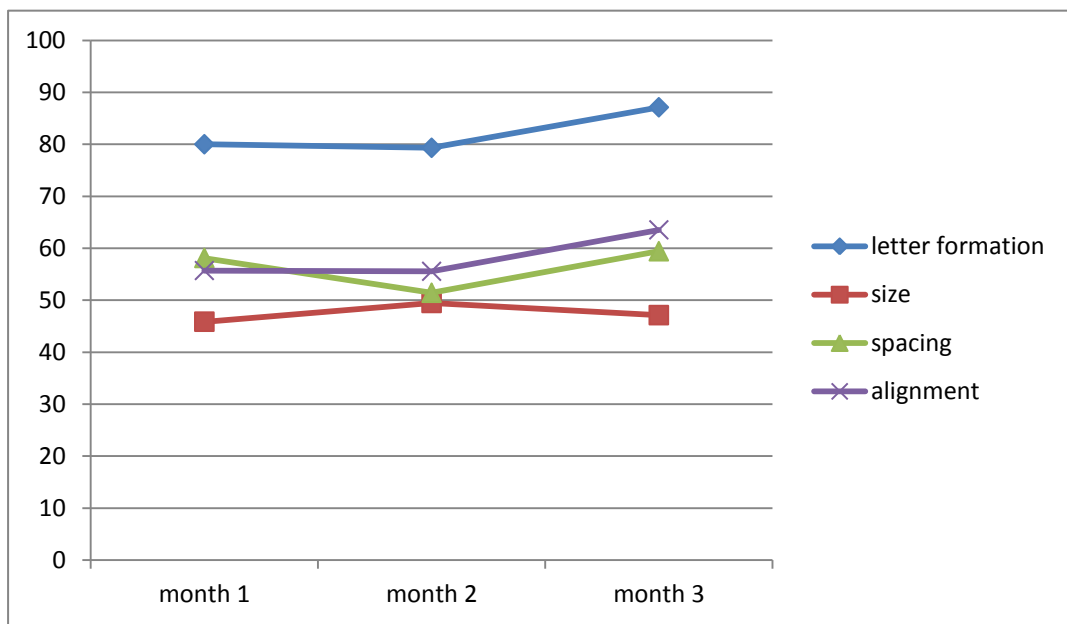
all ten, alignment



alignment with average

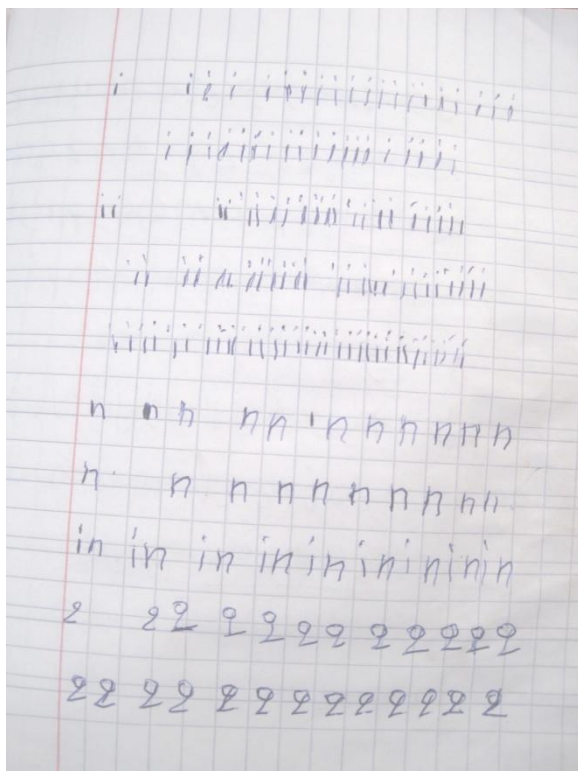


average of collective variable of interest for 3-month span



## Appendix B. Writing samples over a four-month span

### 11. Minata Tounkara, age 16, Diallobougou (4 months, Sept-Dec)



#### (month 1)

symbols: 106

formation: 60/106 variance, 43%

17 over-writes, false starts; 26 dotting mis-matches, one gap in n, 2 more closely h = 46 variances/106

size: 88/106 variance, 16.9%

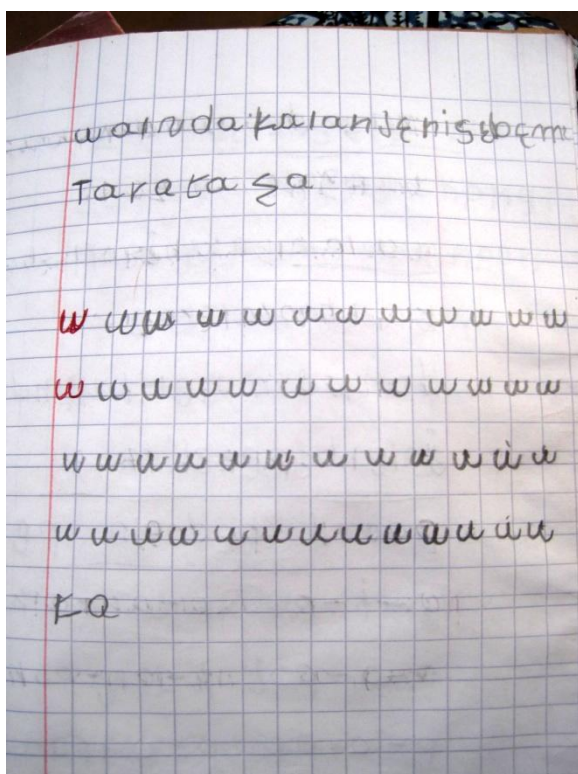
11/38 i's; 5/38.5 ii's; 2/21 n's, 0/8 in's

spacing: 42/97 variance, 56.7%

35/106 (in columns marked on pg)

7/ 38 i's; 9/38.5 ii's; 15/21 n's; 4/8 in's

alignment: 71/106 variance, 33%



#### copied text vs single letters

copied text: 31 letters, w: 47

formation: 58%

11/31, 22/47 substituted or malformed; 42%

size: 4

spacing: 2

(none between words)

alignment: 2

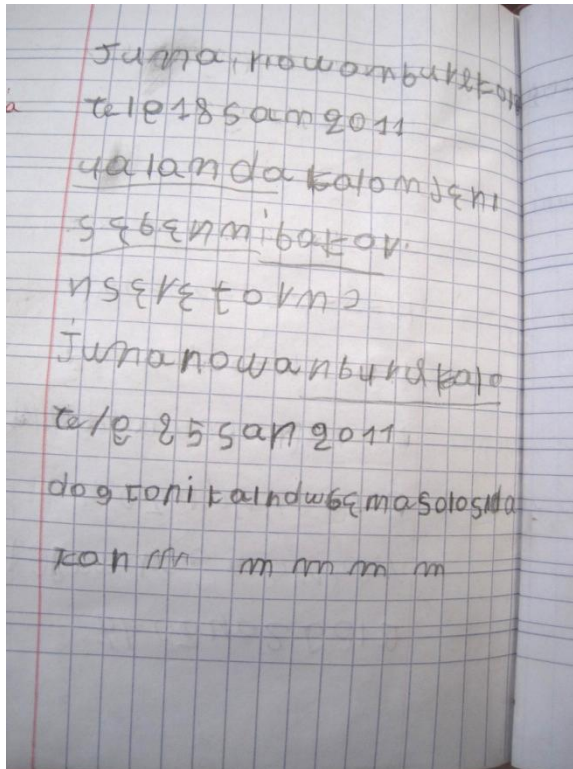
11/29 good (38%), 14/14 good (30%)

“kalanje ni sebeni Tarata”

reading and writing Tuesday

(note: days of the week are not capitalized in Bambara)





### (month 3)

tele 18 san 2011 (day 18, year 2011)

ulanba kalanje ni (blackboard reading and writing)

sebbenni bakor (writing old-mother)

nserɛ tɔrɔ ("dropped the watermelon")

Juma nowanburu kalo (Friday, November-month)

tele 25 san 2011 (day 25 year 2011)

dogɔni kalandɛnw be masɔrɔ sida kan  
(the youngest students are catching AIDS)

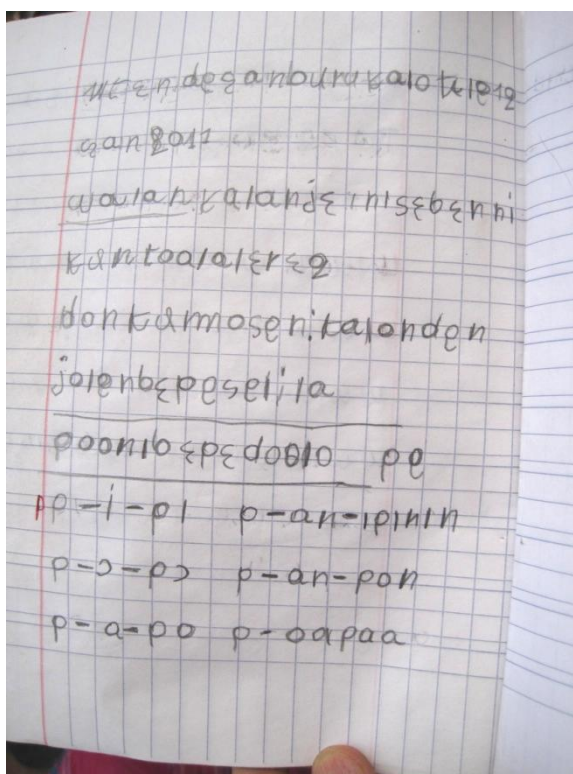
130 symbols

formation: 39/130 variance, 70%

size: 109/130 variance, 19.2%

spacing: 14/30 variance, 53.3%

alignment: 89/130 variance, 31.5%)



### (month 4)

san 2011 (year 2011)

ulanba kalanje ini sebbenni (board reading and writing)

kunto a la lere 2 (said the 2<sup>nd</sup> hour)

donkumosen: kalandɛn

jolen be peseli la

pooni be pe doolo pe

114 symbols

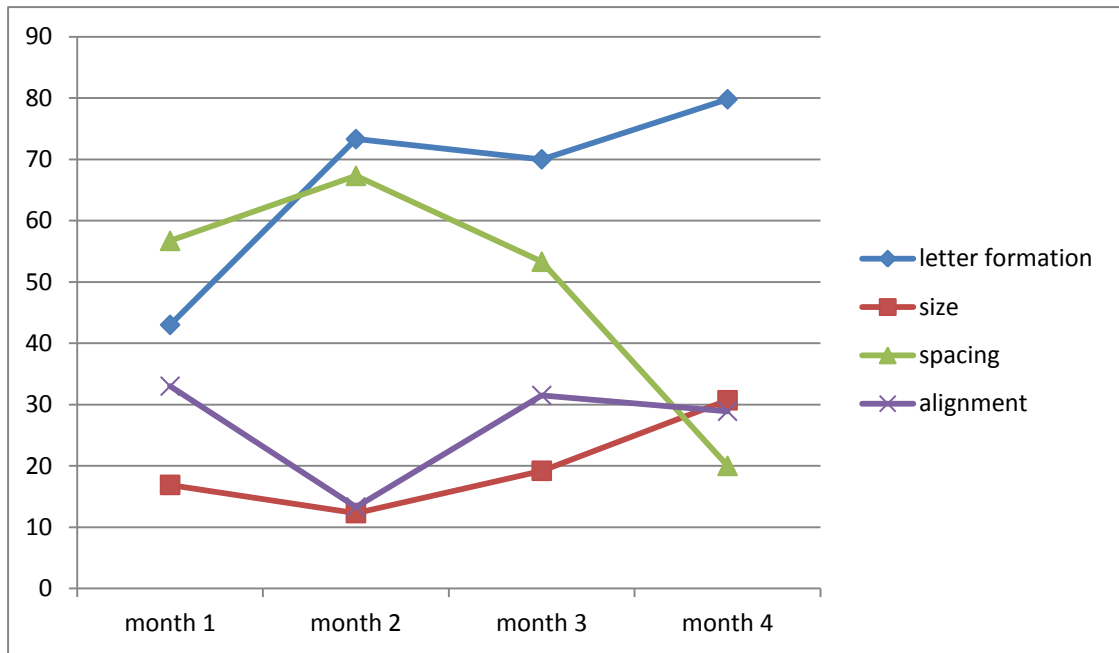
formation: 23/114 variance, 79.8%

size: 79/114 variance, 30.7%

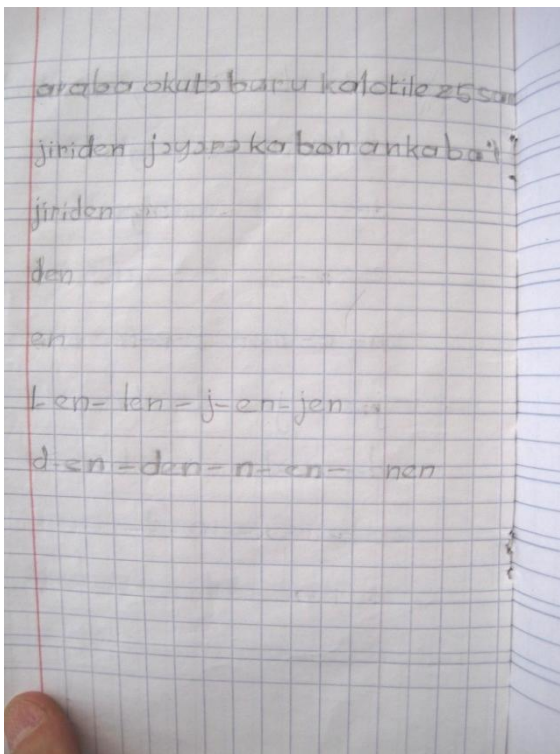
spacing: 16/20 variance, 20%

alignment: 81/114 variance, 28.9%





12. Siata Soumaré, age 39, Diallobougou (4 samples, 4 mo)



**(month 1)**

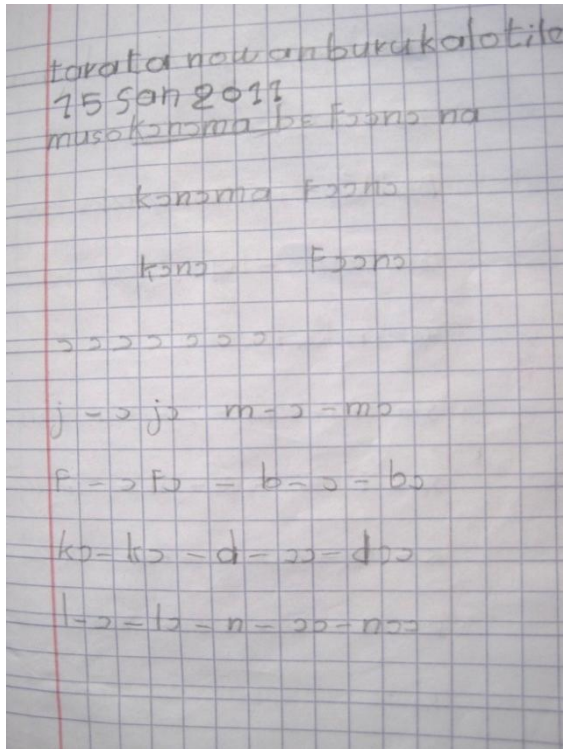
symbols: 88

formation: 6/88 variance, 93.1%

size: 5/88 variance, 94.3%

spacing: 6/12 word break variance, 50%

alignment: 12/88 variance, 86.3%



## (month 2)

symbols: 113

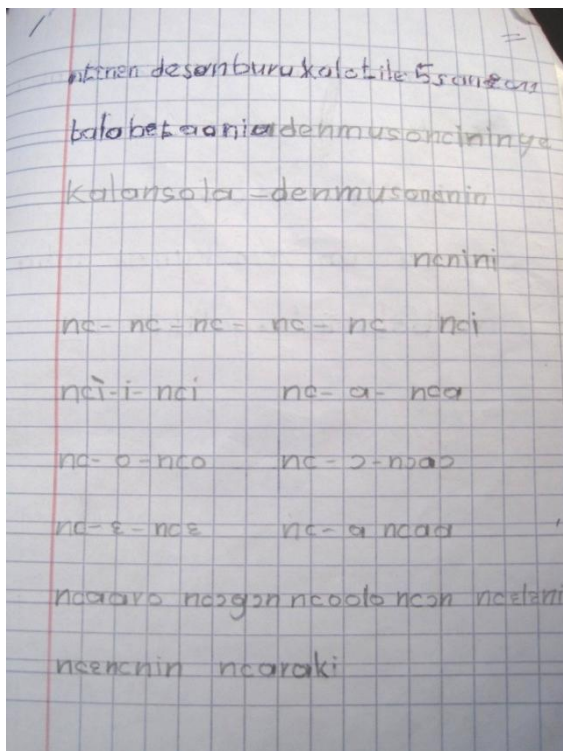
formation: 10/113 variance, 91.1%

size: 22/113 variance, 80.5%

spacing: 3/10 word break variance, 70%

alignment: 17/113 variance, 84.9%

in the last sample, at the end of the line, this learner just stopped writing. In this sample, one month later, she continues to write, but did not put the text on a line.



## (month 3)

symbols: 172

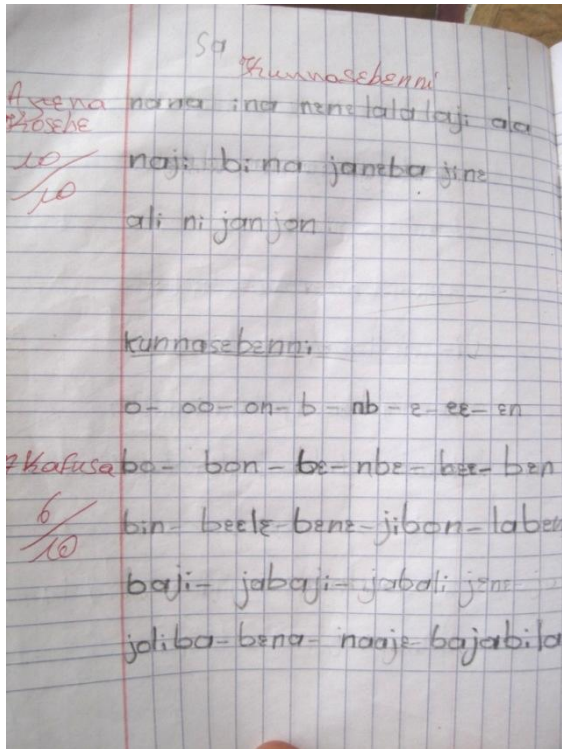
formation: 15/172 variance, 91.2%

size: 7/172 variance, 95.9%

spacing: 7/13 word break variance, 46.1%

alignment: 12/172 variance, 93%

(note the difference between a pen that doesn't write fluidly and a pencil!)



#### (month 4)

(kunnasebenni = dictation)

symbols: 157

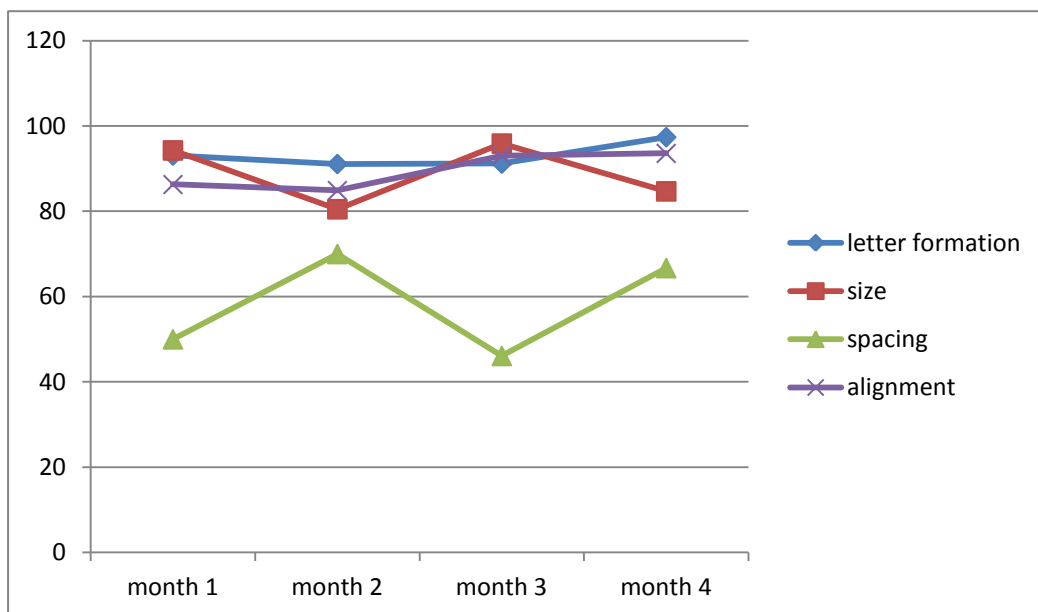
formation: 4/157 variance, 97.4%

size: 24/157 variance, 84.7%

spacing: 4/12 variance, 66.7%

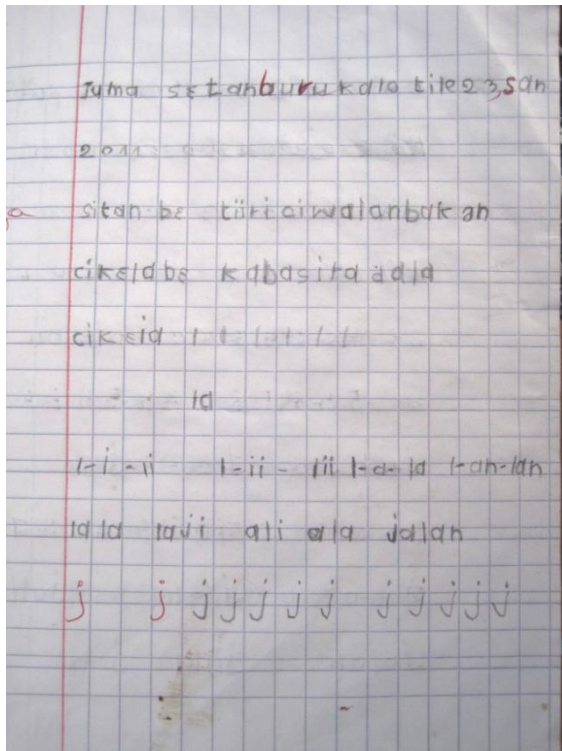
alignment: 10/157 variance, 93.6%

this learner seems to think that the 'i' with the dot all need to fit into the space between the lines-and the instructor is not monitoring for that parameter.





13. Ami Dembélé, age 40, Diallobougou (6 samples, 4 mo)



symbols: 137

formation: 26/137 variance

size: 34/137 variance

spacing: 11/15 word break variance

alignment: 18/137 variance

**(month 1)**

combined:

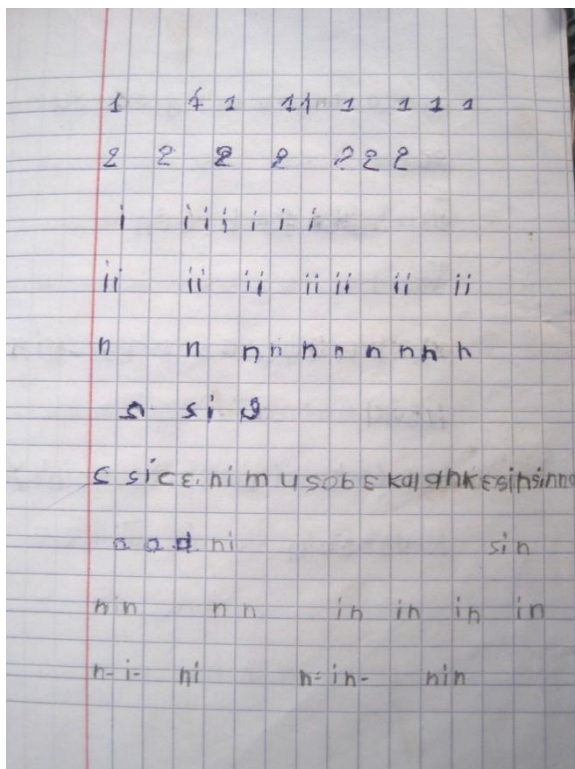
symbols: 227

formation: 35/227 variance, 84.5%

size: 61/227 variance, 73.1%

spacing: 15/22 variance, 31.8%

alignment: 31/227 variance, 86.3%



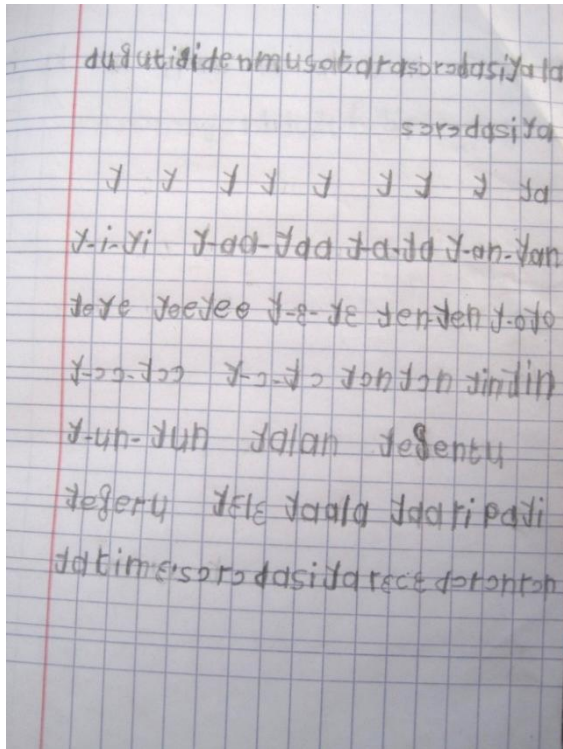
symbols: 90 (numbers excluded)

formation: 9/90 variance

size: 27/90 variances

spacing: 4/7 word break variance,

alignment: 13/90 variances



## (month 2)

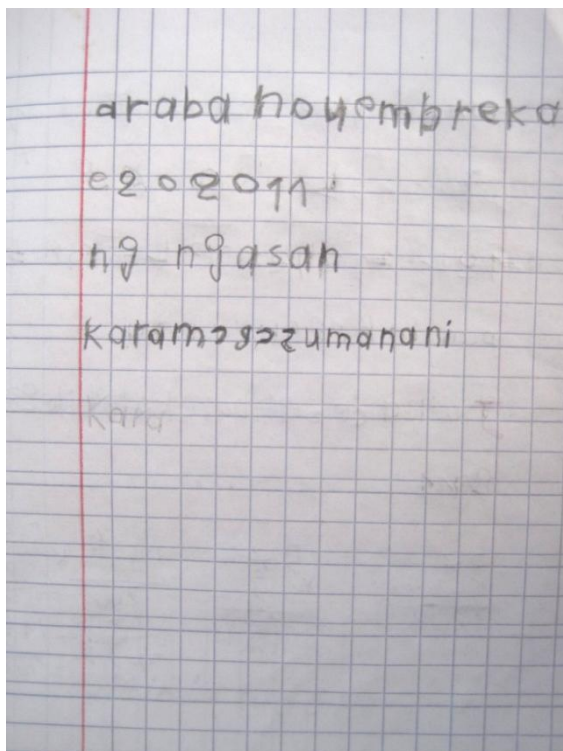
symbols: 187

formation: 65/187 variance, 65.2%

size: 115/187 variance, 38.5%

spacing: 7/9 word break variance, 22%

alignment: 99/187 variance, 53%



symbols: 47

formation: 4/47, 'san' omitted

size: 25/47 variance

spacing: 4/5 variance

alignment: 32/47 variance

## (month 3)

combined:

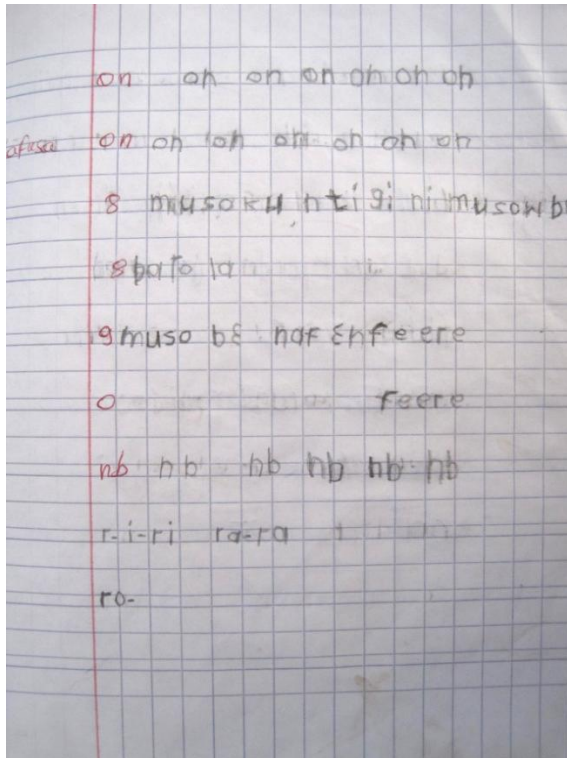
symbols: 138

formation: 22/138 variance, 84%

size: 71/138 variance, 48.9%

spacing: 15/36, 58.3%

alignment: 72/138 variance, 47.8%



symbols: 91

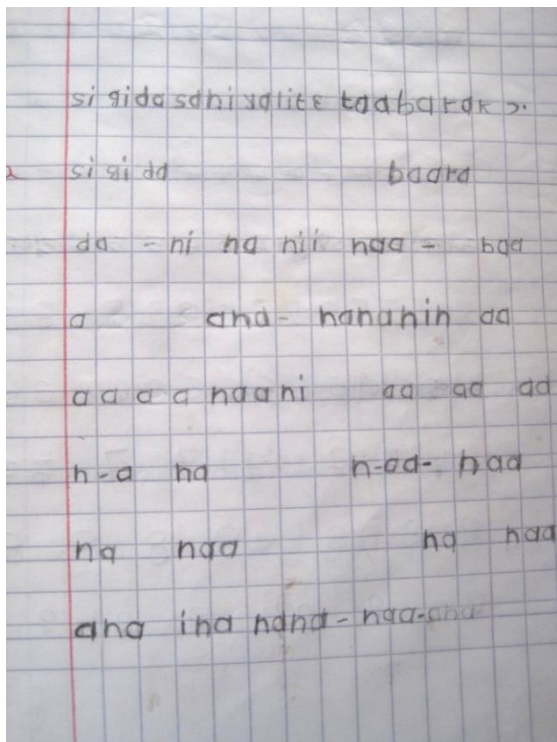
formation: 18/91 variances

size: 46/91 variance

spacing: 2/23 variance between letters/syllables;

9/8 variances: 7 breaks added within 4 of the 11 words in phrases, 2/7 word breaks omitted

alignment: 40/91 variance



**(month 4)**

symbols: 112

formation: 14/112 variance, 87.5%

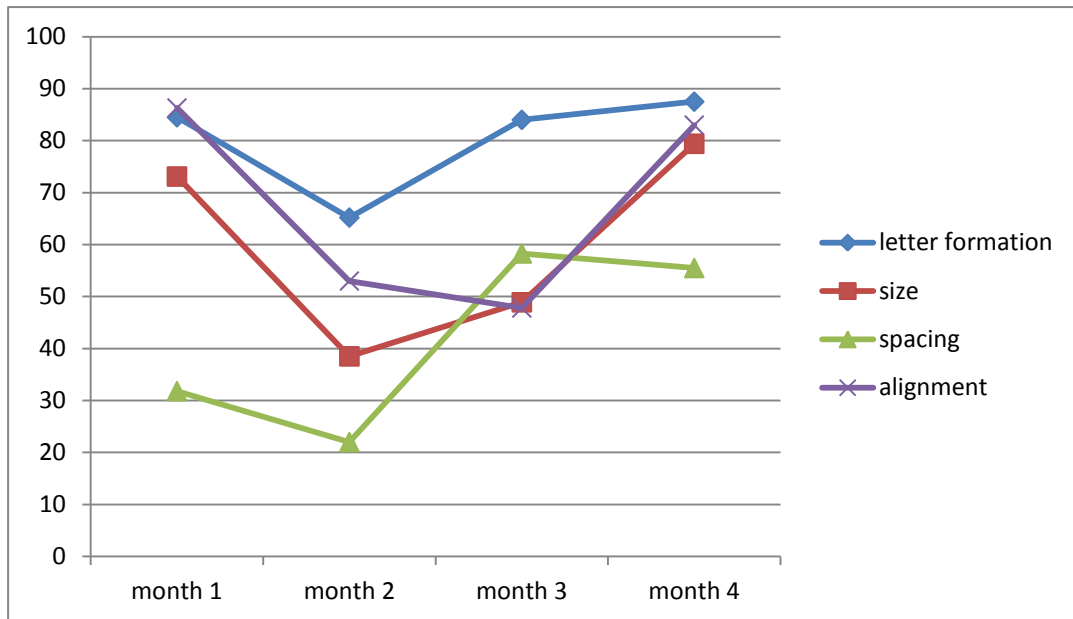
size: 23/112 variance, 79.4%

spacing: 8/18 variance, 55.5%: 2 spaces inserted within words, 2 word breaks omitted, 2 word breaks correct

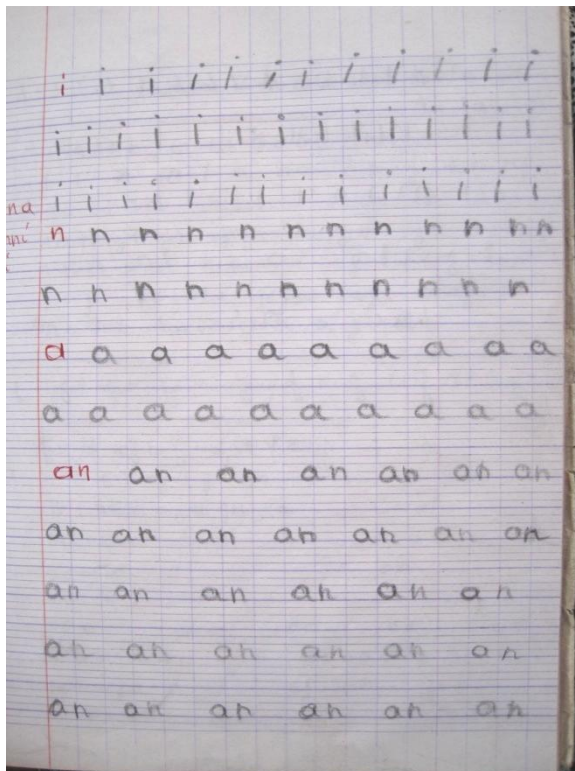
alignment: 19/112 variance, 83%

Sigida saniyali te taabaa ko.

(Cleaning the neighborhood is not the job of the one who leaves)



14. Awa Jara, age 40, Diallobougou (4 samples, 4 mo)



(month 1)

symbols: 142

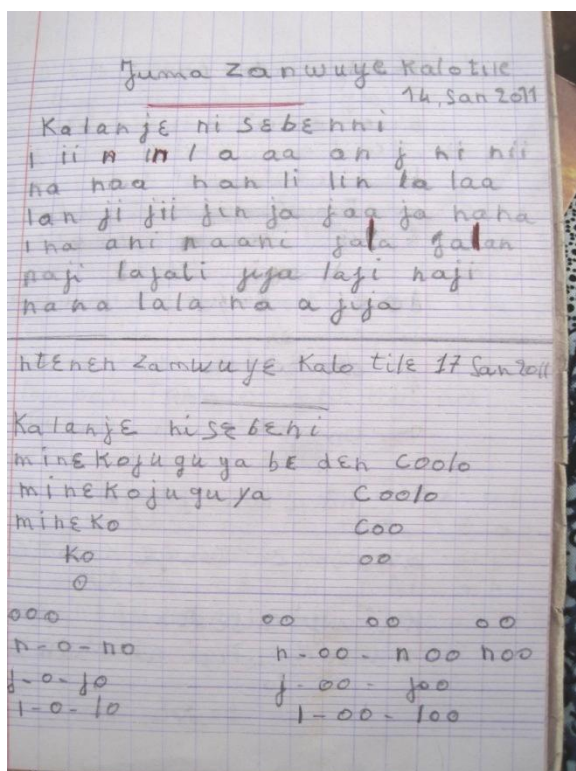
formation: 28/142 variance, 80%

size: 27/142 variance, 80.9%

spacing: 1/100 variance, 99%

alignment: 24/142 variance, 83%





## (month 2)

symbols: 159

formation: 8/159 variance, 94.9%

size: 21/159 variance, 86.7%

spacing: 9/42 (inconsistent w/in words) 78.5%

alignment: 22/159 variance, 86.1%

symbols: 140

formation: 3/140 variance, 97.8%

size: 27/140 variance, 80.7%

spacing: 7/11 (inconsistent w/in words), 36.3%

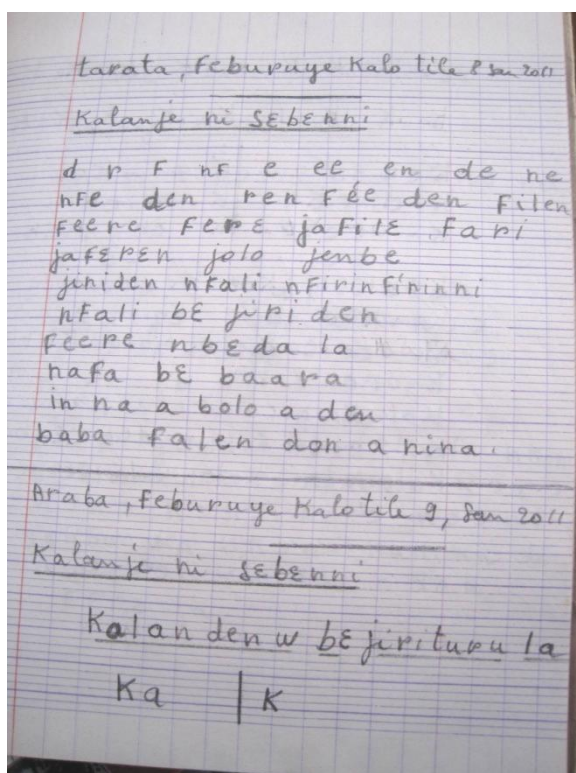
alignment: 28/140 variance, 80%

combined: 299,

f= 11/199, 94.4%, s= 48/199,

75.8%, sp=16/53, 69.8%,

a=50/299, 83.2%



## (month 3)

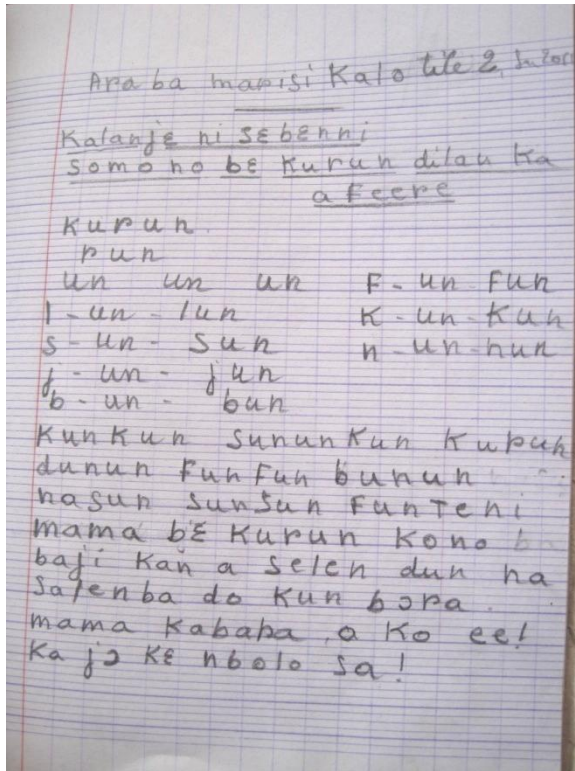
symbols: 176

formation: 13/176 variance, 92.6%

size: 35/176 variance, 80.1%

spacing: 10/55 variance, 81.8%

alignment: 47/176 variance, 73.2%



#### (month 4)

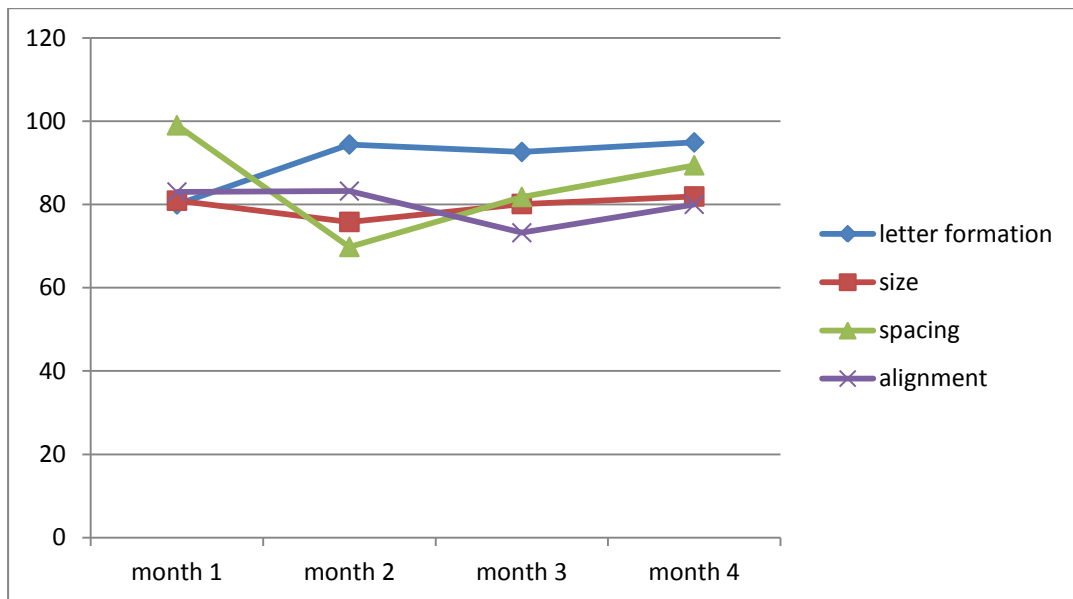
symbols: 255

formation: 13/255 variance, 94.9%

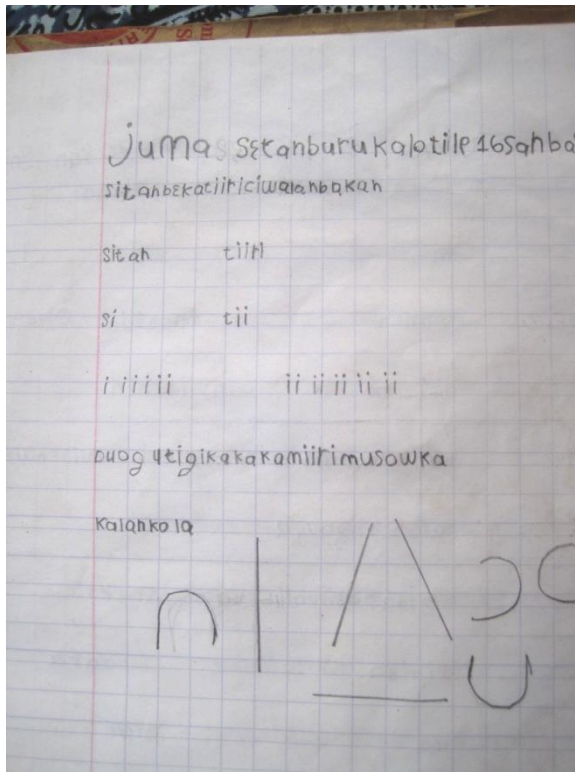
size: 46/255 variance, 81.9%

spacing: 4/38 variance, 89.4%

alignment: 51/255 variance, 80%



15. Fana Sidibé, age 52, Diallobougou (4 samples, 4 mo.)



(month 1)

“Sitan traces the lines on the blackboard.”

symbols: 116

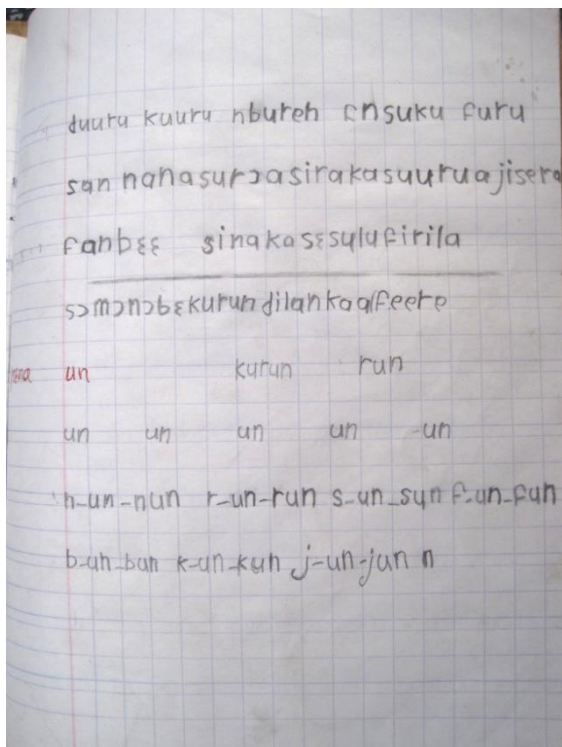
formation: 3/116 variance, 97.4%

size: 75/116 variance, 35.3%

spacing: 17/19 variance, 10.5%

alignment: 53/116 variance, 54.3%

“The village chief must think about [the subject of] women’s study.”



(month 2)

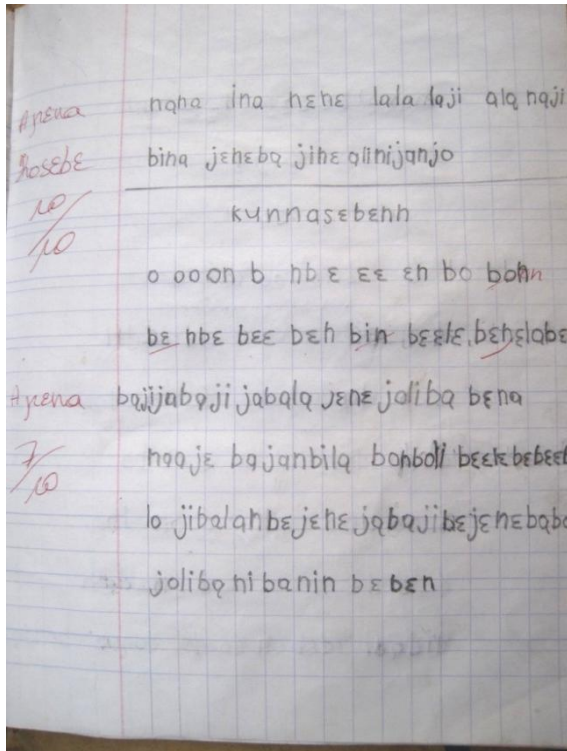
symbols: 167

formation: 6/167 variance, 96.4%

size: 58/167 variance, 65.2%

spacing: 16/22 breaks omitted, 27.2%

alignment: 30/167 variance, 82%



### (month 3)

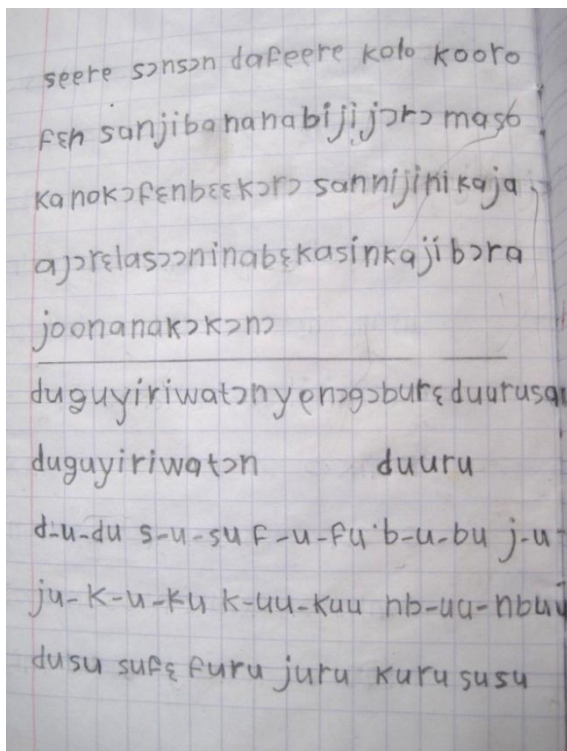
symbols: 217

formation: 18/218 variance, 91.7%

size: 44/217 variance, 79.7%

spacing: 13/42 variance, 69%

alignment: 33/217 variance, 84.7%



### (month 4)

symbols: 233

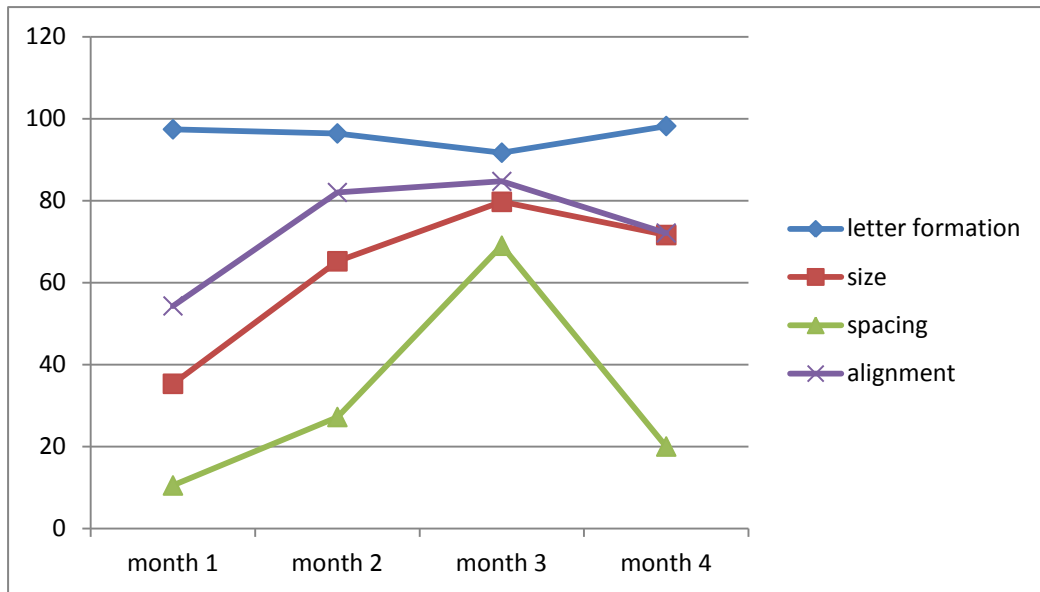
formation: 4/233 variance, 98.2%

size: 66/233 variance, 71.6%

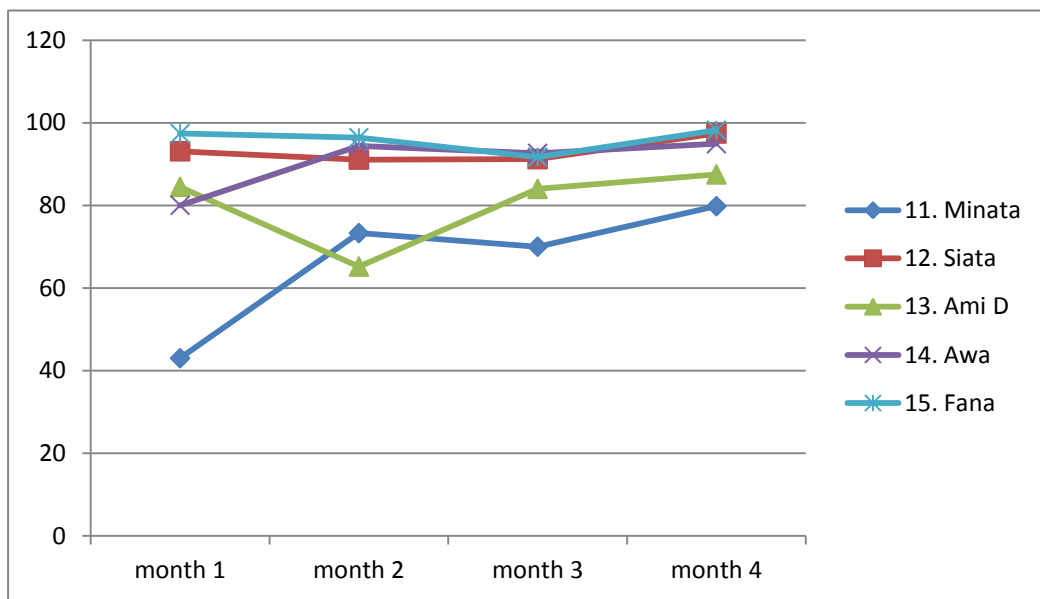
spacing: 24/30 variance, 20%

alignment: 65/233 variance, 72.1%

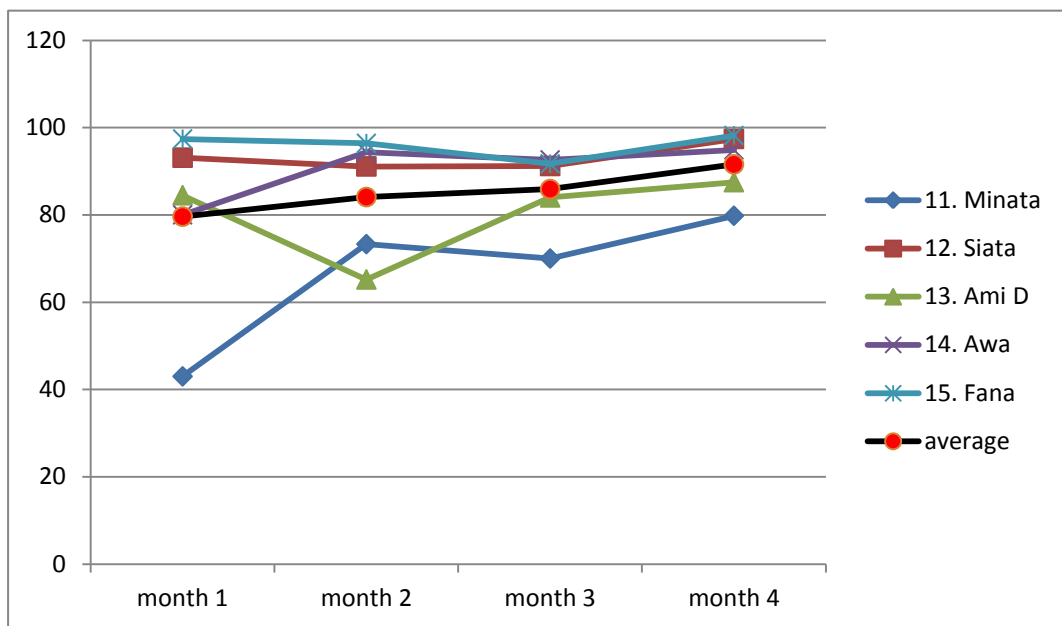




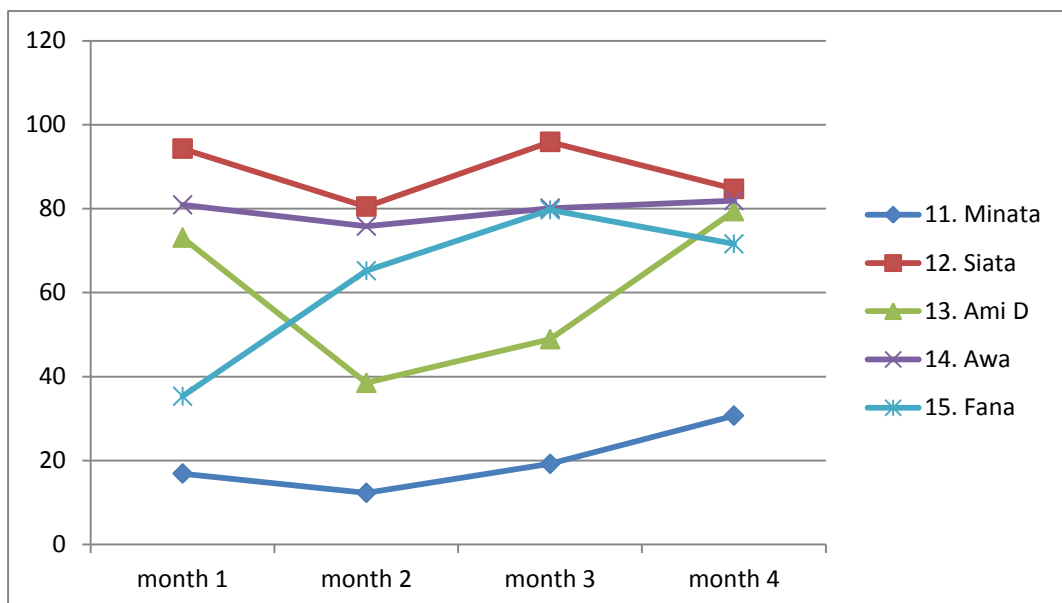
formation, all five



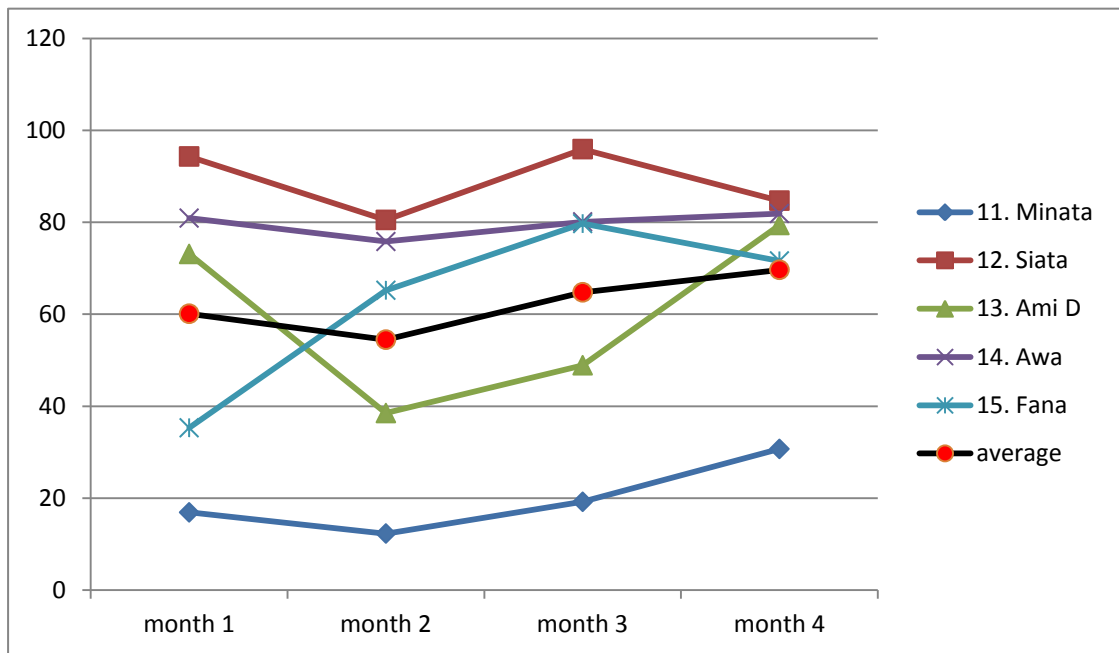
formation with average plotted



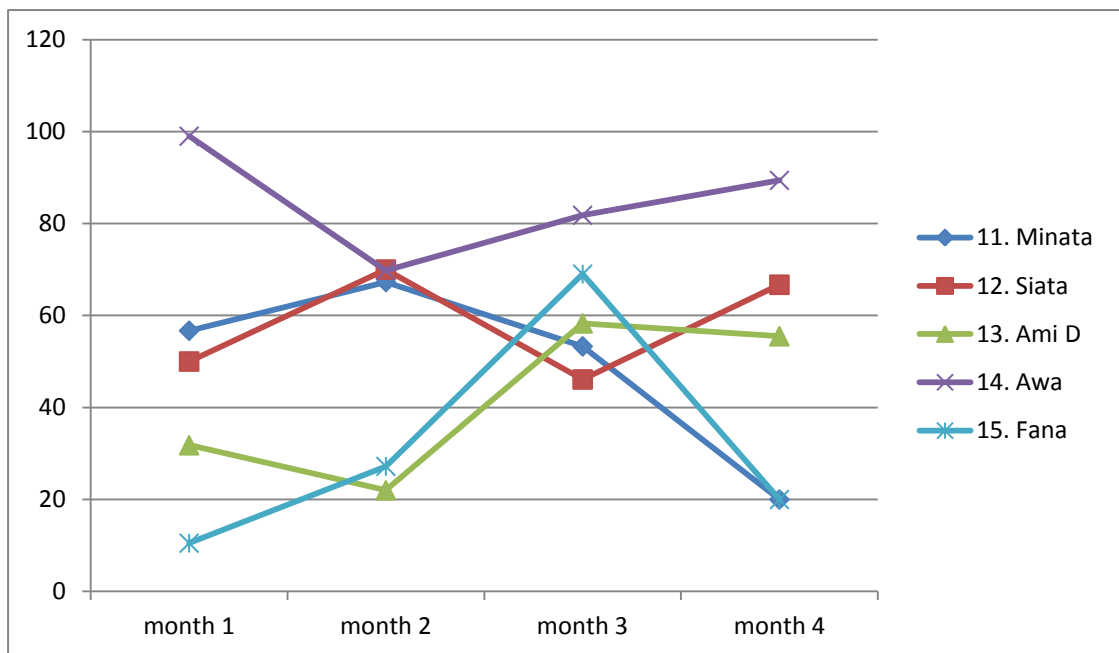
size, all five



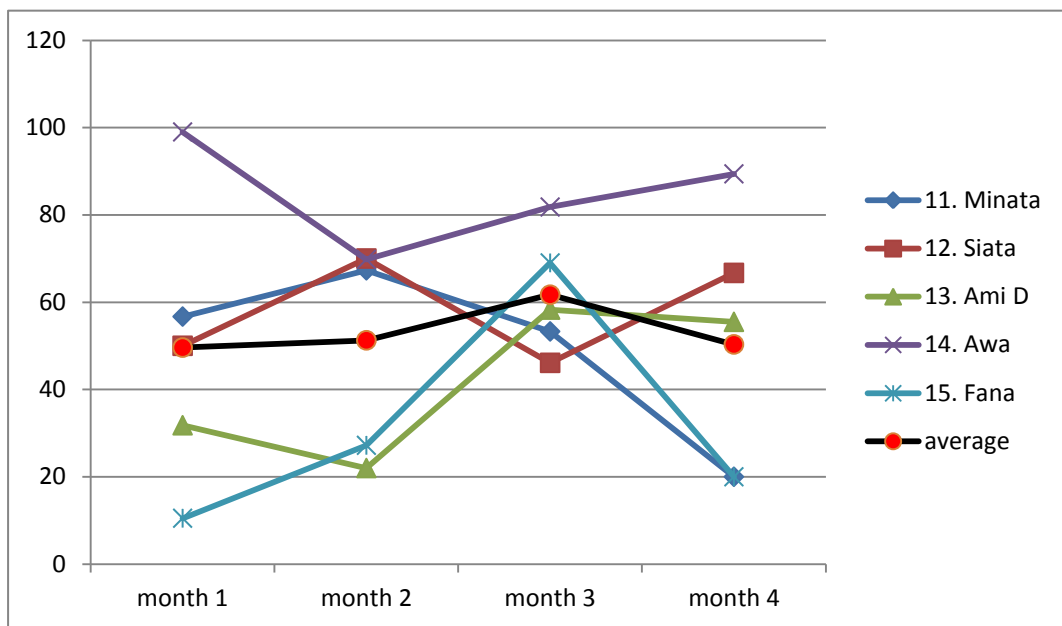
Size with average plotted



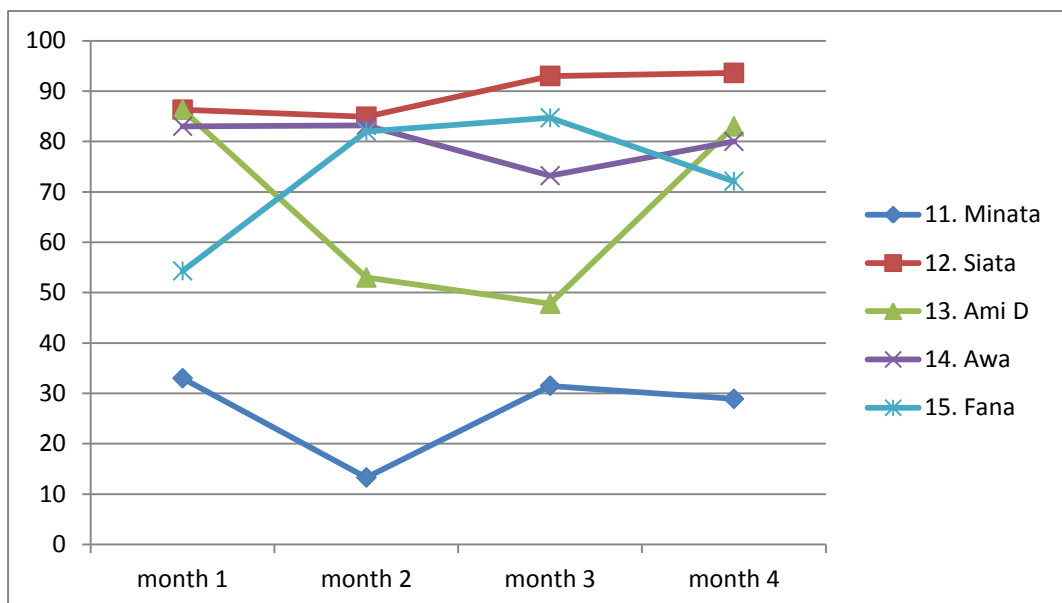
spacing, all five



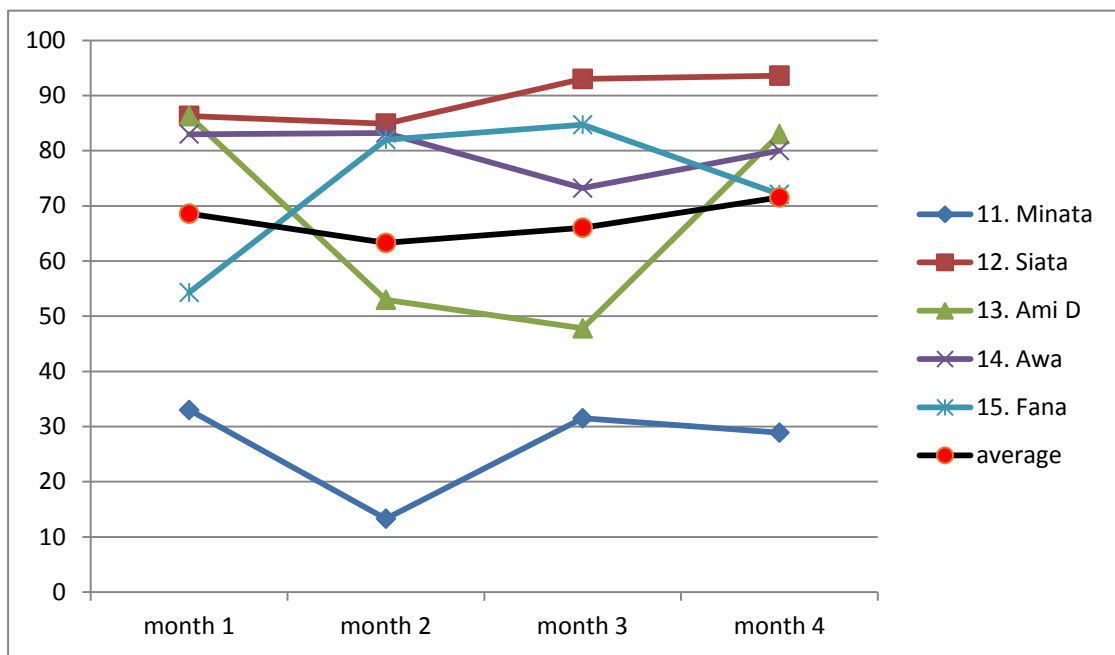
**Spacing with average plotted**



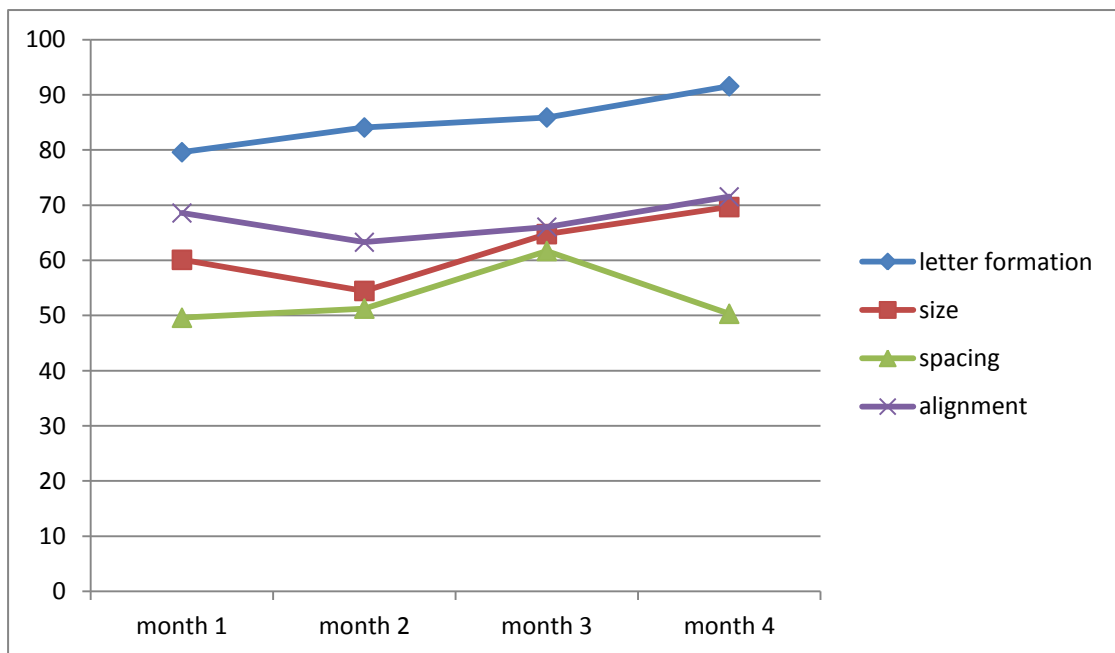
**alignment, all five**



**Alignment with average plotted**

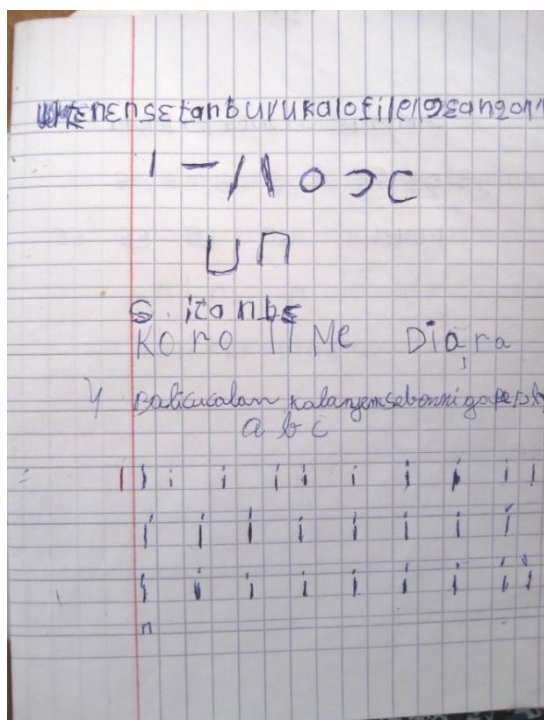


**Average of collective variable of interest, 4-month data**



## Appendix C. Writing samples over a 5- and 6-month span

16. Koro Jara, age 37, Diallobougou (5 samples, 5 mo)



### (month 1)

symbols: 80 (cursive  
“Balikukalan...abc”  
traced from the textbook,  
excluded from count)

formation: 11/80 variance,  
86.2%

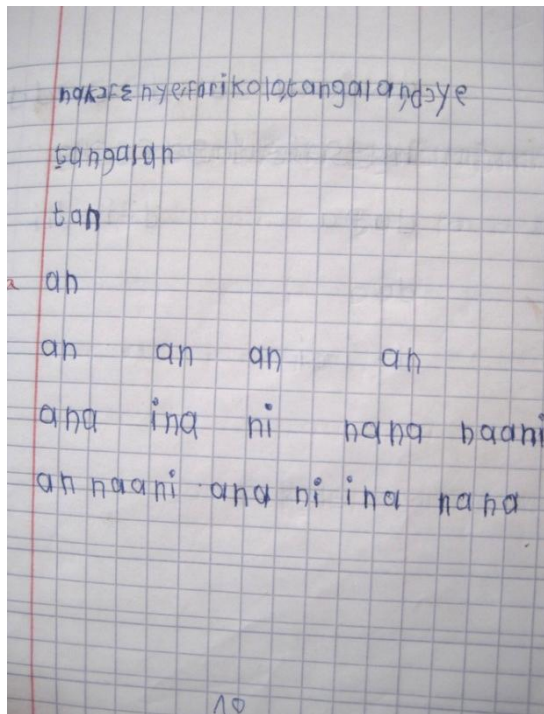
size: 33/80 variance, 58.7%

spacing: 13/32 variance,  
59.3%

9/8 word break variance, 2  
correct, 6 omitted, 3 extras  
inserted, 0%

separate letter spacing: 4/24  
variance, 83.3%

alignment: 26/80 variance,  
67.5%



### (month 2)

symbols: 87

formation: 8/87 variance,  
90.8%

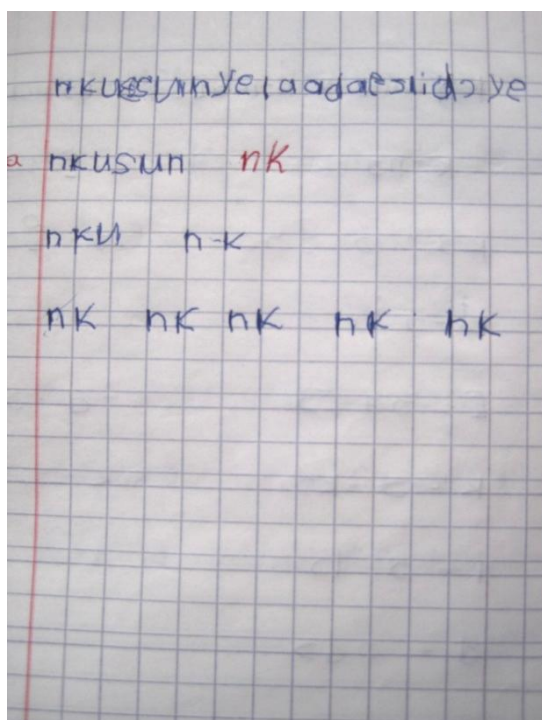
size: 24/87 variance, 72.4%

spacing: 7/18, variance,  
61.1% \*\*

no word breaks out of 6  
possible 0%

words/syllables in isolation  
1/12 variant, 91.6%

alignment: 48/87 variance,  
44.8%



**(month 3)**

symbols: 44

formation: 7/44 variance,  
84%

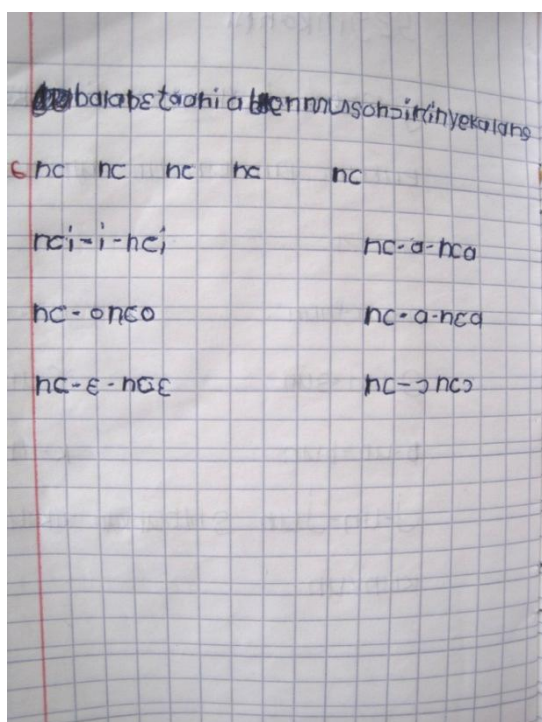
size: 21/44 variance, 52.2%

spacing: 5/10 variance,  
50% \*\*

no word breaks of 5  
possible, 0%

between letters: 0/5, 100%

alignment: 21/44 variance,  
52.2%



**(month 4)**

symbols: 83

formation: 11/83 variance,  
86.7%

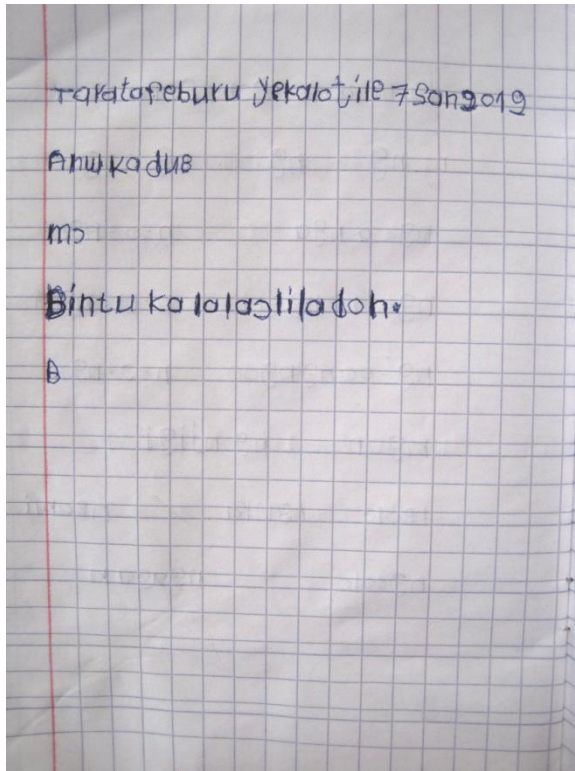
size: 21/83 variance, 74.6%

spacing: 13/23 variance,  
43.3% \*\*

no word breaks of 11  
possible 0%

spaces in syllable-building  
exercise omitted 2/12  
variance, 83.3%

alignment: 21/83 variance,  
74.6%



### (month 5)

symbols: 60

formation: 10/60 variance,  
83.3%

size: 21/60 variance, 65%

spacing: 10/12 variance,  
16.7%

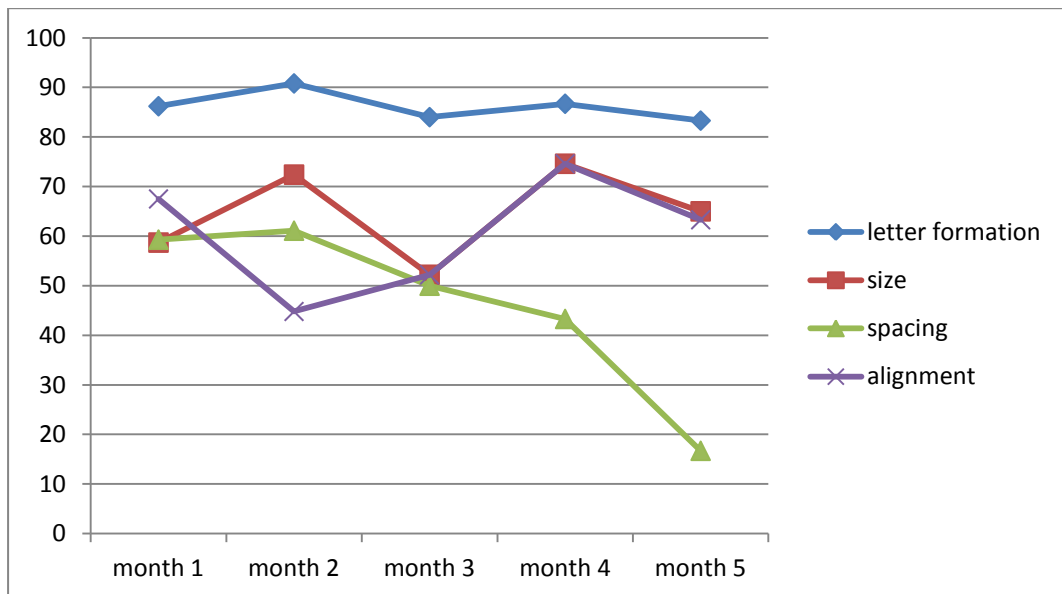
alignment: 22/60 variance,  
63.3%

tarata feburu ye kalo tile 7  
san

Tuesday, February month  
day 7 year 2012

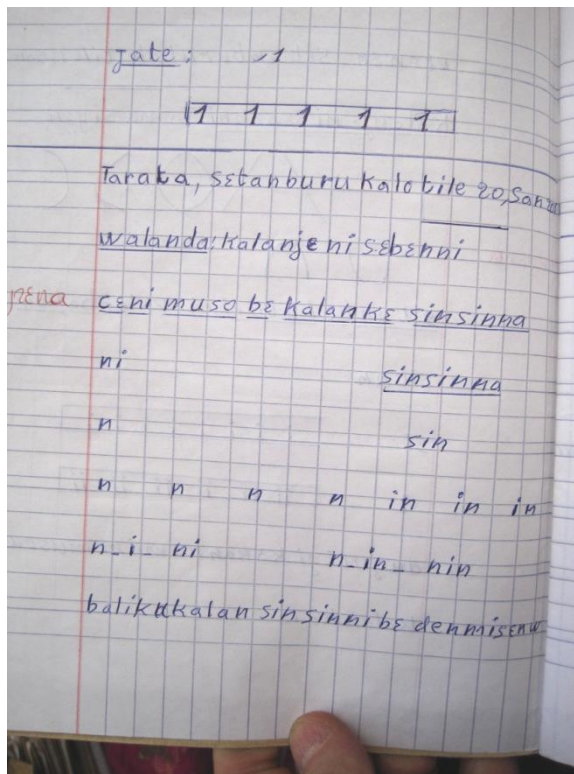
Bintu ka lakoli ladon.

“Bintu must welcome  
school.”





17. Ramatulaye Meyiga, age 37-38, Diallobougou (5 samples, 5 mo)



(month 1)

symbols: 140

formation: 7/140 variance, 95%

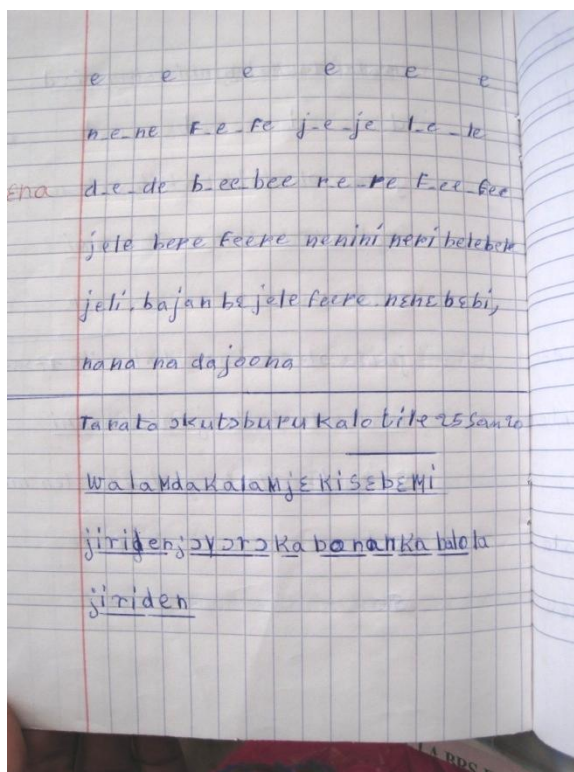
size: 11/140 variance, 92.1%

spacing: 4/18 variance, 77.8%

2 word break variance, 1 missing between 'ce' and 'ni', 1 inserted in last instance of 'sinsinni')

alignment: 6/140 variance, 95.7%

*This woman was not illiterate before beginning the course.*



(month 2)

symbols: 200

formation: 13/200 variance, 93.5%

(year incomplete)

size: 34/200 variance, 83%

spacing: 10/52 variance, 80.7%  
\*\*

word spacing: 9/25 variance, 64%

letters, wds in isolation: 1/27, 96.3%

alignment: 8/200 variance, 96%

of note:

“walanba kalanje ni sebeni”

became:

“walaMdaKalaMje ki sebeMi”

sika be sene fe. a bolila ka don sokolo.  
okepa dappin, den ka sika.

Juma, nowanburu koto bile 18, san 9011

Kalanje ni Seheni:

bakapi be aka nsepeforo kono  
nsepeforo  
nsepe

ns ns ns ns ns  
ns-i-nsi ns-ii-nsii ns-a-nsa  
ns-a-nsaa ns-e-nse ns-c-nsa  
nsanfa nsa je nsaha BBaka nsika  
nsiika nson

nsepeforo belebele be solofe. adenke  
sibiri be sene ke nsebe.  
ni nsepe feerele. a fa be utra selifin sa

(month 3)

symbols: 297

formation: 23/297 variance, 92.2%

size: 30/297 variance, 89.9%

spacing: 12/47 variance, 74.4%

alignment: 43/297 variance, 85.5%

n-an n-an n-e-je  
nintin nani jifin nifin  
pamanten possi jegen line  
dugu fila ka jagan ye sene uye  
kakilinatale nalen ke kaben kele.  
kan. bee ye ita fo min be ben anin  
be ben sigila, obee fara. nin nagan ce  
Kabinin la wale, jaga koto nagan tala  
be sigi diya.

Janab, Zangaye Kala bile 18, San 2012

Walaada: Kalanje ni Seheni  
Kuntala, Iere e  
den Kumasen:

kon ye gunuda donako baawala.  
gunuda  
gu

g g g g g  
g-a-ga g-u-gu g-o-go  
g-e-ge g-i-gi g-e-gi  
gama-gumu-gami-gunuma

(month 4)

symbols: 358

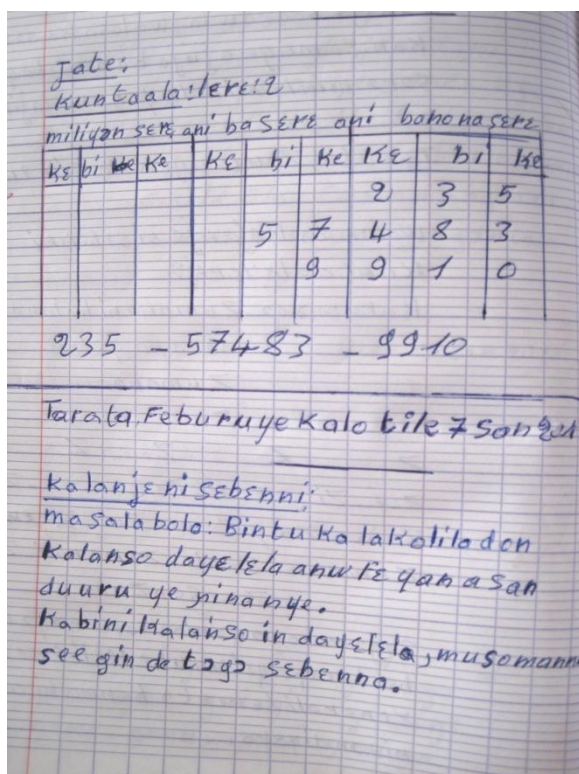
formation: 17/358 variants, 95.2%

size: 74/358 variance, 79.3%

spacing: 15/74 variance, 79.7%

alignment: 87/358 variance, 75.6%

Still no use of capital letters to begin sentences, but letters more resembling the capital are appearing in the text (e.g., f/F, k/K, z/Z), which may be an indicator of more speed/less care with detail.



### (month 5)

symbols: 165 (text including the date and thereafter)

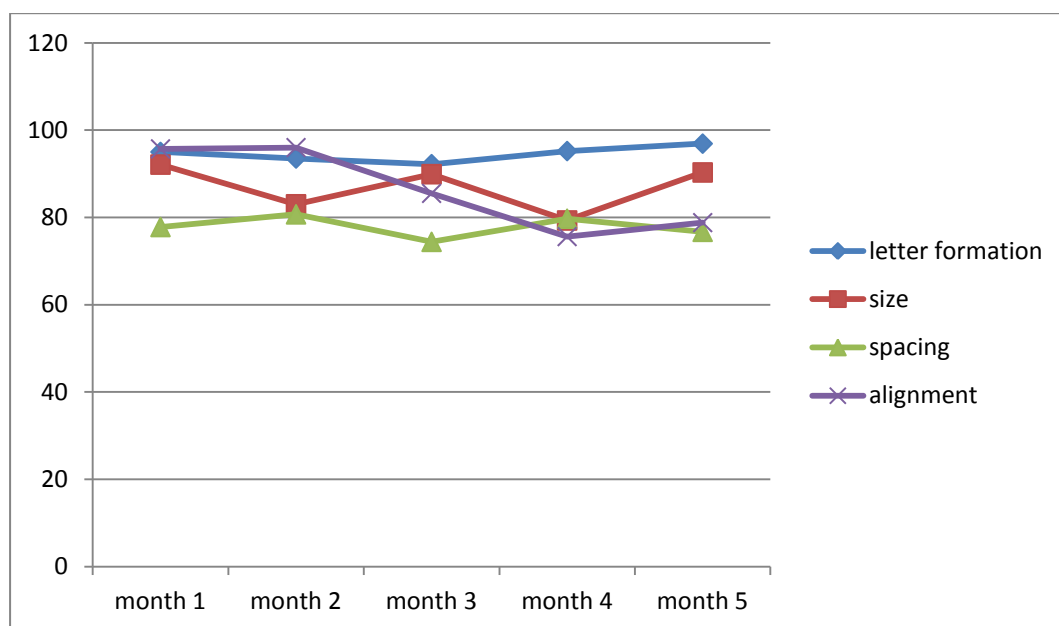
formation: 5/165 variance, 96.9%

size: 16/165 variance, 90.3%

spacing: 7/30 variance, 76.7%

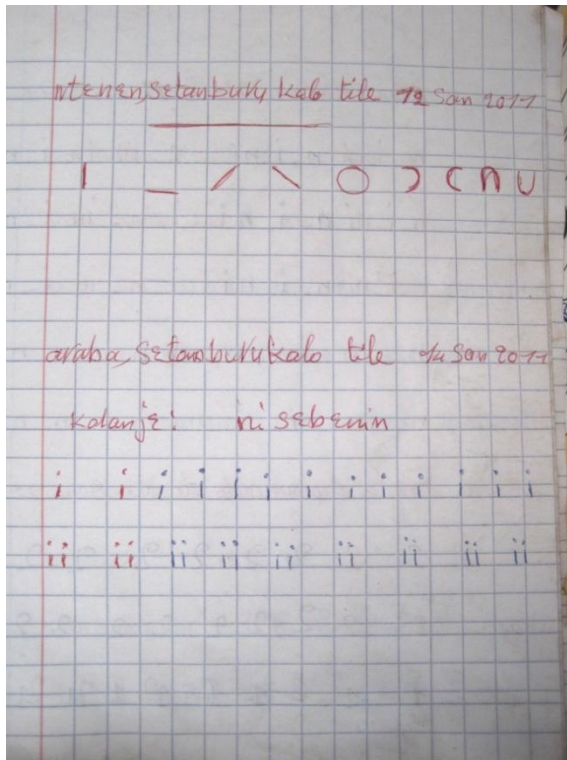
alignment: 35/165 variance, 78.8%

again, the appearance of capitals in unexpected places. In Bambara, as in French, day and month terms are not written with capital letters. Her 'a' is often half-size in relation to the other letters, but not consistently. One 'n' is dotted as for an 'i'.





18. Fanta Coulibaly, age 50, Centre Netaa (6 samples, 5 mo)



**(month 1)**

All information written in red for Fanta's lessons have been written for her by the facilitator as a model to follow.

Even so, in the copying exercise, she has found it difficult to manipulate fine motor movements for consistently writing within the lines provided and to maintain vertical lines in her writing. She also shows a lack of perception of spacing, but does better with the double vowels.

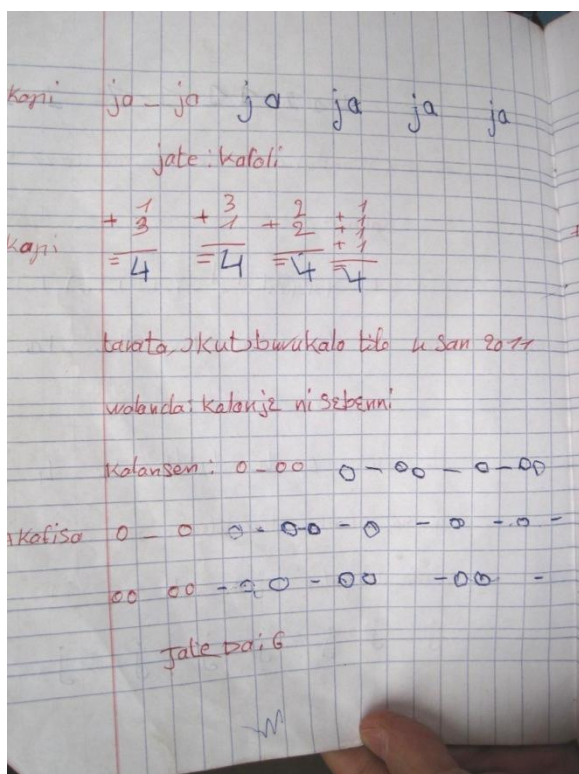
symbols: 25

formation: 0/25, 100%

size: 11/25 variance, 56%

spacing: 100% (for 'i' and 'ii' only)

alignment: 3/25 variance, 88%



## (month 2)

symbols: 26 (numbers excluded)

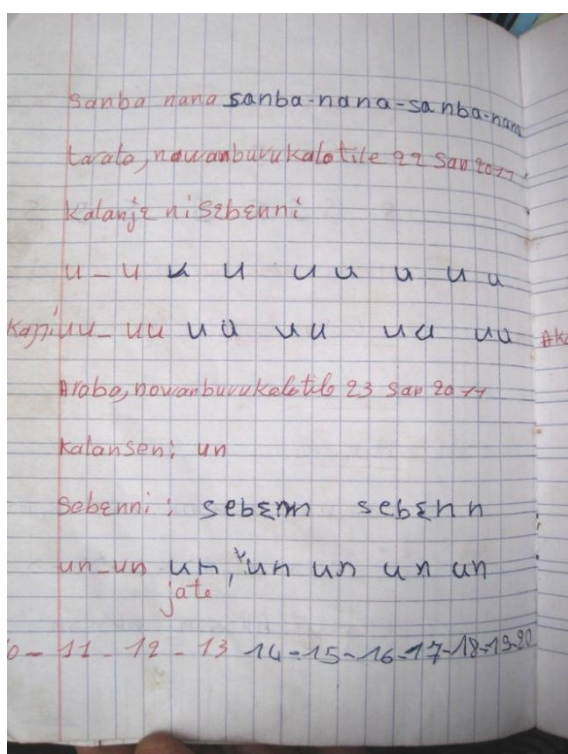
formation: 5/26 variance, 80.7%

size: 12/26 variance, 53.8%

spacing: 5/12 variance, 58.3%

(still letters, not words)

alignment: 12/26 variance, 53.8%



## (month 3)

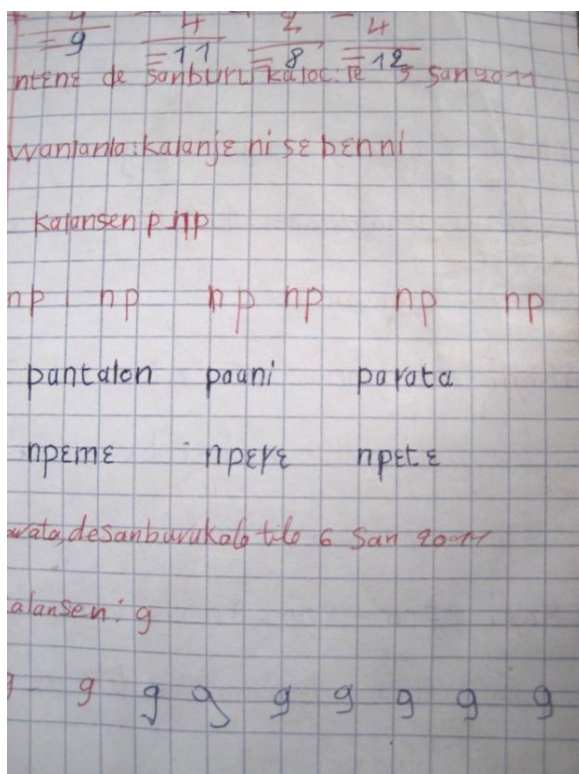
symbols: 56 (numbers excluded)

formation: 10/56 variance, 82.1%

size: 18/56 variance, 67.8%

spacing: 6/26 variance, 76.9%

alignment: 14/56 variance, 75%



#### (month 4)

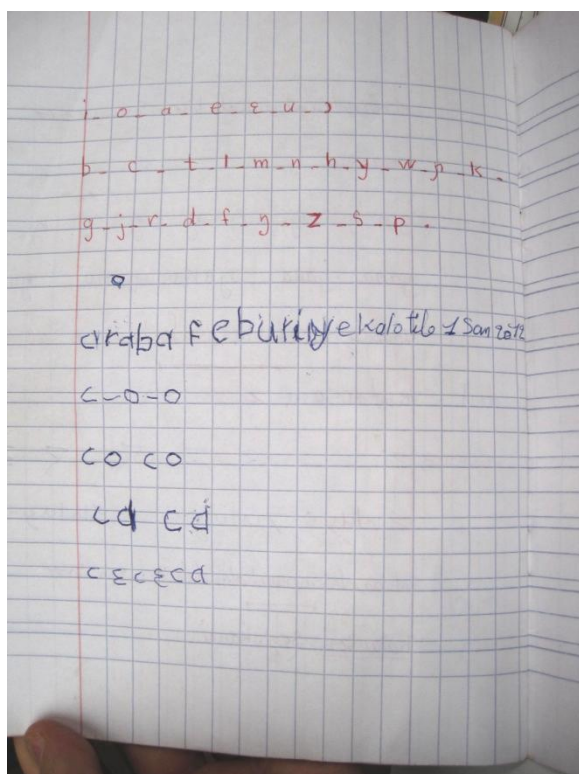
symbols: 40

formation: 3/40 variance, 92.5%

size: 17/40 variance, 57.5%

spacing: 2/10 variance, 80%

alignment: 8/40 variance, 80%



#### (month 5)

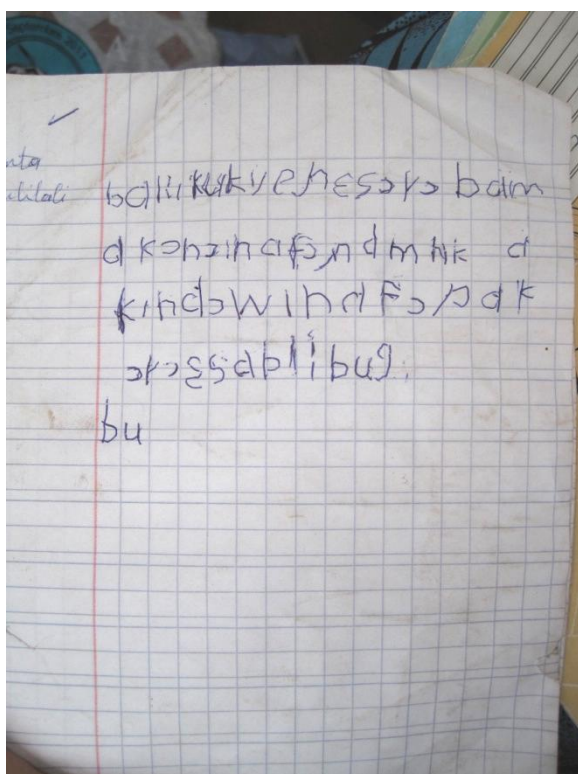
symbols: 29

formation: 8/29 variance, 72.4%

size: 24/29 variance, 17.2%

spacing: 5/20 variance, 75%

alignment: 18/29 variance, 37.9%



### (connected text writing)

Again, learner performance in letter formation dips in form and in size uniformity. Left-to-right orientation of the text is clear, but lines on the page wander. Letters are situated with less relationship to one another; some letters are partially or completely malformed. Three or perhaps four words can be discerned in the first line, but one continues to the second line without regard for the line break. From the second line of the text, meaningful words are no longer discernible in the text and letter formation worsens.

symbols: 61

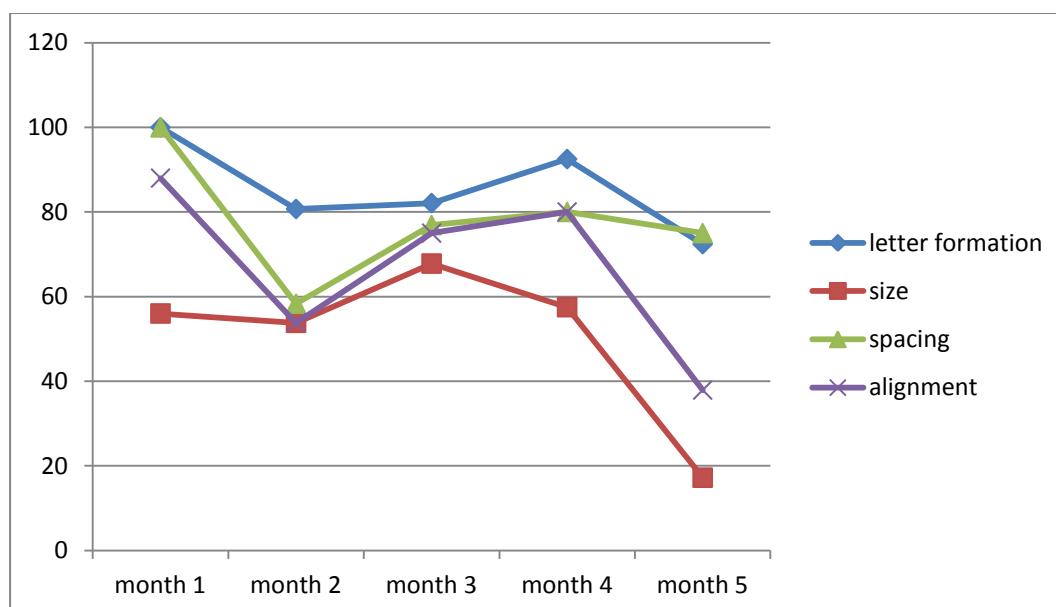
formation: 25/61 variance, 41%

size: 0

spacing: 0

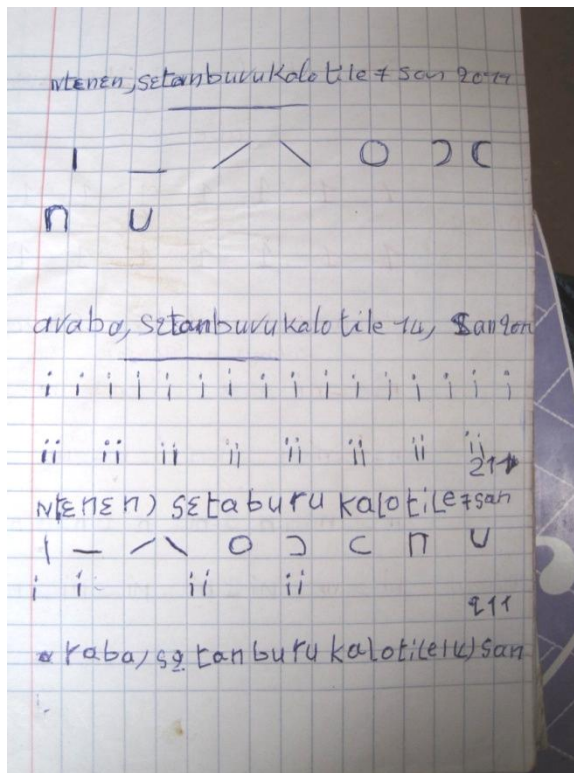
alignment: 40/61 variant, 66%

baliku ye nesoro bam[line break]ako adulthood was attained Bamako (then random letters, no further discernible words or combinations of letters corresponding to the phonological or orthographical pattern of the language).





19. Tene Kone, age 59, Centre Netaa (5 samples, 5 mo)



(month 1)

(Practicing drawing shapes – the top half of the page is a model written in by the class facilitator)

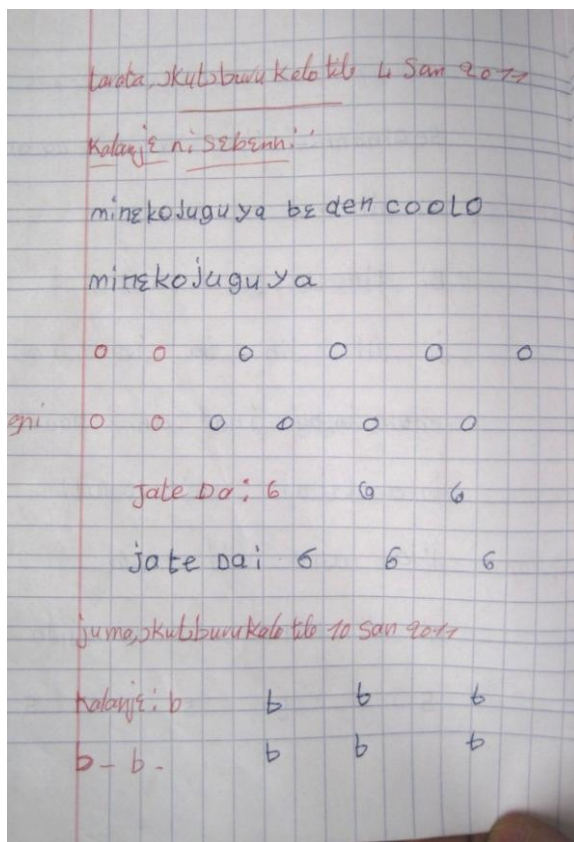
symbols: 90

formation: 13/90 variance, 85.5%

size: 54/90 variance, 40%

spacing: 10/35 variance, 71.4%

alignment: 64/90 variance, 28.9%



(month 2) (red text written by the facilitator)

“Too many restraints make a child wander.”

(Phrase copied by learner from the board)

symbols: 59

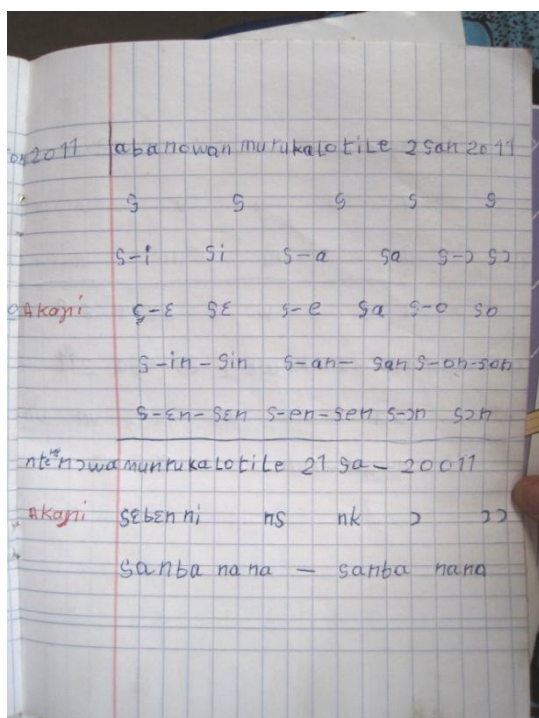
formation: 4/59 variance, 93.2%

size: 43/59 variance, 27.1%

spacing: 2/14 variance, 85.7%

alignment: 22/59 variance, 62.7%





### (month 3)

a syllable missing from the copied word 'araba' (Wednesday), still a lot of variation in size, but a distinct effort to write on the line. Substitution of 'nm' for 'mb' in the word 'November', indicating an effort at phonological representation. Inconsistent word-break spacing. Some trouble with verticality on the 's' letter formation

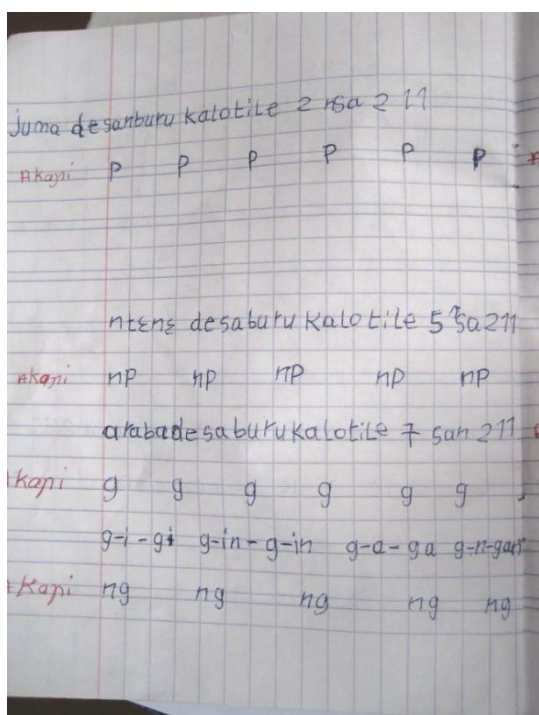
symbols: 156

formation: 13/156 variance, 91.7%

size: 70/156 variance, 55.1%

spacing: 13/53 variance, 75.4%

alignment: 63/156 variance, 59.6%



### (month 4)

Suspected increased ease of letter formation may be leading to less care in order and in inclusion of all symbols.

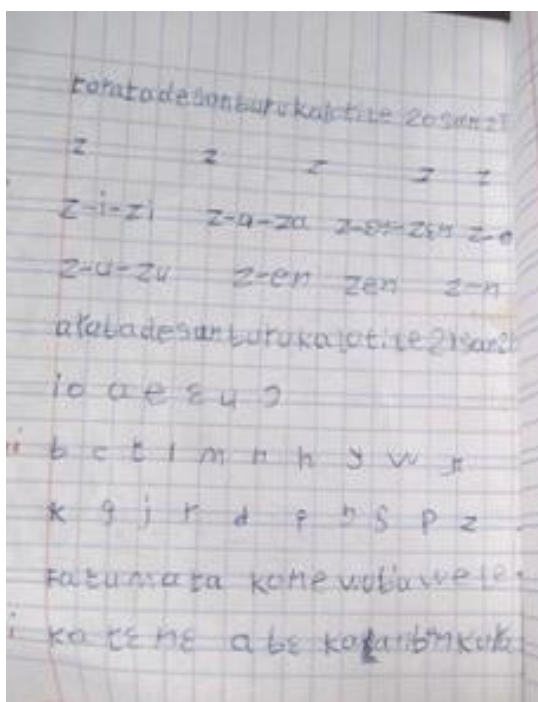
symbols: 136

formation: 11/136 variance, 91.9%

size: 73/136 variance, 46.3%

spacing: 8/48 variance, 83.3%

alignment: 53/136 variance, 61%



### (month 5)

no spaces between words, but continued progress with letter formation.

Wednesday, December 21, 2011:

letter review and first sentence:

“Fatumata Kone wo bi wele ka tene a be kalan bon kura.”

Fatumata Kone (a woman’s name) stopped today to announce that it is forbidden for her to do a big new study.

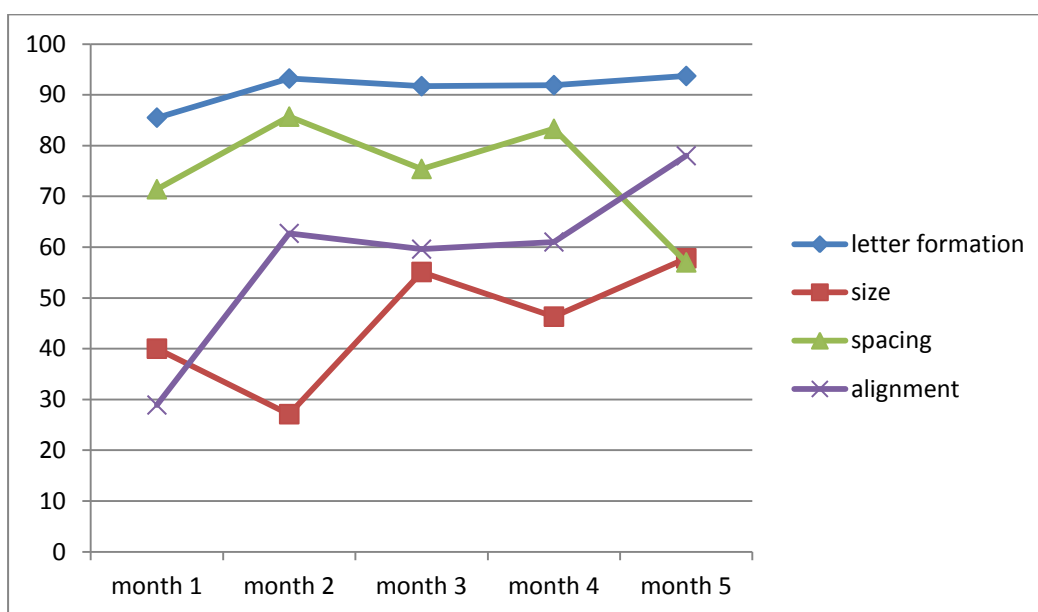
symbols: 159

formation: 10/159 variance, 93.7%

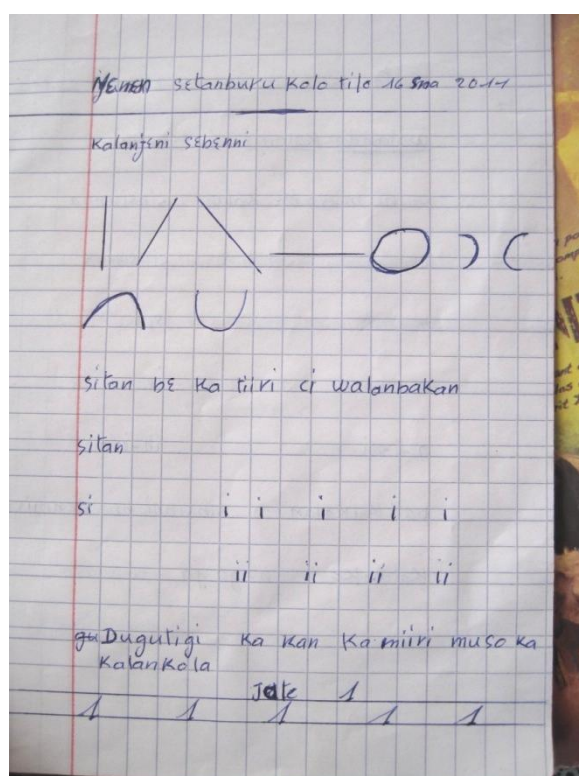
size: 67/159 variance, 57.8%

spacing: 16/64 variance, 57%

alignment: 35/159 variance, 78%



20. Kadjatou Sangaré, age 34, Diallobougou (6 samples, 6 mo)



(month 1)

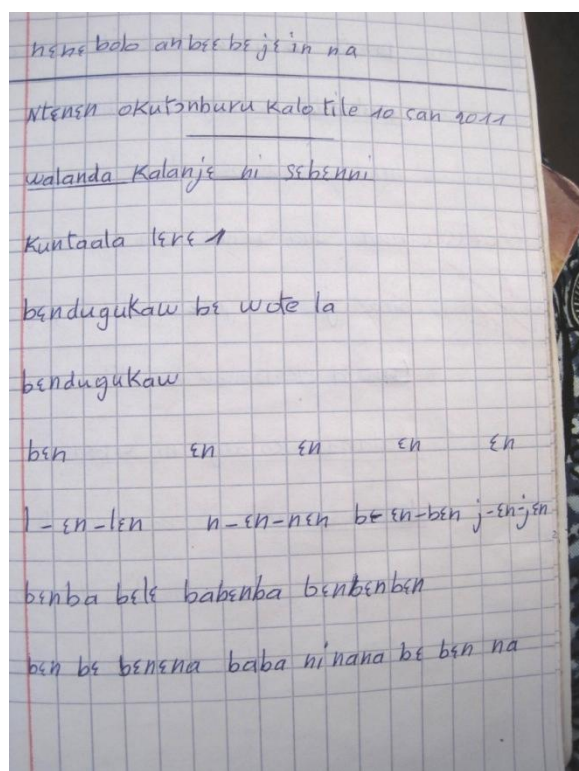
symbols: 135

formation: 10/135 variance, 92.5%

size: 47/135 variance, 65.1%

spacing: 6/28 variance, 78.5%

alignment: 7/135 variance, 94.8%



(month 2)

symbols: 106

formation: 6/106 variance, 94.3%

size: 50/106 variance, 52.8%

spacing: 4/49 variance, 91.8%

alignment: 10/106 variance, 90.5%

*Obviously not illiterate before beginning this literacy class.*

walanda Kalanije ni sebenni  
 seginkanni K nk 7 33 3n s ns K2K2  
 Kon 52 522 523 524 ns2 ns2n  
 KonKon Kon nK22n 5225 ns2n nak2  
 joona danfara seere 522n dafere Kolo Koro  
 fen sanjiba nana bi ji jora masa Kanakofen bee  
 K22 sanni ji in Kaja a jorela 522n abe Kasi  
 nKa ji bora joona nako Kon2  
 Araba nowanbura Kalo tile 9 san 2014  
 walanda Kalanije ni sebenni

### (month 3)

symbols: 296

formation: 14/196 variance, 92.8%

size: 233/296 variance, 21.2%

spacing: 4/64 variance, 93.7%

alignment: 29/296 variance, 90.2%

ce ni muso be jolisegesege la  
 ce c c  
 C-i-ci C-o-co C-on-con  
 C-an-can C-en-cen C-in-cin  
 ce ceso cesiri 5225 Cooa Laman bolocimi  
 ce a cencen ce ni muso an bee Ka ar  
 cesiri Ka siola Kefe m2g2 Filo man Kan K  
 bolocimin en tamalimin en ani Farikolocimin  
 sita  
 Wenen de sanbura Kalo tile 5 san 2014  
 walanda Kalanije ni sebenni

### (month 4)

symbols: 250

formation: 13/250 variance, 94.8%

size: 155/250 variance, 38%

spacing: 6/59 variance, 89.8%

alignment: 37/250 variance, 85.2%



w - i - wi      w - e - we      w - an - wan  
 w - on - won      w - in - win      w - ti - wte  
 waajuli    wamba    welenin    wete woko  
 witiini    wolan    woko    wote Kera Kunu  
 wasa Koro, bee    sewara    ba wo awatara

---

juma Zanwuye Kalo tile 6 San 1012

Kalange ni Sebenni  
 Segim Kanini  
 P g w np ng nt  
 pan gantan wan npan ngan ntan pengan  
 ten wen npen ngen nten pin gin tin win  
 npin ngin ntin peng en ten wen npen ngen  
 nten pengan ten wan npan ngan nton pnan  
 tin won won npon ngon nton pnan ganton  
 won npan ngon nton pnan  
 pun gun tun wun npun ngun ntun palan  
 Kooki wolo galama npalan ntam ngala  
 densoke nana Ka aka npalan ni npete to  
 ntomisun Koro

### (month 5)

symbols: 243 (below the line only)

formation: 12/243 variance, 95%

size: 83/243 variance, 65.8%

spacing: 5/79 variance, 93.6%

alignment: 80/243 variance, 67%

lahalaaya halalafen yayi jo jintin  
 ganahana gunumani zu zumana yakuba ye  
 horo ye muja b de jogan te ganaya te soko  
 gansafo i Ka Ka Ke Ko ye here ni baaden  
 sabatili be soko yiriwa baaradege te je  
 hakili Ko

---

takata feburuye Kalo tile 7 San 1012

walanda: Kalange ni Sebenni  
 Kuntaala: lere

Dugufigi Ka welekan tun be a jini duguden bee  
 fe, ce ani muse, u Ka jogan soko Kalangoro  
 dukene na, ni dara Kaw dunna.  
 Ciden dowa bora BamaKo, u ni dugudenu  
 benna masala musomanninw Ka jetaa sokoli  
 Kan lakolila.

### (month 6)

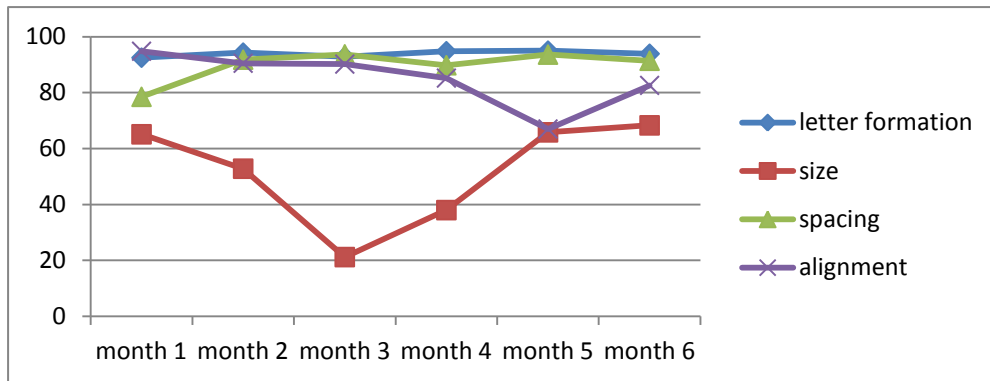
symbols: 231 (below the line only)

formation: 14/231 variance, 93.9%

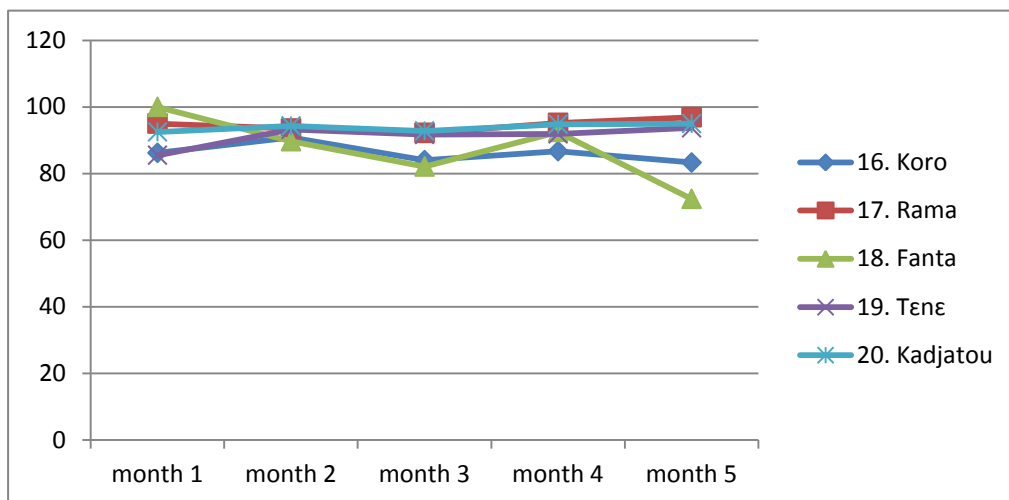
size: 73/231 variance, 68.3%

spacing: 4/47 variance, 91.4%

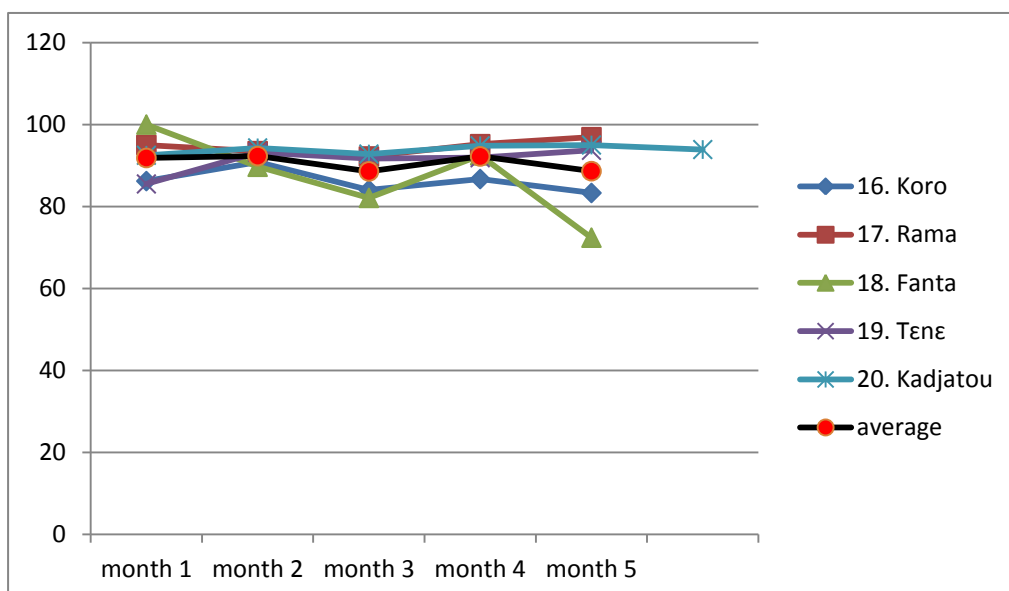
alignment: 40 /231 variance, 82.6%



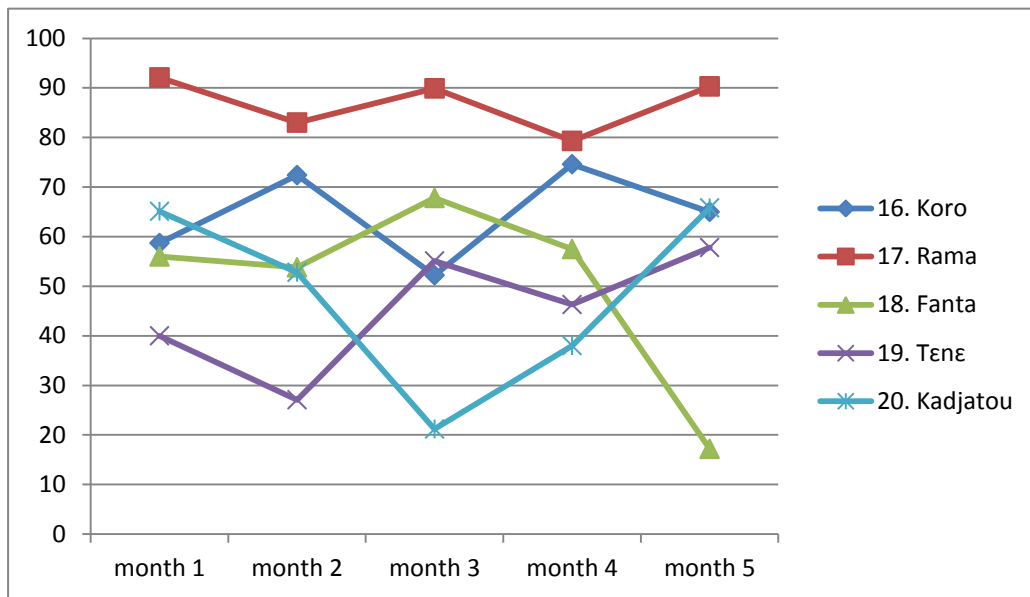
#### formation, all 5



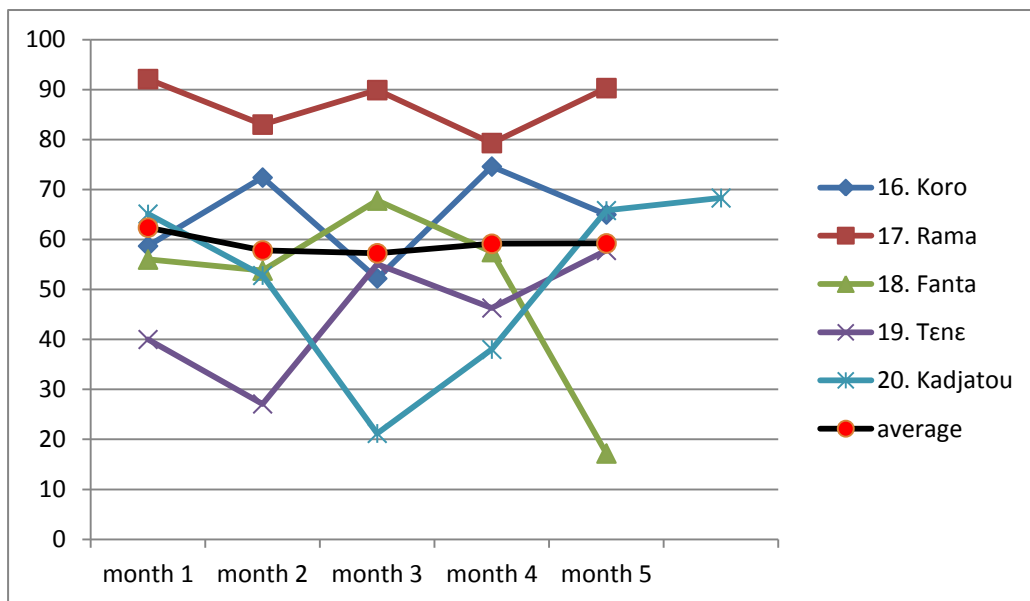
#### Formation with average plotted



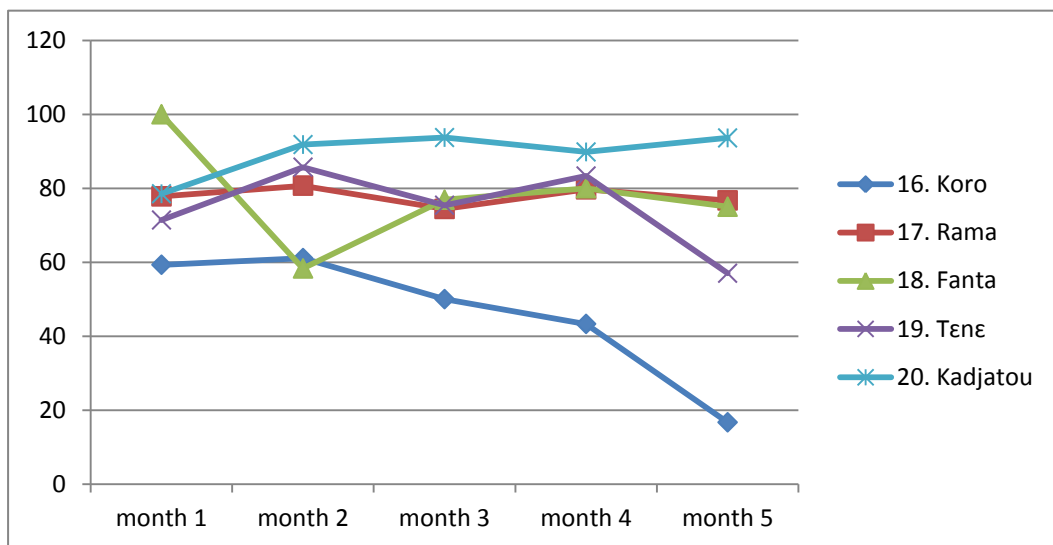
size, all 5



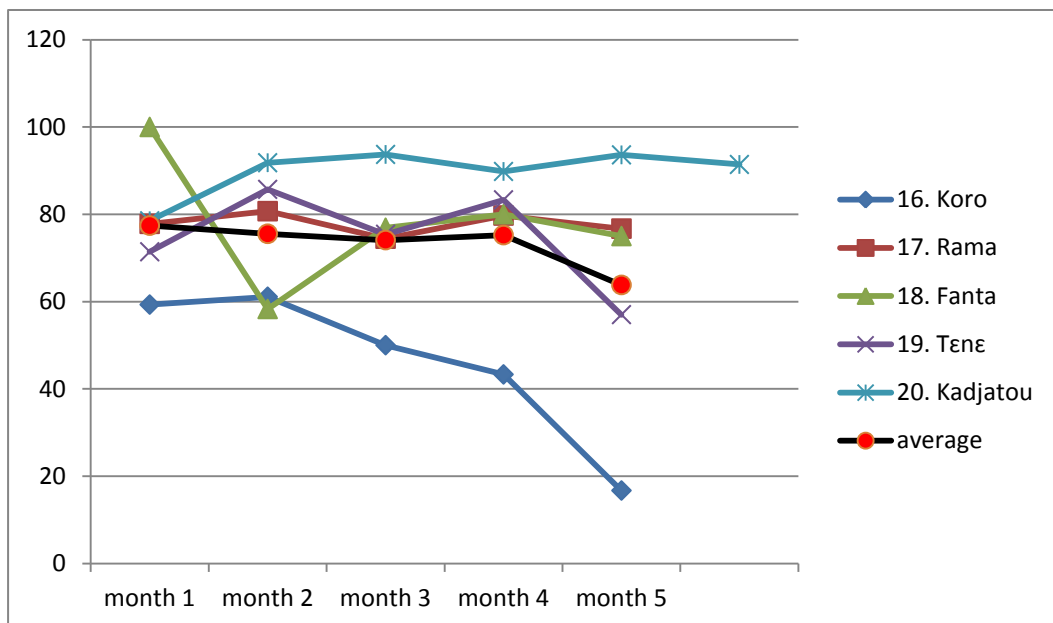
Size with average plotted



spacing, all 5

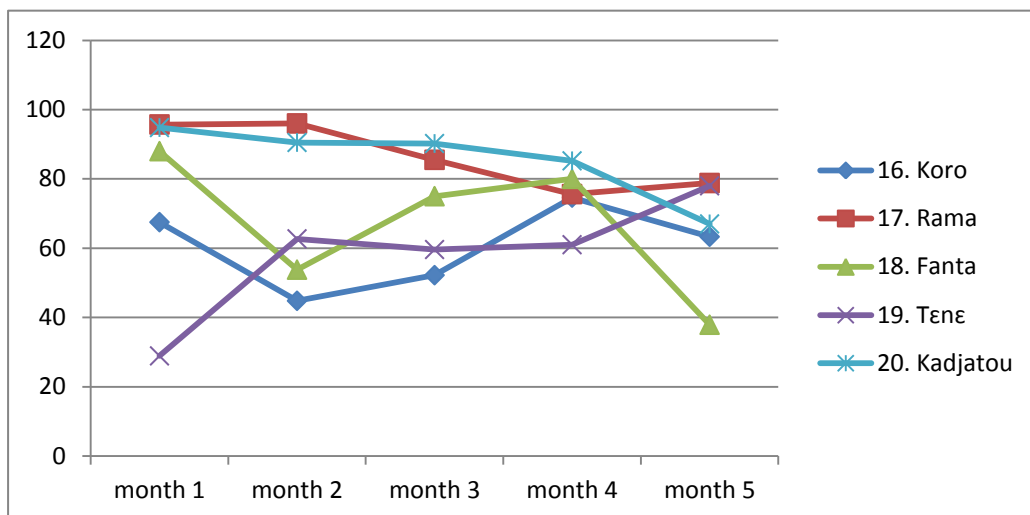


spacing with average plotted

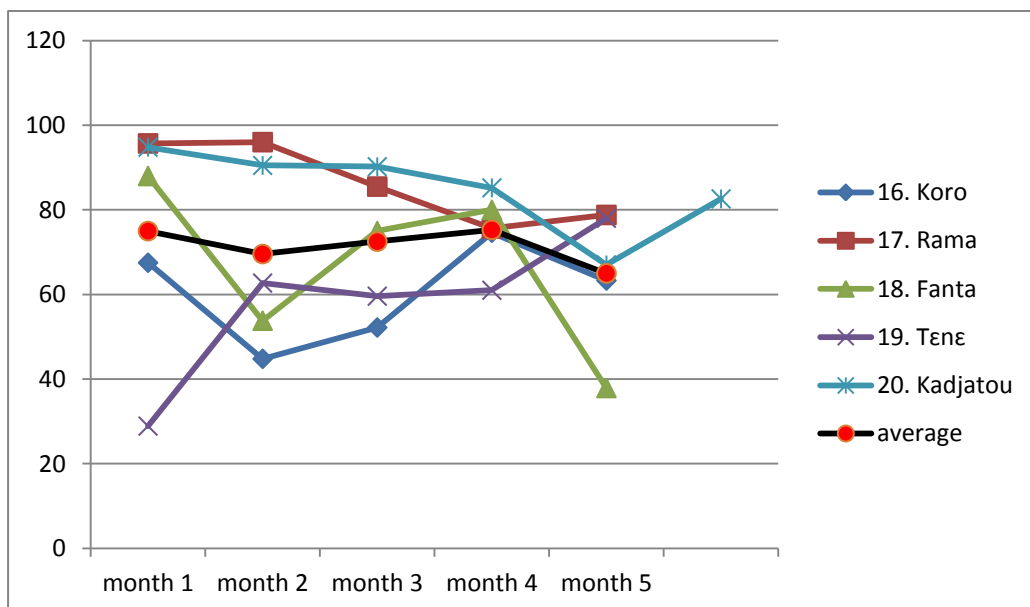




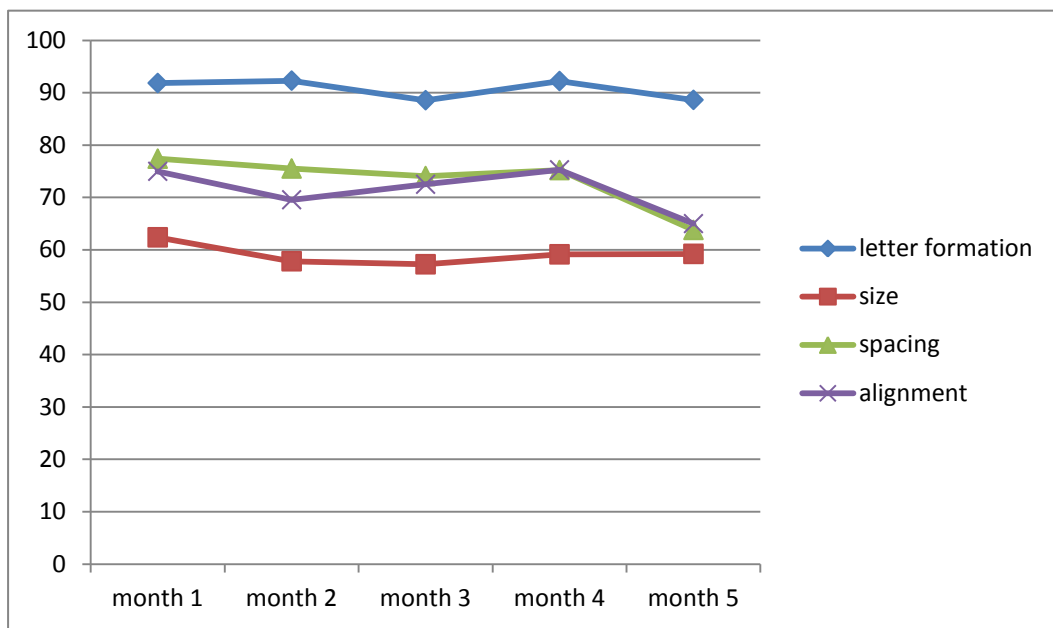
alignment, all 5



alignment with average plotted

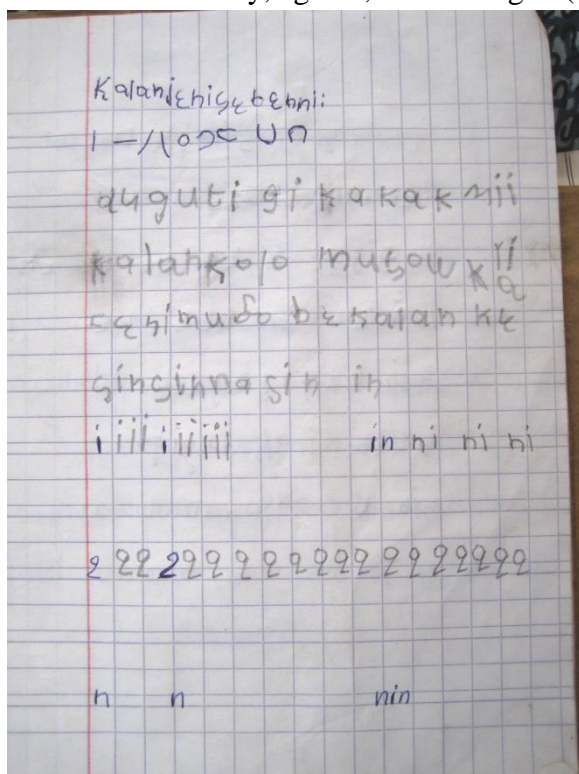


average for collective variable of interest, 5-6 month data



## Appendix D. Intra-individual performance at varying task-complexity levels

1. Assan Coulibaly, age 23, Diallobougou (3 months)



*dictation written correctly with translation:*

“Dugutigi ka kan ka miiri musow ka kalan ko la.”  
(The village chief must think about [the subject of]  
women’s study.)

“Cε ni muso be kalan kε sinsinni.” (The man and woman persevere in study.)

**(month 1)** (numbers excluded)

**Letters: (21 symbols: 'i', 'in')**

formation: 2/21 variance,  
90.4%

size: 16/21 variance,  
23.8%

spacing: 3/9 variance,  
66.7%

alignment: 12/21  
variance, 42.8%

*copied from board: 16  
symbols ("kalanje ni  
sebenni")*

formation: 4/16 variance,  
50%

size: 11/16 variance,  
31.2%

spacing: 3/2 variance,  
0%

alignment: 12/16  
variance, 25%

**dictation: (61 symbols,  
15 spaces)**

duguti gi ka ka k mii  
kalankolo musowka (ĩi –  
may be the missing ‘ri’  
from ‘miiri’) f6; sz6;  
sp5; a34  
cenimuso be kalan ke  
sinsinna si n in

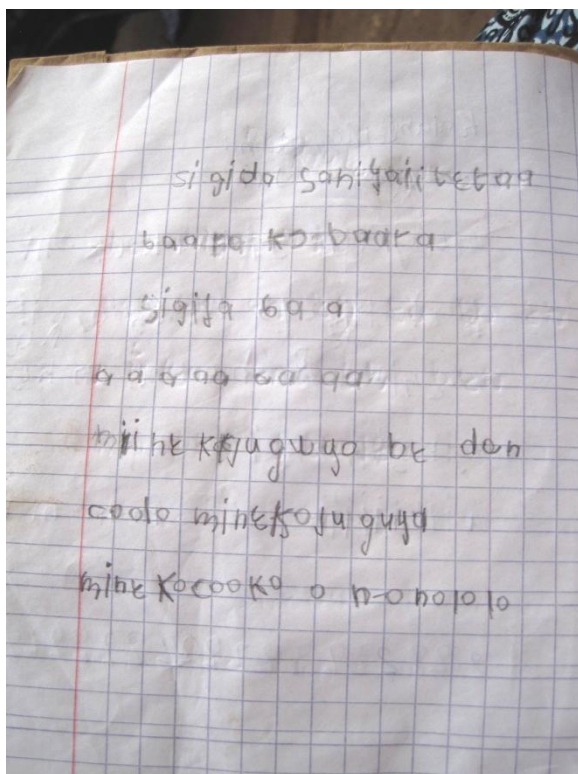
f4; sz19; sp2; a20

formation: 10/61  
variance, 83.6%

size: 25/61 variance,  
59%

spacing: 7/15 variance,  
53.3%

alignment: 54/61  
variance, 11.4%



Sigida saniyali te taa baara ko.

“Neighborhood cleaning does not go after work.”

Miiri kojuguya be don cogo.

“Bad thoughts give entry to [bad] ways.”

(month 2)

**letters: (27 symbols)**

formation: 5/27 variance,  
81.4%

size: 16/27 variance,  
40.7%

spacing: 3/12 variance,  
75%

alignment: 22/27  
variance, 18.5%

**copied from board: (33  
symbols; see following  
sample)**

formation: 5/33 variance,  
87.8%

size: 13/33 variance,  
60.6%

spacing: 4/5 variance,  
20%

alignment: 18/33  
variance, 45.4%

**dictation: (49 symbols, 9  
spaces)**

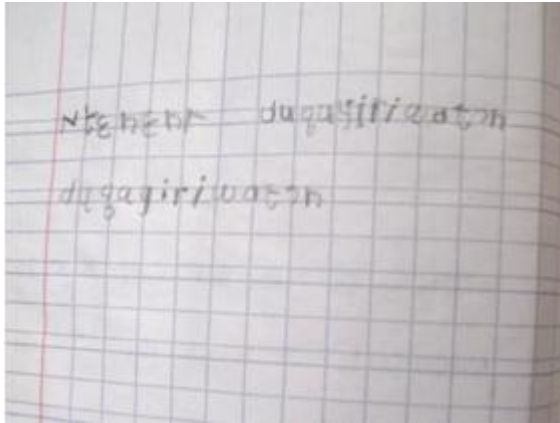
formation: 25/49  
variance, 48.9%

size: 33/49 variance,  
32.6%

spacing: 4/9 variance,  
55.5%

alignment: 33/49  
variance, 32.6%

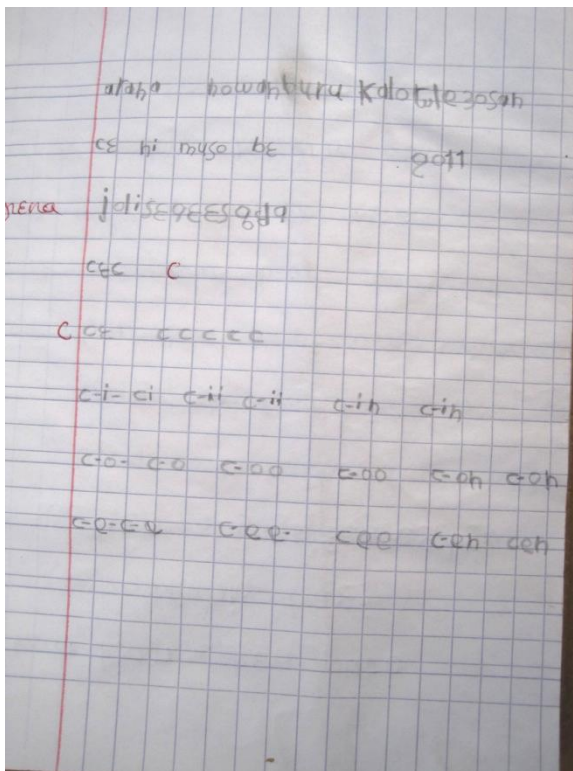
awareness of words, but  
difficulty in getting a  
whole word without  
error



***copied from the board:***

ntenen – Monday

dugu yiriwa ton (village  
development association)



***text on the board:***

araba, nowanburu kalo tile 30, san 2011

“Wednesday, November 30, 2011”

***dictation text:***

Ce ni muso be joli segesegeli la?

“How many men and women took the exam?”

**(month 3)**

***letters: (58 symbols)***

formation: 3/58 variance,  
94.8%

size: 33/58 variance,  
43.1%

spacing: 6/24 variance,  
75%

alignment: 28/58  
variance, 51.7%

***copied from board: (27  
symbols, 5 spaces)***

formation: 6/27 variance,  
77.8%

size: 21/27 variance,  
22.2%

spacing: 2/5 variance,  
60%

alignment: 16/27  
variance, 40.7%

***dictation: (26 symbols, 6  
spaces)***

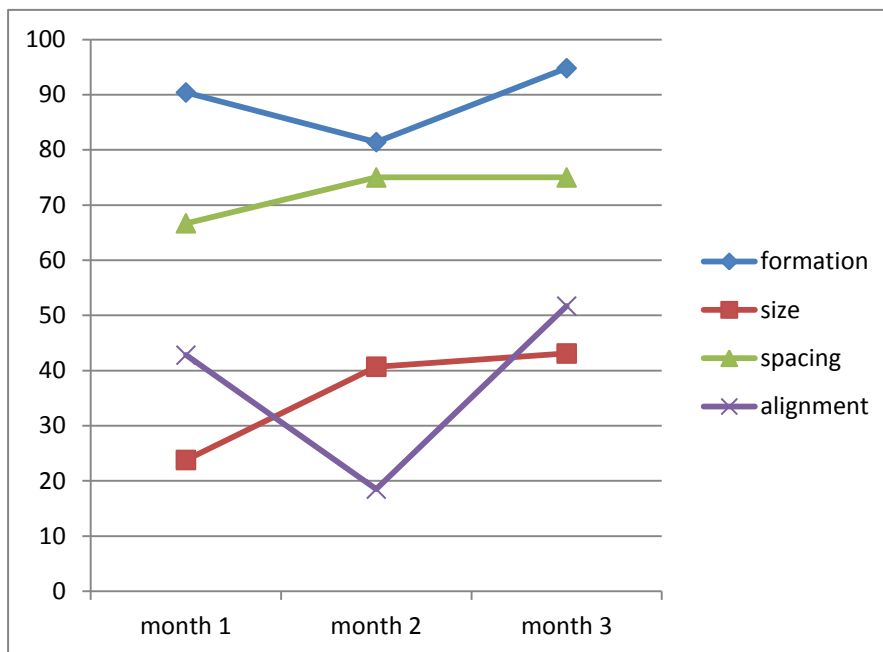
formation: 7/26  
variance, 73%

size: 16/26 variance,  
38.5%

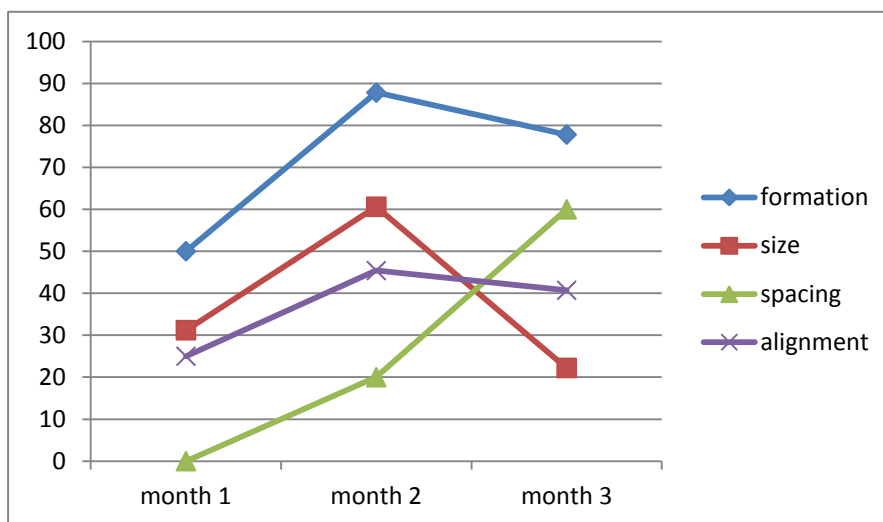
spacing: 2/6 variance,  
66.7%

alignment: 17/26  
variance, 34.6%

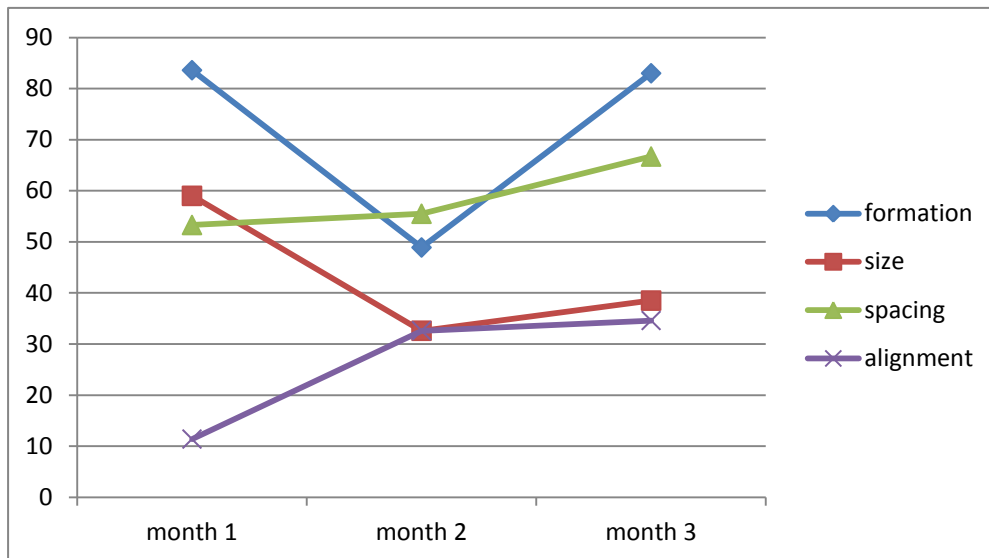
### 1. Assan, letters



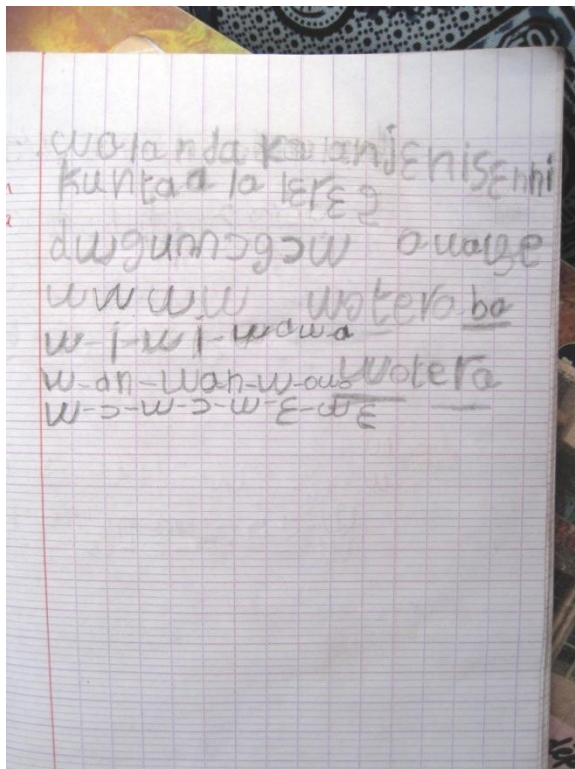
### 1. Assan, copied



## 1. Assan, dictation



## 4. Maï Danté, age 35, Dialloubougou (3 mo, debutant example)



walanda kalanje ni sebenni

“today’s lesson reading and writing”

kuntaala lere 2 “session hour 2”

dugu nəgəw o waleya wotoro ba

“village dirt that uses a wagon big” (referring

(month 1)

**letters: (35 symbols)**

formation: 6/35 variance, 82.8%

size: 26/35 variance, 25.7%

spacing: 4/16 variance, 75%

alignment: 25/35 variance, 28.5%

**copied from board: (35 symbols, 5 spaces)**

formation: 10/35 variance, 71.4%

size: 29/35 variance, 17.1%

spacing: 4/5 variance, 20%

alignment: 27/35 variance, 22.8%

**dictation: (24 symbols, 5 spaces)**

formation: 8/24 variance, 66.7%

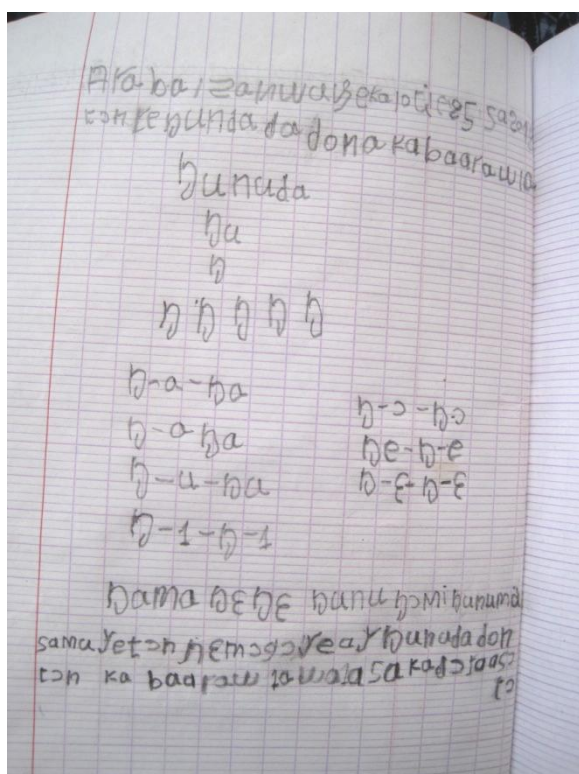
size: 22/24 variance, 8%

spacing: 3/5 variance, 40%

alignment: 18/24 variance, 25%



to refuse wagons used to take away trash)



araba, zanwuye kalo tile 25 san 2012

“Wednesday, January month day 25 year 2012”

tɔn ye ɲunudala donna ka baara wa [sic - baaraw ma]

“the association put the beekeepers in business ”

ɲama ɲeɲe ɲunu ɲomi ɲumuma

(a list of words using the new letter ɲ)

samu yetɔ ɲemɔɔ ye ay ɲunuda don

[Sama ye tɔn ɲemɔɔ ye. A ye ɲunuda don.]

Sama is the head of the association. He entered the hive.

Tɔn ka baaraw la walasa ka dɔ taa sɔ tɔ.

The association works so that others can take (the leftovers) home.

[translation provided by Béatrice Konfé]

(month 2)

**letters: (42 symbols)**

formation: 7/42 variance, 83.3%

size: 35/42 variance, 16.7%

spacing: 5/18 variance, 72.2%

alignment: 39/42 variance, 7%

**copied from board: (23 symbols, 6 spaces)**

formation: 6/23 variance, 73.9%

size: 18/23 variance, 21.7%

spacing: 4/6 variance, 33.3%

alignment: 19/23 variance, 17.3%

**dictation: (88 symbols, 23 spaces)**

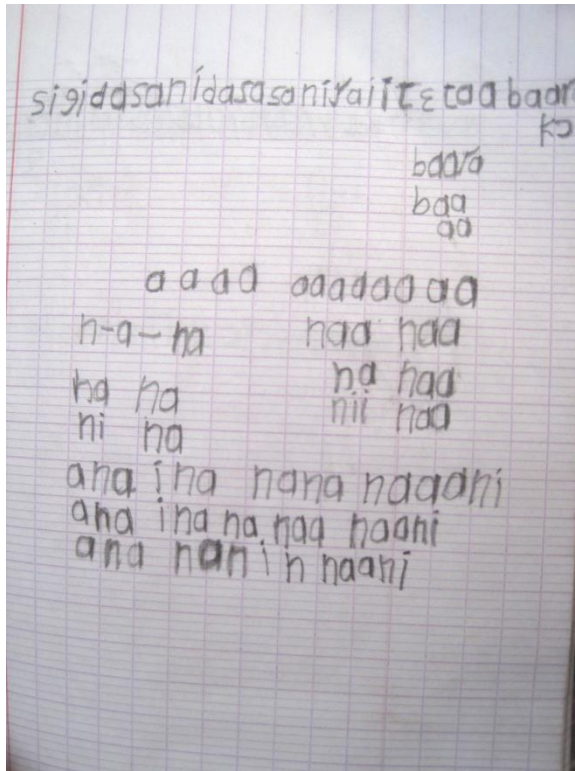
formation: 17/88 variance, 80.6%

size: 76/88 variance, 13.6%

spacing: 11/23 variance, 52.1%

alignment: 79/88 variance, 10.2%





Sigida saniyali te taa baara ko.

“Neighborhood cleaning does not go after work.”

Bintu ka lakoli ladon

“Bintu must welcome school.”

(month 3)

**letters: (96 symbols)**

formation: 12/96 variance, 87.5%

size: 78/96 variance, 18.7%

spacing: 5/22 variance, 77.2%

alignment: 81/96 variance, 15.6%

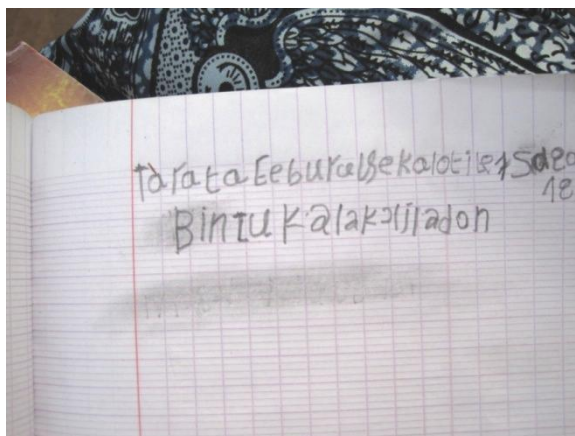
**dictation: (44 symbols, 8 spaces)  
(two phrases)**

formation: 12/44 variance, 72.7%

size: 33/44 variance, 75%

spacing: 6/8 variance, 25%

alignment: 27/44 variance, 38.6%



tarata, feburuye kalo tile 7 san 2012

“Tuesday, February month day 7 year 2012”

**copied from board: (25 symbols, 6 spaces)**

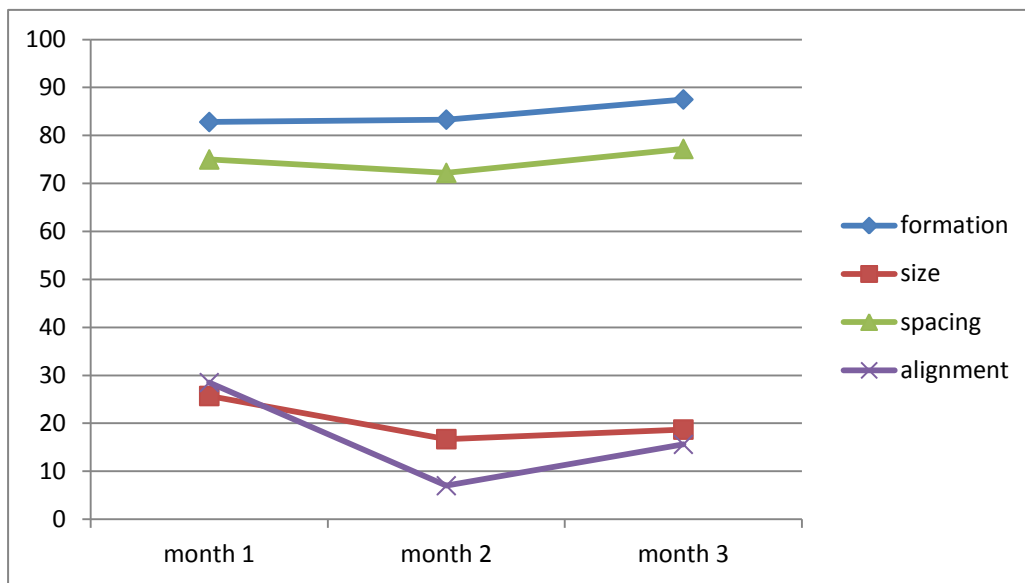
formation: 5/25 variance, 80%

size: 21/25 variance, 16%

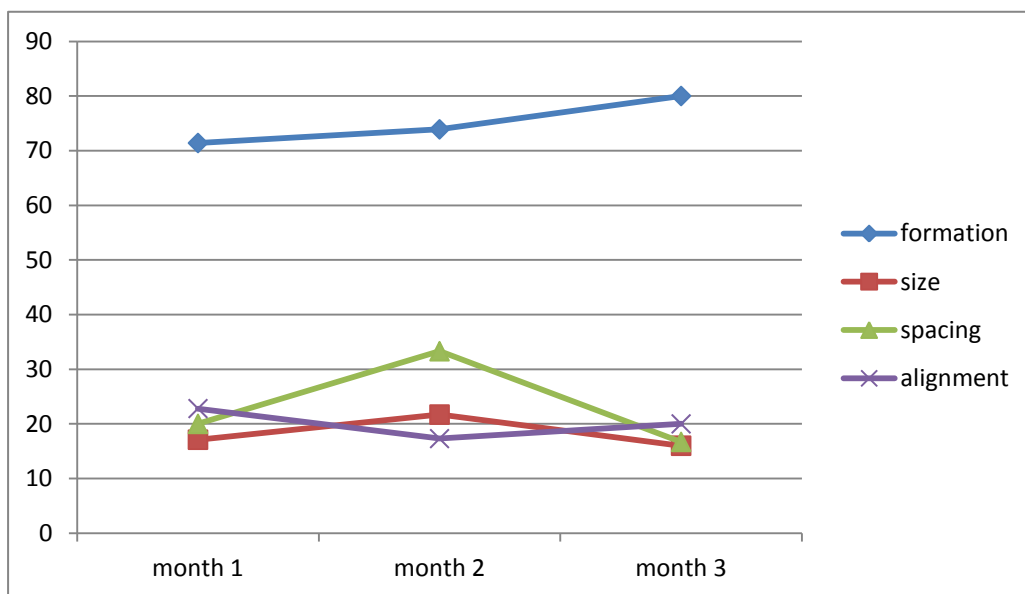
spacing: 5/6 variance, 16.7%

alignment: 20/25 variance, 20%

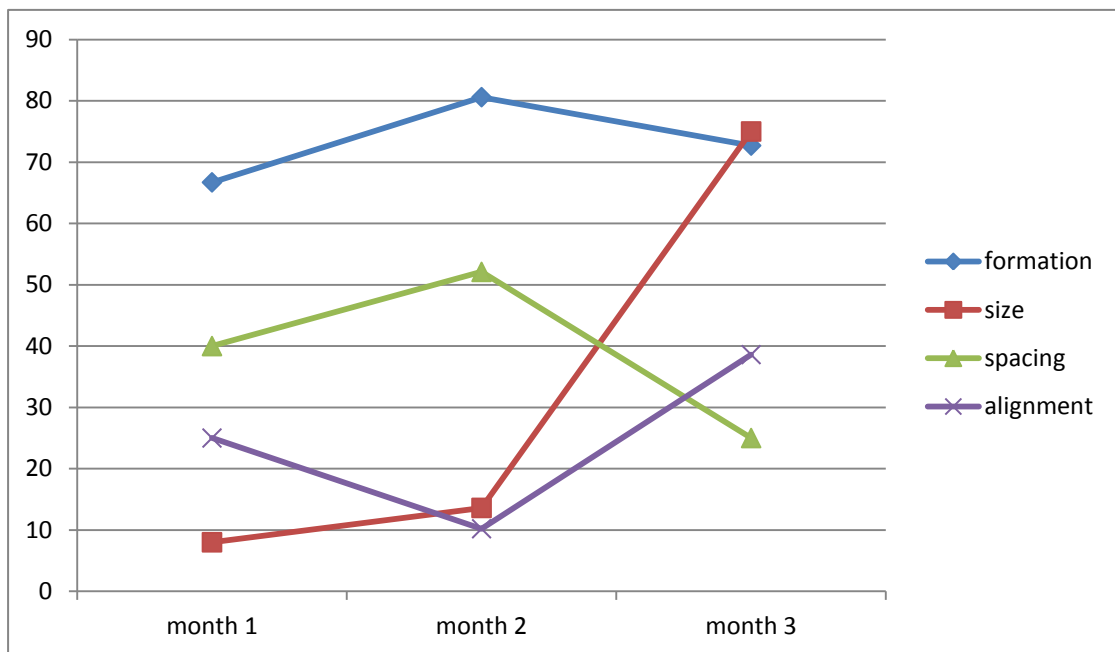
#### 4. Mai, letters



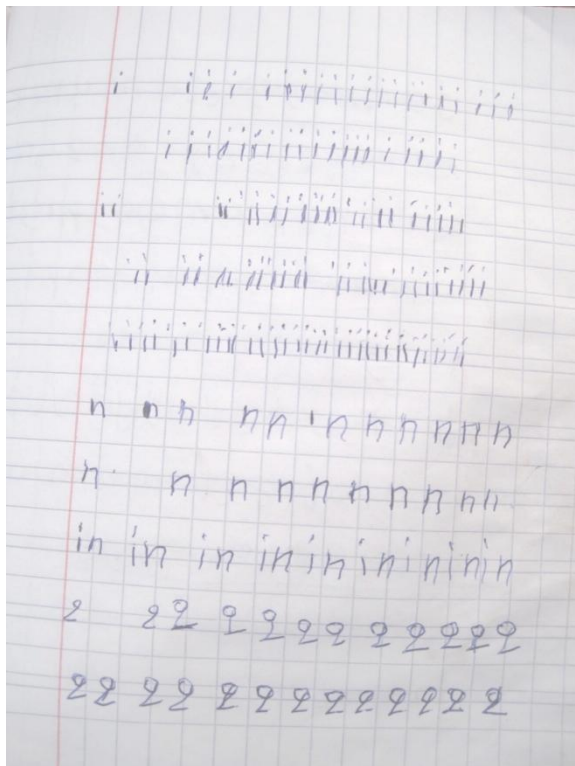
#### 4. Mai, copied



#### 4. Mai, dictation



#### 11. Minata Tounkara, age 16, Diallobougou (4 months)



##### (month 1)

**letters: (154 symbols, numbers omitted)**

formation: 40/154 variance, 74%

size: 111/154 variance, 25.9%

spacing: 41/98 variance, 58.1%

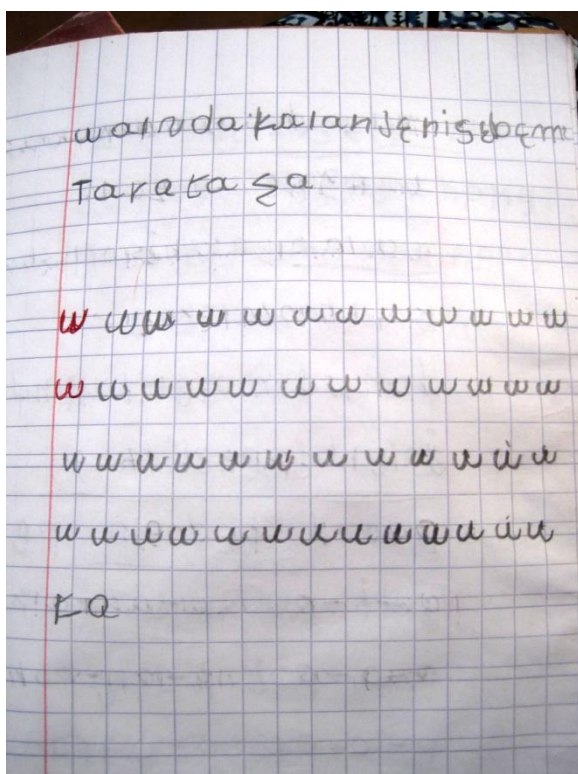
alignment: 93/98 variance, 6.1%

**copied from board: ( symbols)**

n/a

**dictation: ( symbols, spaces)**

n/a

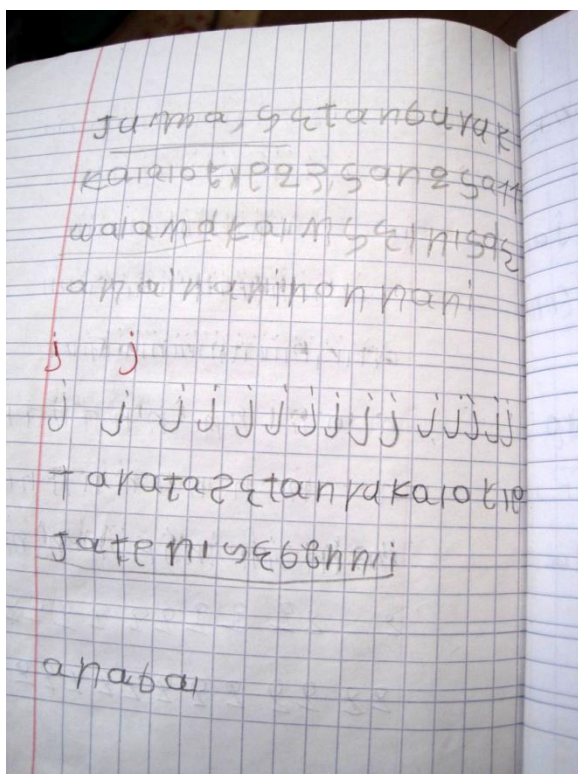


walanda kalanje ni sebenni  
 “today’s lesson reading and writing”  
 tarata  
 “Tuesday”

**copied text vs single letters**  
**letters: (51 symbols, including ‘sa’ and ‘ka’)**

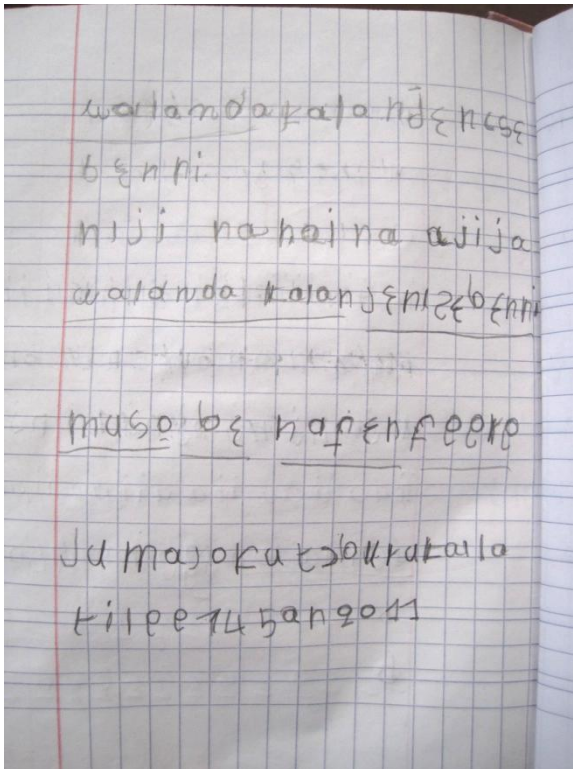
formation: 14/51 variance, 72.5%  
 size: 25/51 variance, 50.9%  
 spacing: 5/46 variance, 93.3%  
 alignment: 36/51 variance, 29.4%  
**copied from board: (29 symbols)**  
 formation: 9/29 variance, 68.9%  
 size: 17/29 variance, 41.3%  
 spacing: 3/4 omitted, 25%  
 alignment: 19/29 variance, 34.4%  
**dictation: ( symbols, spaces)**  
 n/a

(note: days of the week are not capitalized in Bambara)



**(month 2)**  
**letters: (30 symbols)**  
 formation: 4/30 variance, 86.7%  
 size: 22/30 variance, 26.7%  
 spacing: 5/28 variance, 82.1%  
 alignment: 17/30 variance, 43.3%  
**copied from board: (90 symbols)**  
 formation: 29/90 variance, 67.8%  
 size: 67/90 variance, 25.5%  
 spacing: 11/13 variance, 15.3%  
 alignment: 70/90 variance, 22.2%  
**dictation: ( symbols, spaces)**  
 n/a

juma, setanburu kalo tile 23 san 2011  
 “Friday, September month day 23 year 2011”  
 walanda kalanje ni sebenni  
 “today’s lesson reading and writing”  
 tarata setanburu kalo tile \_\_\_\_\_  
 “Tuesday, September month day”  
 jate ni sebenni  
 “math and writing”  
 araba  
 “Wednesday”



walanda kalanje ni sebenni  
 “today’s lesson reading and writing”  
 juma, okutoburu kalo tile 14 san 2011  
 “Friday, October month day 14 year 2011”

### copied text vs dictated text

#### letters:

n/a

#### **copied from board: (67 symbols)**

formation: 21/67 variance, 68.6%

size: 50/67 variance, 25.3%

spacing: 9/12 variance, 25%

alignment: 44/67 variance, 34.3%

#### **dictation: (32 symbols, 10 spaces)**

formation: 12/32 variance, 62.5%

size: 26/32 variance, 18.7%

spacing: 6/10 variance, 40%

alignment: 25/32 variance, 21.8%

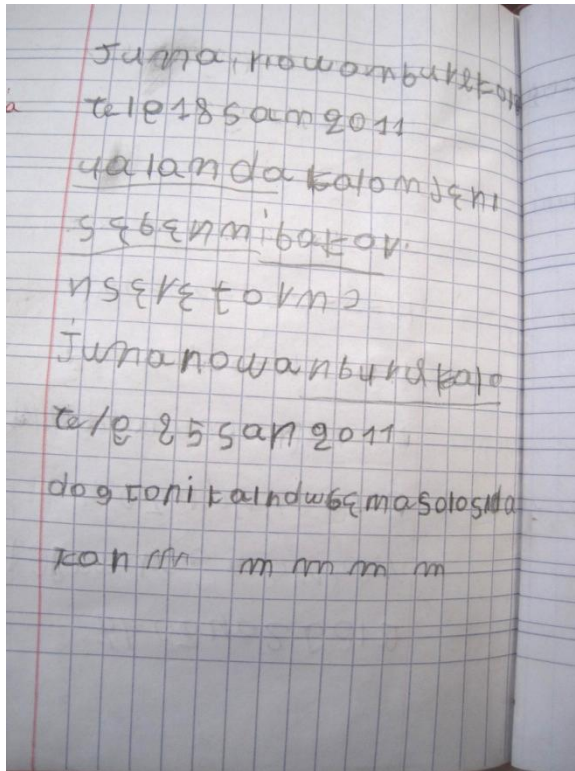
Ni ji nana, i na a ji ja.

“If rain came, you dried the water.”

Muso be nafen feere.

“The woman sells sauce-ingredients.”





juma, nowamburu kalo tile 18 san 2011

“Friday, November month day 18 year 2011”

walanda kalanje ni sebenni

“today’s lesson reading and writing”

juma, novanburu kalo tile 25 san 2011

“Friday, November month day 25 year 2011”

(month 3)

**letters: (5 symbols)**

formation: 1/5 variance, 80%

size: 3/5 variance, 40%

spacing: 0/4 variance, 100%

alignment: 4/5 variance, 20%

**copied from board: (71 symbols )**

formation: 18/71 variance, 74.6%

size: 63/71 variance, 11.2%

spacing: 9 /13 variance, 30.7%

alignment: 53/71 variance, 25.3%

**dictation: (46 symbols, 8 spaces)**

formation: 20/46 variance, 56.5%

size: 34/46 variance, 26%

spacing: 4/7 variance, 42.8%

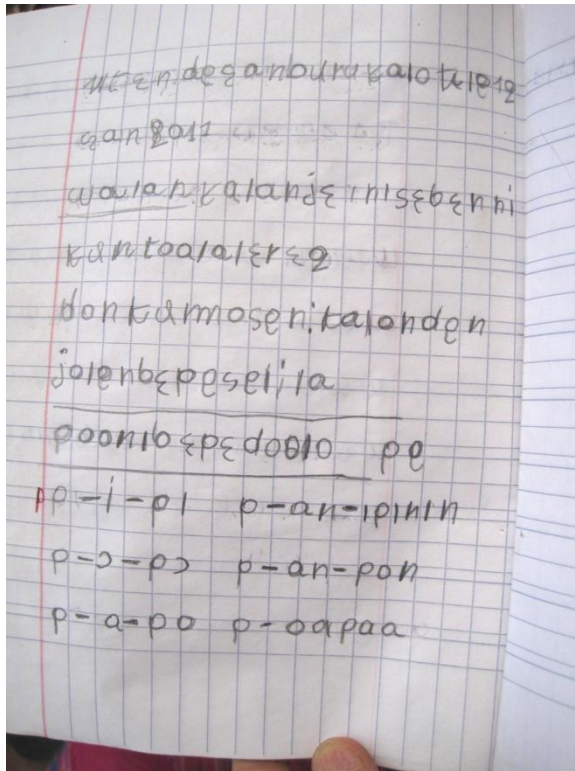
alignment: 30/46 variance, 34.7%

Ba korɔ nsere tɔrɔ.

“The old woman sharply hit [to open] the watermelon.”

Dagonin kalandenw be masoro sida kan.

“The youngest students are catching AIDS.”



ntenen desanburu kalo tile 12 san 2011  
 walanda kalanje ni sebenni  
 kuntaala lere 2 “session hour 2”  
 donkamosen: kalanden “students of  
 Donkamosen [place name]”  
 jolen be peseli la “are stopped at the scales”

[translation given by Béatrice Konfé]  
 pooni be pe doolo (not connected text)

(month 4)

**letters: (35 symbols)**

formation: 6/35 variance, 80.5%

size: 23/35 variance, 34.2%

spacing: 2/15 variance, 86.7%

alignment: 19/35 variance, 45.7%

**copied from board: (61 symbols )**

formation: 18/61 variance, 70.4%

size: 51/61 variance, 16.3%

spacing: 7/9 variance, 22.2%

alignment: 49/61 variance, 19.6%

**dictation: (33 symbols, 4 spaces)**

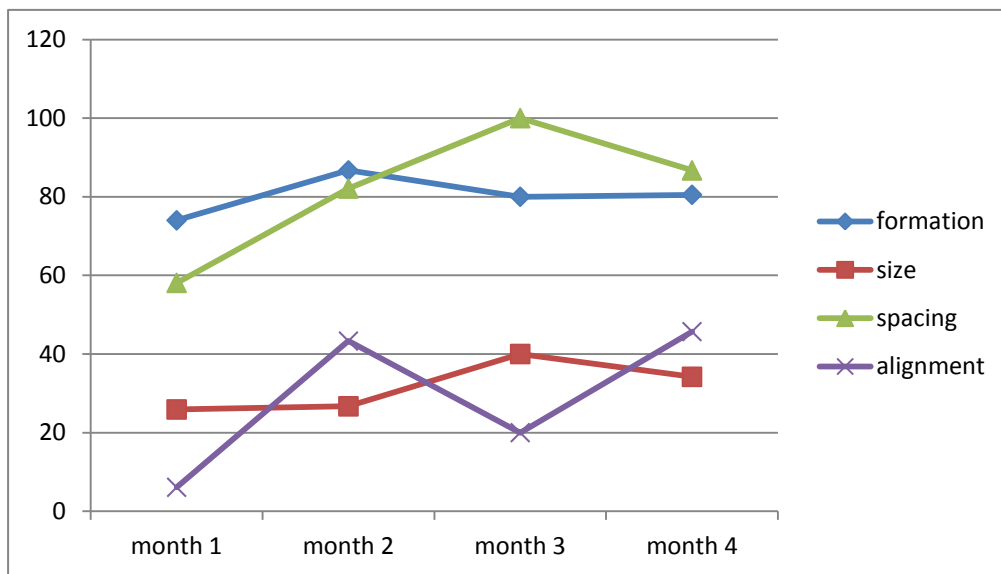
formation: 6/33 variance, 81.8%

size: 28/33 variance, 18.1%

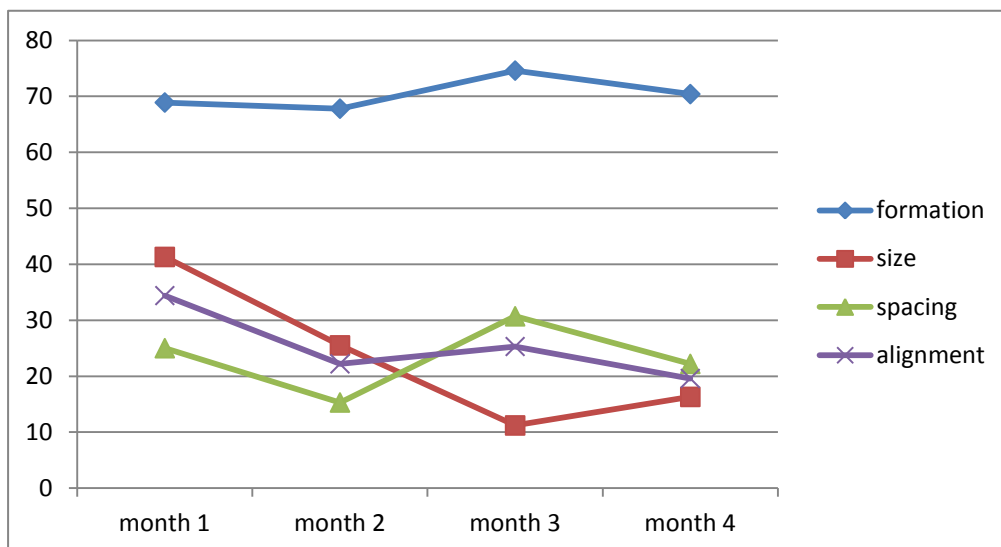
spacing: 3/4 variance, 25%

alignment: 25/33 variance, 24.2%

11. Minata Tounkara, age 16, D, letters

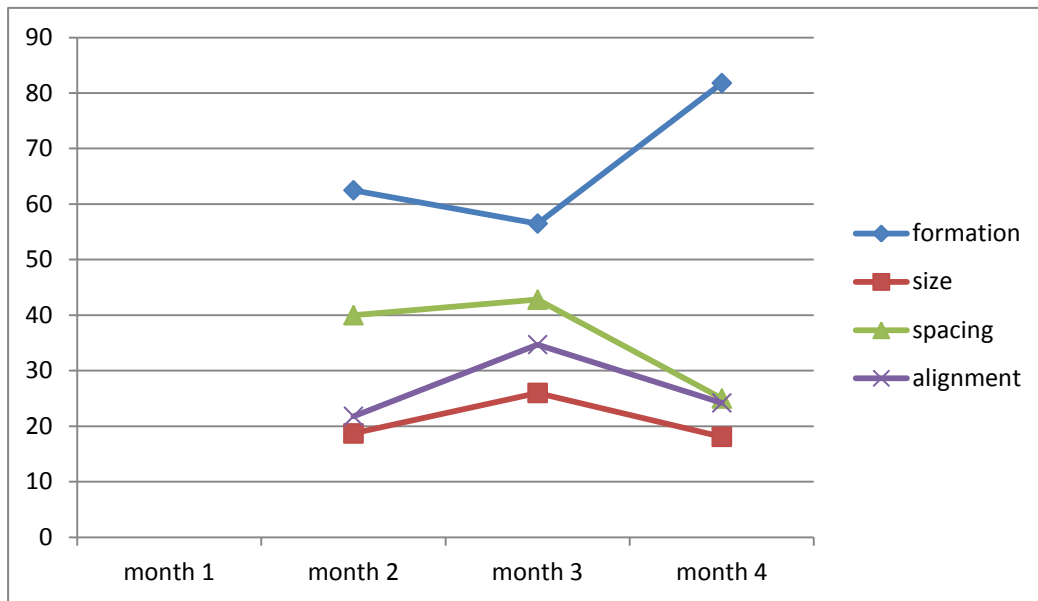


11. Minata Tounkara, age 16, D, copied

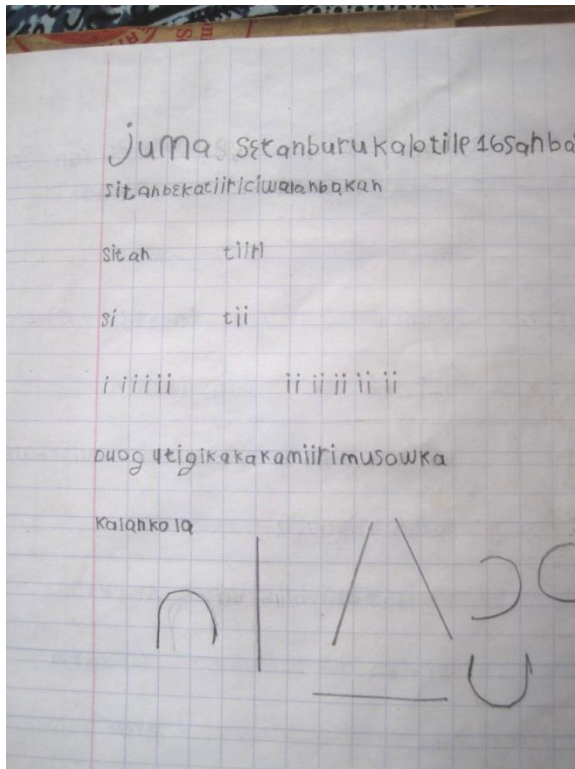




11. Minata Tounkara, age 16, D, dictation



15. Fana Sidibé, age 52, Diallobougou (4 samples, 4 mo.)



(month 1)

**letters: (31 symbols)**

formation: 1/31 variance, 96.7%%

size: 7/31 variance, 77.4%

spacing: 2/13 variance, 84.6%

alignment: 9/31 variance, 70.9%

**copied from board: (26 symbols)**

formation: 3/24 variance, 87.5%

size: 20/24 variance, 16.7%

spacing: 4/6 variance, 33.3%

alignment: 17/24 variance, 29.1%

**dictation: (62 symbols, 14 spaces)**

formation: 6/62 variance, 90.3%

size: 37/62 variance, 40.3%

spacing: 13/14 variance, 7.1%

alignment: 24/62 variance, 61.2%

juma, setanburu kalo tile 16 san

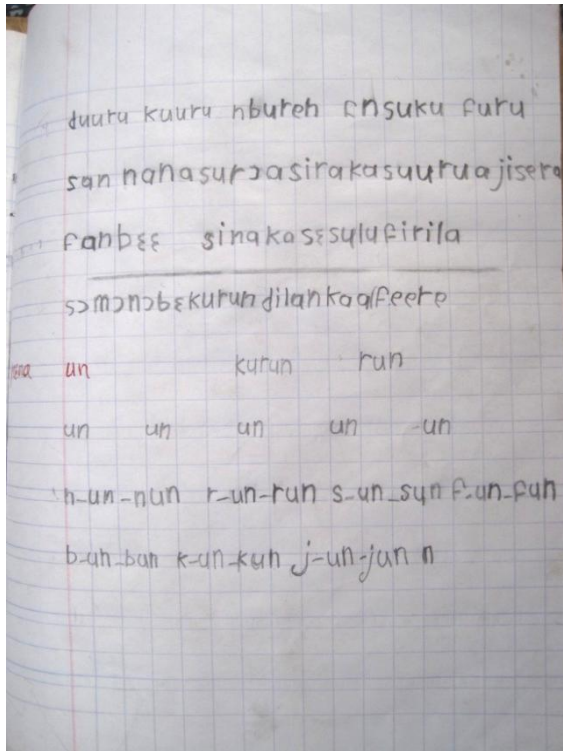
“Friday, September month day 16 year”

Sitan be ka tiiri ci walanba kan.

Dugutigi ka kan ka miiri musow ka kalanko la.

“Sitan draws the lines on the blackboard.”

“The village chief must think about [the subject of] women’s study.”



San nana su ro. A sera ka suuru a ji sera  
fanbee. Ji na ka sekulu firila.

Somono be kurun dilan ka a feere.

(month 2)

**letters: (87 symbols)**

formation: 8/87 variance, 90.8%

size: 65/87 variance, 25.2%

spacing: 2/29 variance, 93.1%

alignment: 27/87 variance, 68.9%

**copied from board: (symbols)**

n/a

**dictation: (80 symbols, 20 spaces)**

formation: 7/80 variance, 91.2%

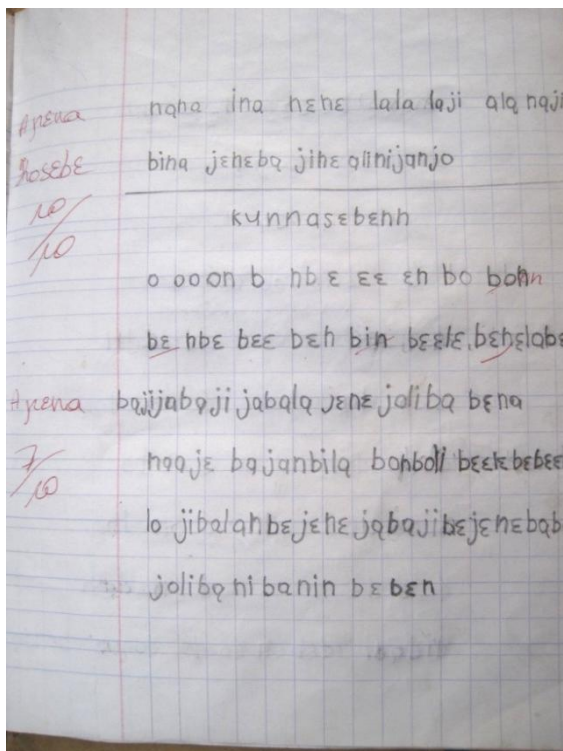
size: 54/80 variance, 32.5%

spacing: 17/20 variance, 15%

alignment: 44/80 variance, 45%

“It rained in the evening. It arrived from high [it poured], water was everywhere. The water overturned the henhouse.”

“Somono is making a canoe to sell [it].”



kunnasebenni = dictation

(month 3) from below the line

**letters: (45 symbols) 1<sup>st</sup> 2 lines**

formation: 6/45 variance, 86.7%

size: 30/45 variance, 33.3%

spacing: 3/16 variance, 81.2%

alignment: 24/45 variance, 46.7%

**copied from board: (12 symbols)**

formation: 1/12 variance, 91.7%

size: 9/12 variance, 25%

spacing: 100%

alignment: 6/12 variance, 50%

**dictation: (101 symbols, spaces)**

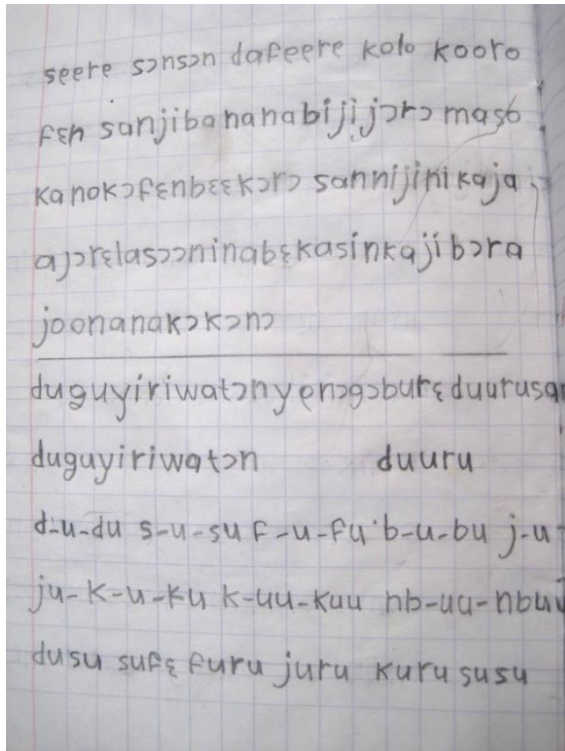
word-level, not sentences

formation: 11/101 variance, 89.1%

size: 60/101 variance, 40.5%

spacing: 9/25 variance, 46%

alignment: 44/101 variance, 56.4%



Duguyiriwaton ye nogo bureti duuru san.

“The village development association bought five trash wagons.”

(month 4) below the line

**letters: (62 symbols)**

formation: 7/62 variance, 88.7%%

size: 45/62 variance, 27.4%

spacing: 3/28 variance, 89.2%

alignment: 40/62 35.4%

**copied from board: symbols ()**

formation: na

size: na

spacing : na

alignment: na

**dictation: (33 symbols, 5 spaces)**

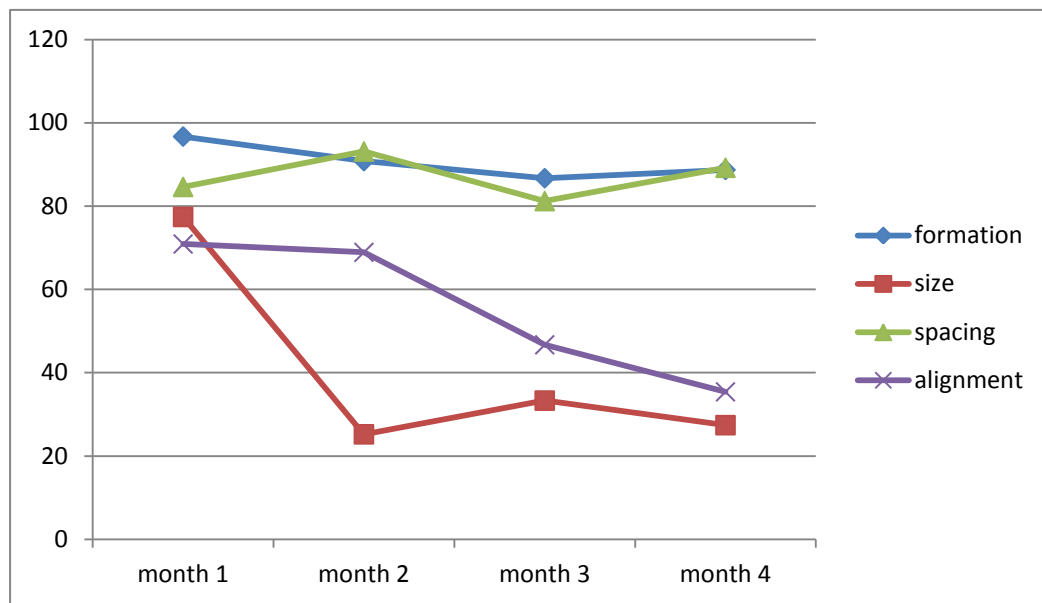
formation: 3/33 variance, 90.9%

size: 14/33 variance, 27.2%

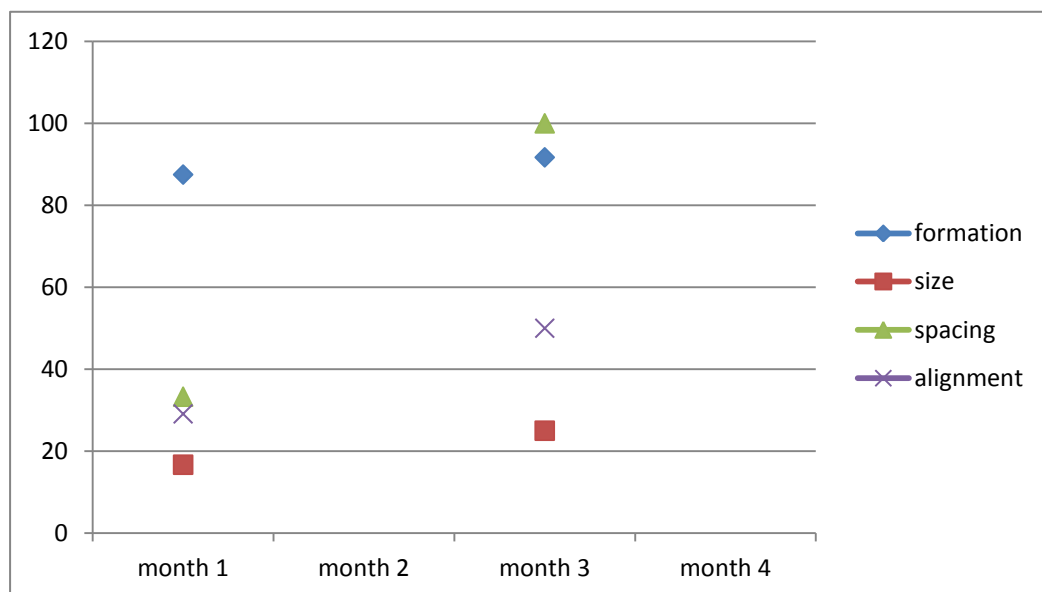
spacing: 3/5 variance, 40%

alignment: 23/33 variance, 69.6%

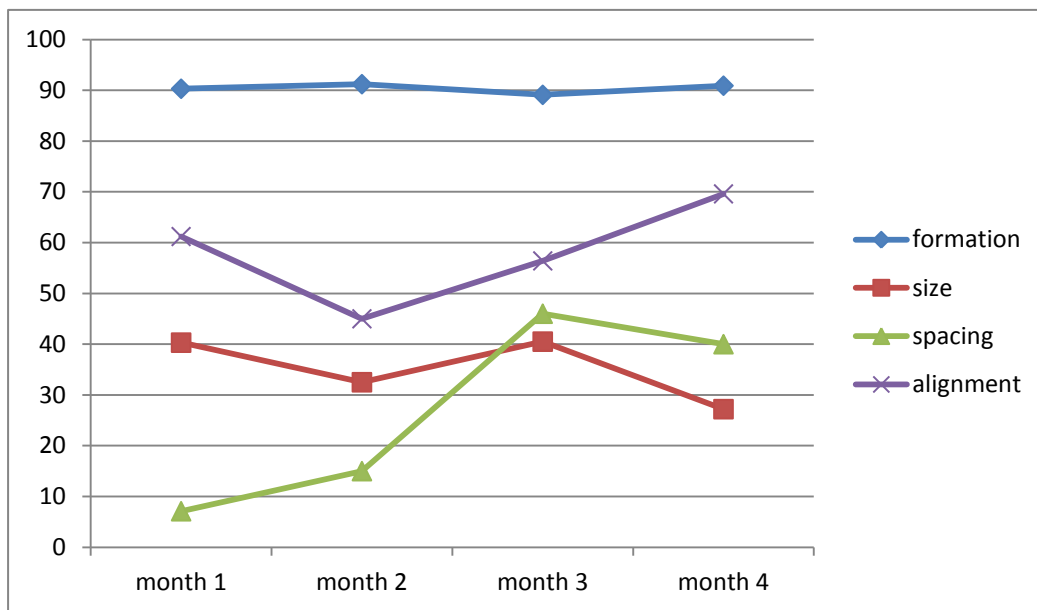
15. Fana Sidibé, age 52, D, letters



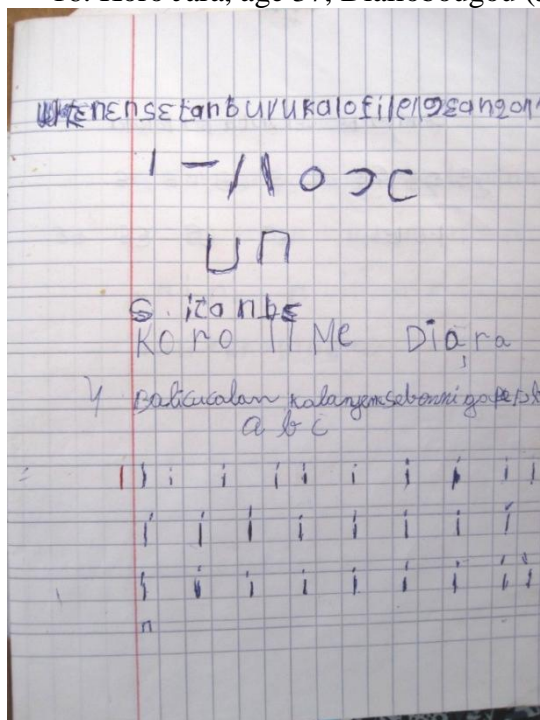
15. Fana Sidibé, age 52, D, copied



15. Fana Sidibé, age 52, D, dictation



16. Koro Jara, age 37, Diallobougou (5 samples, 5 mo)



ntenen setanburu kalo tile 19 san 2011  
Monday, September month day 19 year 2011  
Sitan be [... dictation phrase incomplete]

**(month 1)** (cursive  
“Balikukalan...abc” traced  
from the textbook, excluded from  
count)

**letters: (27 symbols)**

formation: 13/27 variance, 51.8%

size: 20/27 variance, 25.9%

spacing: 4/24 variance, 83.3%

alignment: 14/24 variance, 41.6%

**copied from board: symbols (26)**

formation: 9/26 variance, 65.3%

size: 23/26 variance, 11.5%

spacing: 5/6 variance, 83.3%

alignment: 19/26 variance, 26.9%

**dictation: (7 symbols, 1 spaces)**

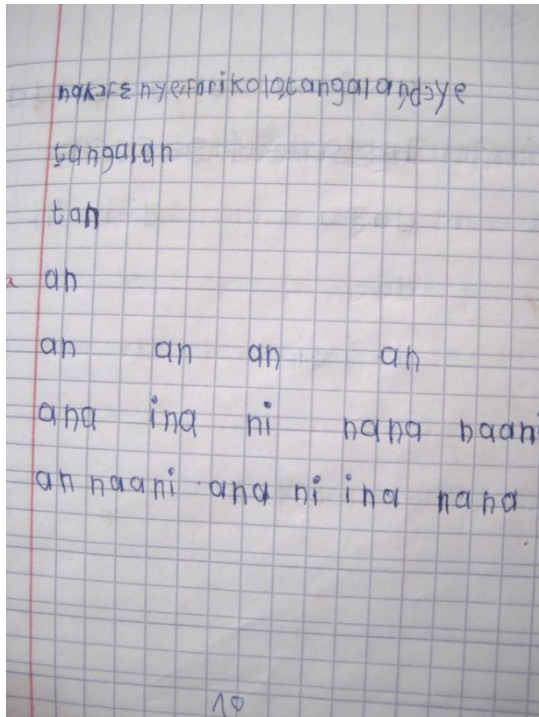
formation: 6/7 variance, 14.2%

size: 5/7 variance, 28.5%

spacing: 3/1 variance, 0%

alignment: 6/7 variance, 14.2 %





Nakofen ye farikolo tangalan do ye  
garden-things are some body-protecting  
("Vegetables are good for you.")

(month 2)

**letters: (49 symbols)**

formation: 6/49 variance, 87.7%

size: 39/49 variance, 20.4%

spacing: 1/12 variance, 91.6%

alignment: 40/49 variance, 18.3%

**copied from board: symbols (na)**

formation: -

size: -

spacing: -

alignment: -

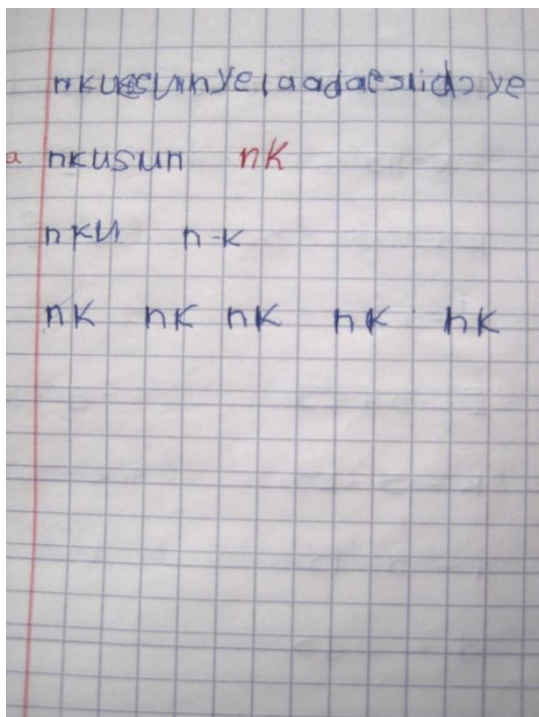
**dictation: (29 symbols, 5 spaces)**

formation: 4/29 variance, 86.2%

size: 17/29 variance, 41.3%

spacing: 0%

alignment: 22/29 variance, 24.1%



nkusun ye laada toli do ye  
"the gourd is a sort of traditional roofing"

(month 3)

**letters: (21 symbols)**

formation: 8/21 variance, 61.9%

size: 18/21 variance, 14.2%

spacing: 1/5 variance, 80%

alignment: 17/21 variance, 19%

**copied from board: symbols (na)**

formation: -

size: -

spacing: -

alignment: -

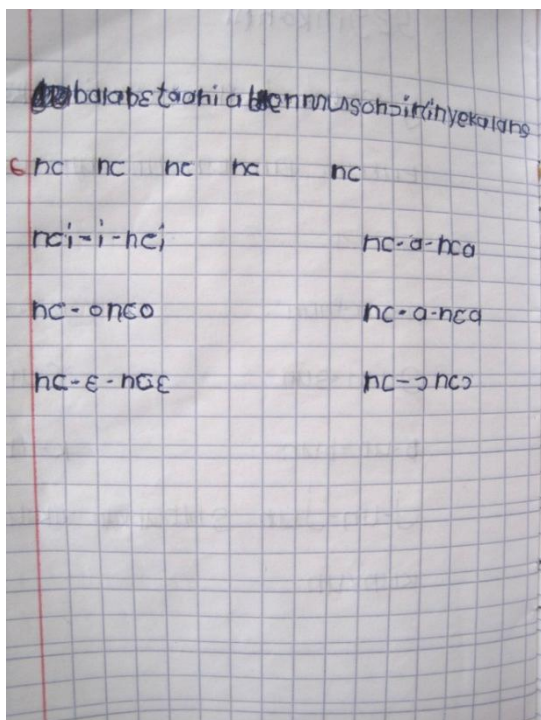
**dictation: (21 symbols, 5 spaces)**

formation: 6/21 variance, 71.4%

size: 14/21 variance, 33.3%

spacing: 5/6 variance, 16.6%

alignment: 12/21 variance, 42.8%



bala be taa ni a ben muso noirin ye kalans  
Bala be taa ni a be muso neon ye kalaso la.  
“The porcupine is going and it sees a female  
quill in the classroom.”

#### (month 4)

##### **letters: (47 symbols)**

formation: 9/47 variance, 80.8%

size: 22/47 variance, 53.1%

spacing: 4/16 variance, 75%

alignment: 26/47 variance, 44.6%

##### ***copied from board: symbols (na)***

formation: -

size: -

spacing: -

alignment: -

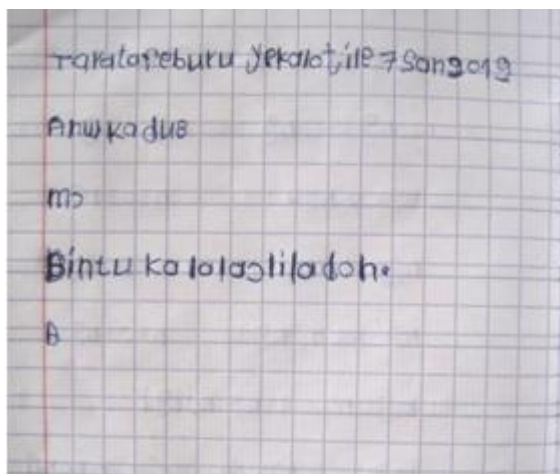
##### ***dictation: (32 symbols, 10 spaces)***

formation: 8/32 variance, 75%

size: 22/32 variance, 31.2%

spacing: 8/10 variance, 20%

alignment: 17/32 variance, 46.8%



Tarata feburu ye kalo tile 7 san 2012  
Tuesday, February month day 7 year 2012  
Bintu ka lakoli ladon  
“Bintu must welcome school.”

#### (month 5)

##### **letters: (11 symbols)**

formation: 4/11 variance, 63.6%

size: 7/11 variance, 36.3%

spacing: 0%

alignment: 8/11 variance, 27.2%

##### ***copied from board: symbols (25)***

formation: 3/25 variance, 88%

size: 20/25 variance, 20%

spacing: 5/6 variance, 16.6%

alignment: 15/25 variance, 40%

##### ***dictation: (18 symbols, 3 spaces)***

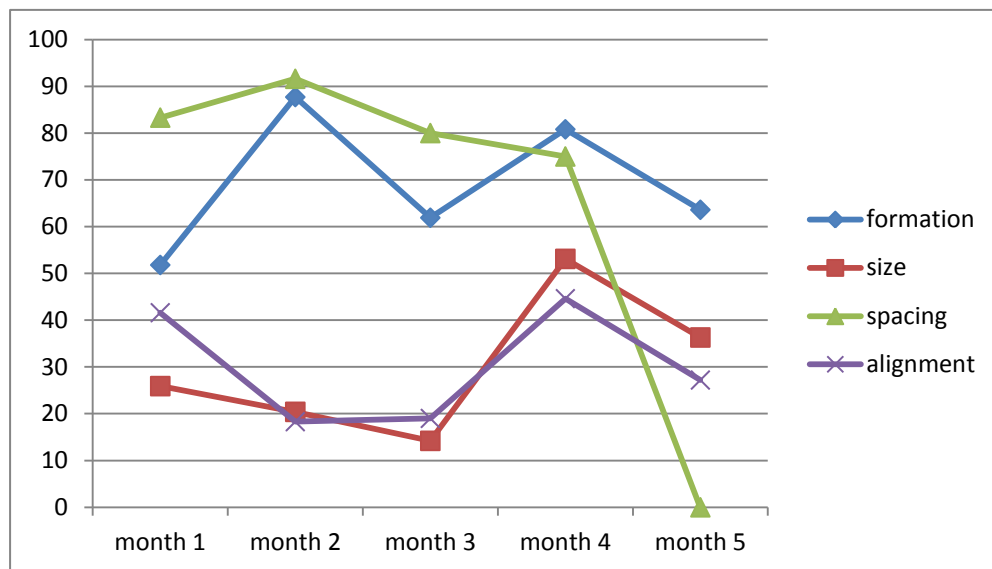
formation: 9/18 variance, 50%

size: 8/18 variance, 55.5%

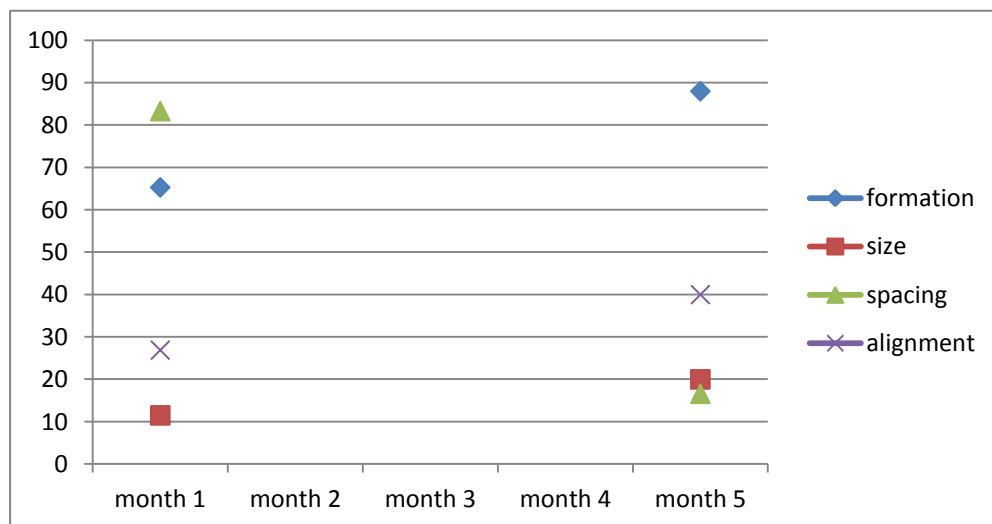
spacing: 1/3 variance, 66.6%

alignment: 13/18 variance, 27.7%

16. Koro Jara, age 37, D, letters

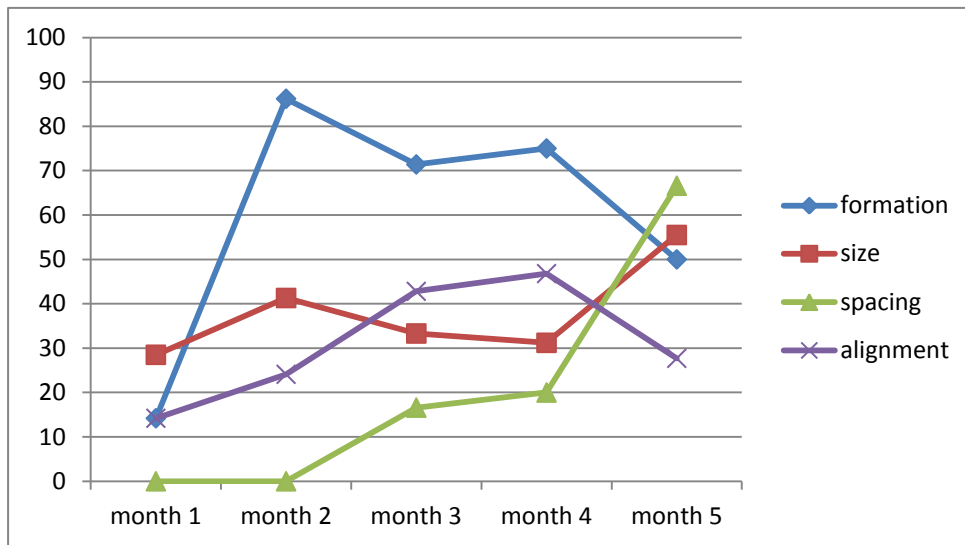


16. Koro Jara, age 37, D, copied



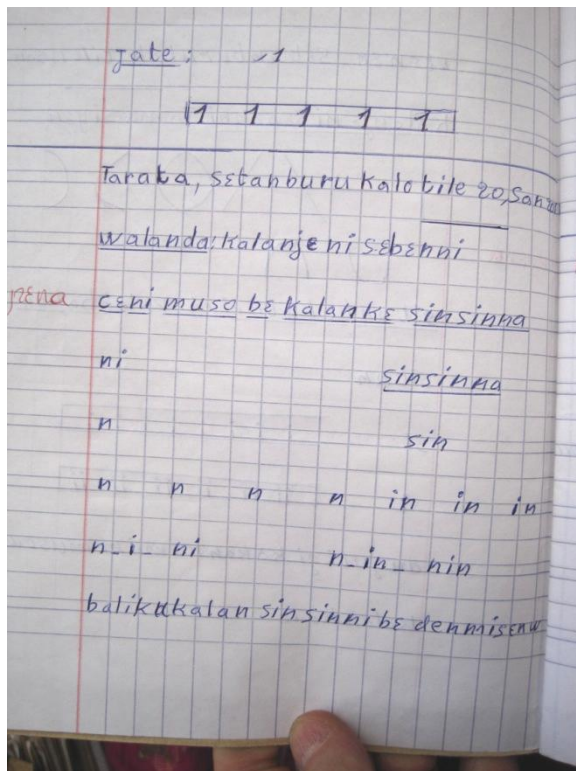


16. Koro Jara, age 37, D, dictation



17. Ramatulaye Meyiga, age 37-38, Diallobougou (5 samples, 5 mo)

*This woman was not illiterate before the course; she was training to be a teacher.*



Tarata, setanburu kalo tile 20, san 2011  
 Tuesday, September month day 20, year 2011  
 walanda: kalanje ni sebenni  
 today's lesson: reading and writing  
 Cɛ ni muso be kalan ke sinsinna.  
 "The man and woman persevere in study."

**(month 1)**

**letters: (23 symbols)**

formation: 13/23 variance, 43.4%

size: 10/23 variance, 56.5%

spacing: 100%

alignment: 11/23 variance, 52.1%

**copied from board:  
symbols (49)**

formation: 6/49 variance, 87.7%

size: 15/49 variance, 69.3%

spacing: 100%

alignment: 7/49 variance, 85.7%

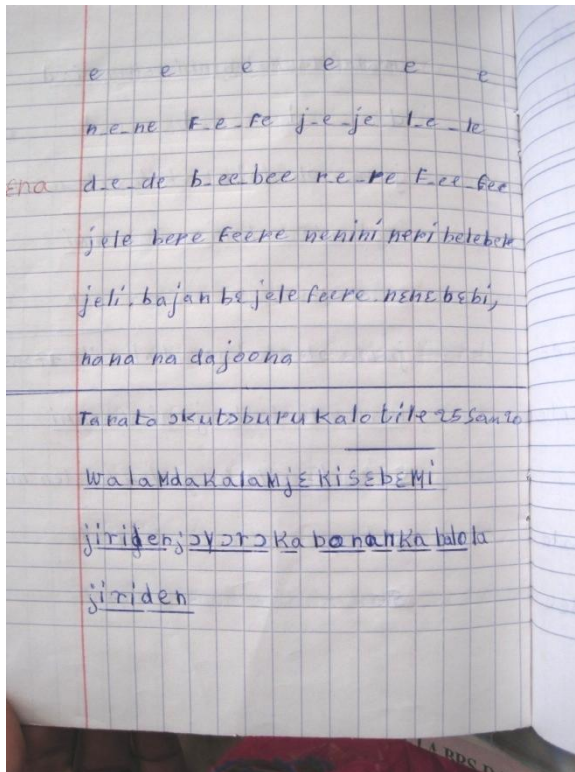
**dictation: (25 symbols, 6 spaces)**

formation: 5/25 variance, 80%

size: 7/25 variance, 72%

spacing: 2/6 variance, 66.6%

alignment: 10/25 variance, 60%



tarata okutoburu kalo tile 25 san 2011

Tuesday October month day 25 year 2011

jiriden jɔyɔɔ ka bonan ka balo la.

[bonya]

The purpose of fruit is to be a food [nutritional] supplement.

(month 2)

**letters: (114 symbols)**

formation: 16/114 variance, 85.9%

size: 28/114 variance, 75.4%

spacing: 6/41 variance, 85.3%

alignment: 19/114 variance, 83.3%

**copied from board:**

**symbols (48)**

formation: 10/48 variance, 79.1%

size: 28/48 variance, 41.6%

spacing: 3/9 variance, 66.6%

alignment: 15/48 variance, 68.7%

**dictation: (28 symbols, 6 spaces)**

formation: 6/28 variance, 78.5%

size: 9/28 variance, 67.8%

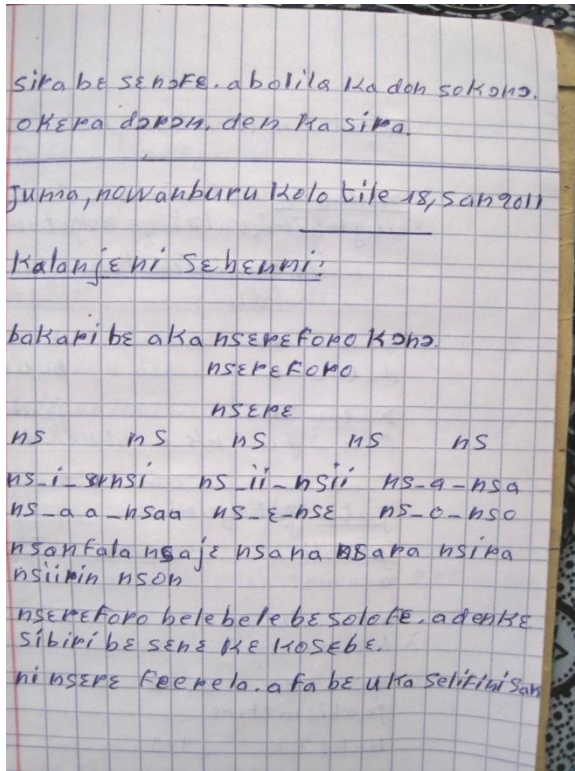
spacing: 3/6 variance, 50%

alignment: 4/28 variance, 85.7%

of note:

“walanda kalanje ni sebeni”  
became:

“walaMdakalaMje ki  
sebeMi”



juma, nowanburu kalo tile 18, san 2011  
 Friday, November month day 18, year 2011  
 kalanje ni se ben ni – reading and writing  
 Bakari be a ka nse re fo ro ko no.  
 Nse re fo ro be le be le be so lo fe. A den ke  
 si bi ri be se ne ke ko se be.  
 Ni nse re fe er e la, a fa be u ka se li fi ni san.

(month 3)

**letters: (102 symbols)**

formation: 17/102 variance, 83.3%

size: 34/102 variance, 61.7%

spacing: 3/25 variance, 88%

alignment: 18/102 variance, 82.3%

**copied from board:  
symbols (41)**

formation: 11/41 variance, 73.1%

size: 17/41 variance, 58.5%

spacing: 4/8 variance, 50%

alignment: 12/41 variance, 70.7%

**dictation: (109 symbols, 25 spaces)**

formation: 29/109 variance, 73.3%

size: 44/109 variance, 59.6%

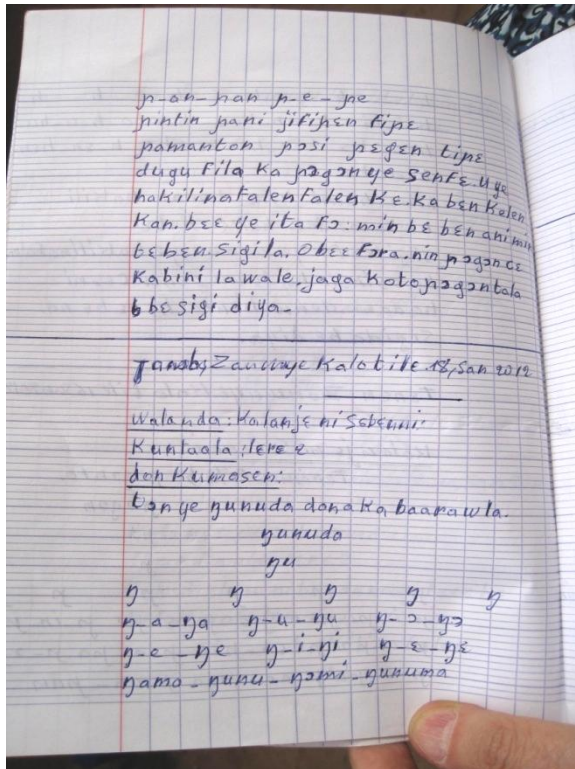
spacing: 6/25 variance, 76%

alignment: 21/109 variance, 80.7%

Bakari is in his watermelon field.

The big watermelon field is guarded. His son Sibiri is a good cultivator.

If the watermelon is sold, his father will buy their special clothes.



araba, zanwuye kalo tile 18, san 2012  
 Wednesday, January month day 18, year 2012  
 walanda: kalanje ni sebenni – today's lesson:  
 reading and writing  
 kuntaala: lere 2 period: hour 2  
 don kumaseɓ: sentence of the day  
 ton ye ŋunuda don a ka baaraw la.  
 the association started the beekeeper in his work.

(month 4)

**letters: (55 symbols)**

formation: 9/55 variance,  
83.6%

size: 9/55 variance, 83.6%

spacing: 1/23 variance,  
95.6%

alignment: 22/55 variance,  
60%

**copied from board:  
 symbols (68)**

formation: 26/68 variance,  
61.7%

size: 34/68 variance, 50%

spacing: 3/12 variance, 75%

alignment: 30/68 variance,  
55.8%

**dictation: (25 symbols, 7  
 spaces)**

formation: 7/25 variance,  
72%

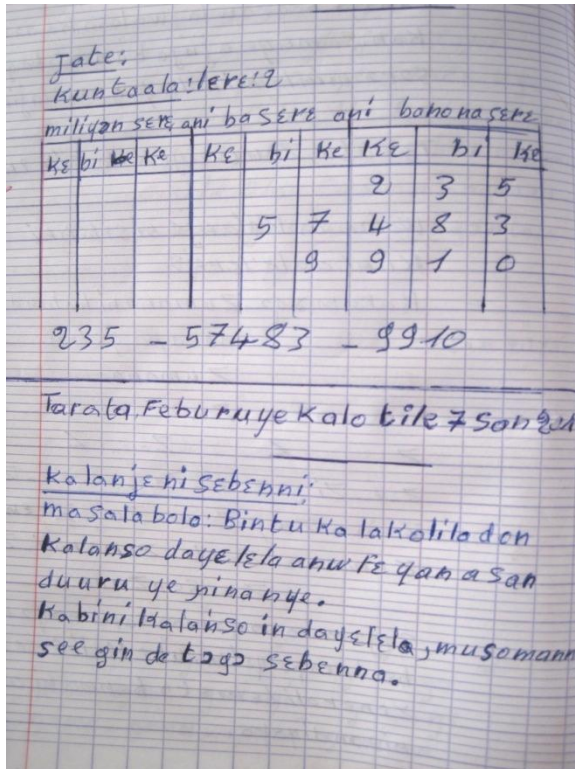
size: 8/25 variance, 68%

spacing: 3/7 variance, 57.1%

alignment: 15/25 variance,  
40%

Still no use of capital letters  
 to begin sentences, but  
 letters more resembling the  
 capital are appearing in the  
 text (e.g., f/F, k/K, z/Z),  
 which may be an indicator  
 of more speed/less care with  
 detail.





tarata, feburuye kalo tile 7 san 2012

Tuesday, February month day 7 year 2012

kalanje ni sebenni - reading and writing

masala bolo: Bintu ka lakoli ladon

kalanso dayele la anw fe yan a san duuru ye pinan ye.

Kabini kalanso in dayele la, muso manni seegin de togo sebenna. [musomanin]

[se girin]

(month 5)

letters: (symbols) na

formation: -

size: -

spacing: -

alignment: -

**copied from board:**

**symbols (42)**

formation: 10/42 variance, 76.1%

size: 20/42 variance, 52.3%

spacing: 4/8 variance, 50%

alignment: 21/42 variance, 50%

**dictation: (103 symbols, 23 spaces)**

formation: 28/103 variance, 72.8%

size: 49/103 variance, 52.4%

spacing: 8/23 variance, 65.2%

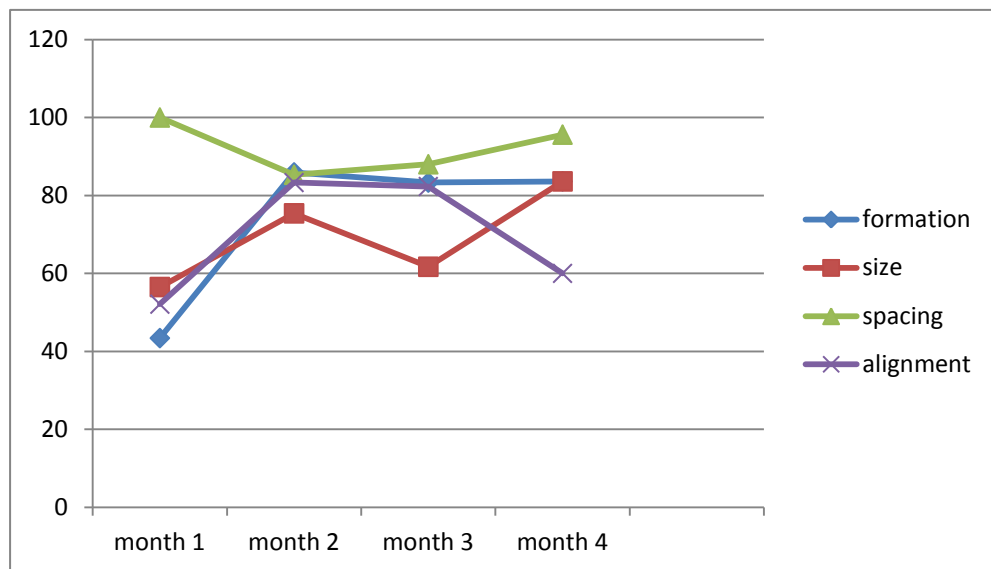
alignment: 50/103 variance, 51.4%

conversation branch: Bintu must welcome school.

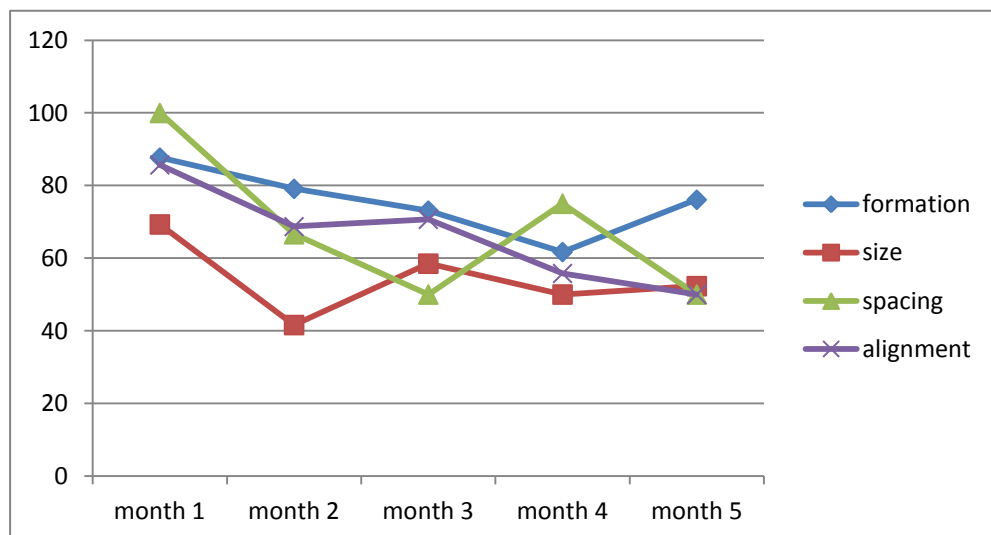
The classroom opened to us five years ago this year.

Since this classroom opened, girls hurry to arrive to write their name.

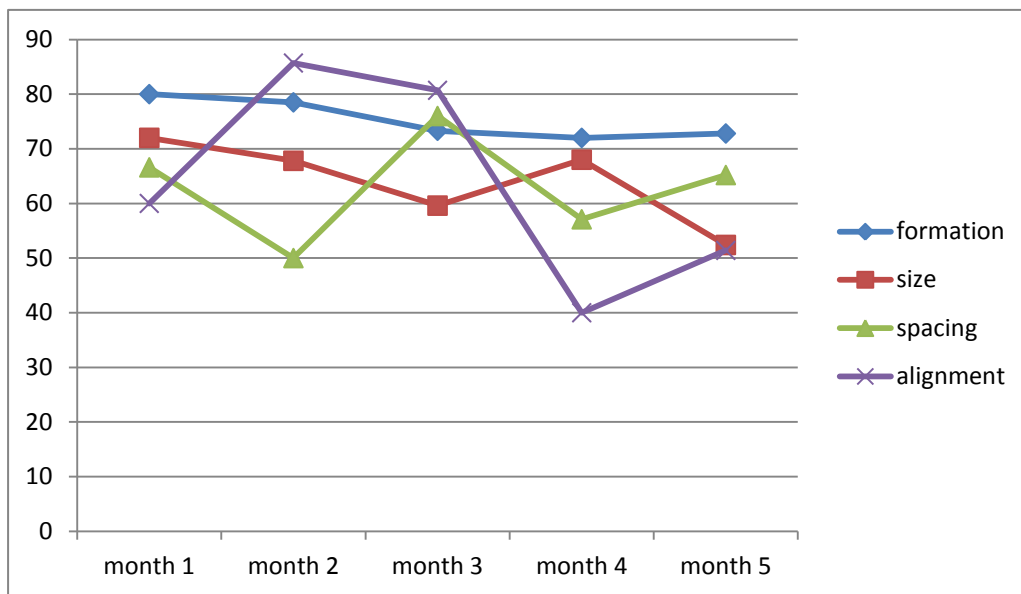
17. Ramatulaye Meyiga, age 37-38, D, letters



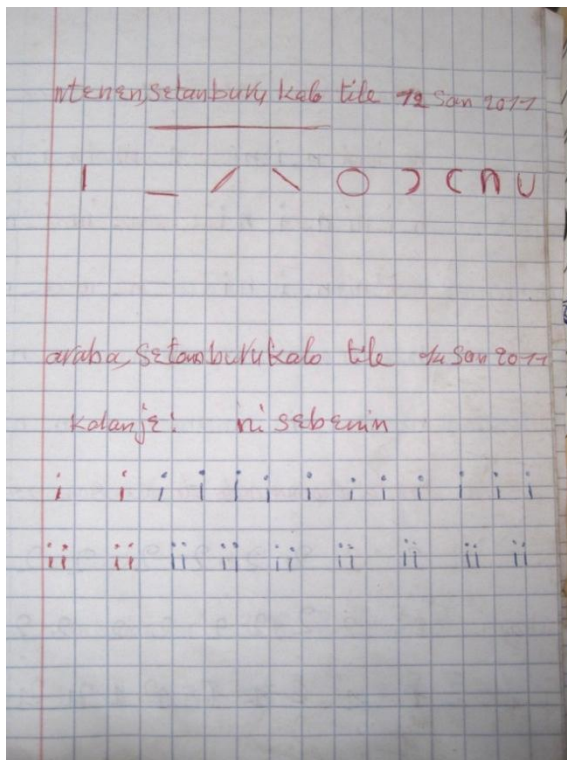
17. Ramatulaye Meyiga, age 37-38, D, copied



17. Ramatulaye Meyiga, age 37-38, D, dictation



18. Fanta Coulibaly, age 50, Centre Netaa (6 samples, 5 mo)



**(month 1)**

All information written in red for Fanta's lessons have been written for her by the facilitator as a model to follow.

Even so, in the copying exercise, she has found it difficult to manipulate fine motor movements for consistently writing within the lines provided and to maintain vertical lines in her writing. She also shows a lack of perception of spacing, but does better with the double vowels.

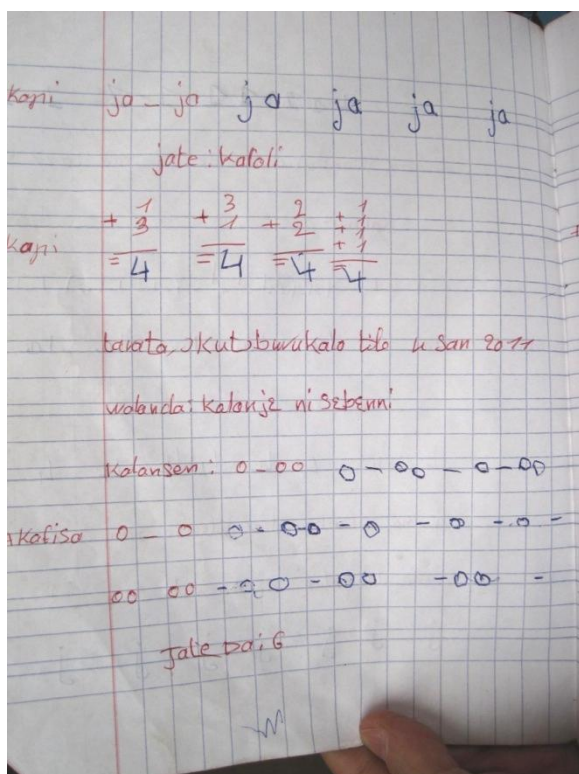
symbols: 25

formation: 0/25, 100%

size: 11/25 variance, 56%

spacing: 100% (for 'i' and 'ii' only)

alignment: 3/25 variance, 88%



## (month 2)

symbols: 26 (numbers excluded)

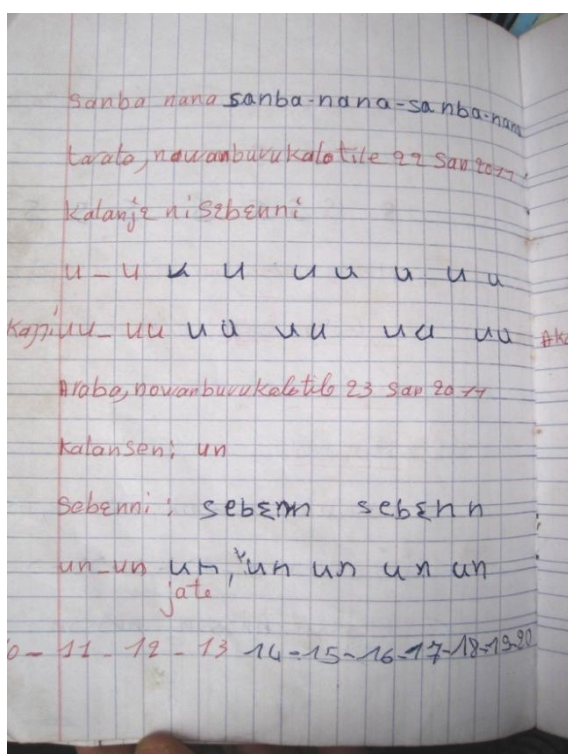
formation: 5/26 variance, 80.7%

size: 12/26 variance, 53.8%

spacing: 5/12 variance, 58.3%

(still letters, not words)

alignment: 12/26 variance, 53.8%



## (month 3) (numbers excluded)

**letters: (25 symbols)**

formation: 5/25 variance, 80%

size: 18/25 variance, 28%

spacing: 2/13 variance, 84.6%

alignment: 13/25 variance, 48%

**copied from model words:**

**symbols (32)**

formation: 9/32 variance, 71.8%

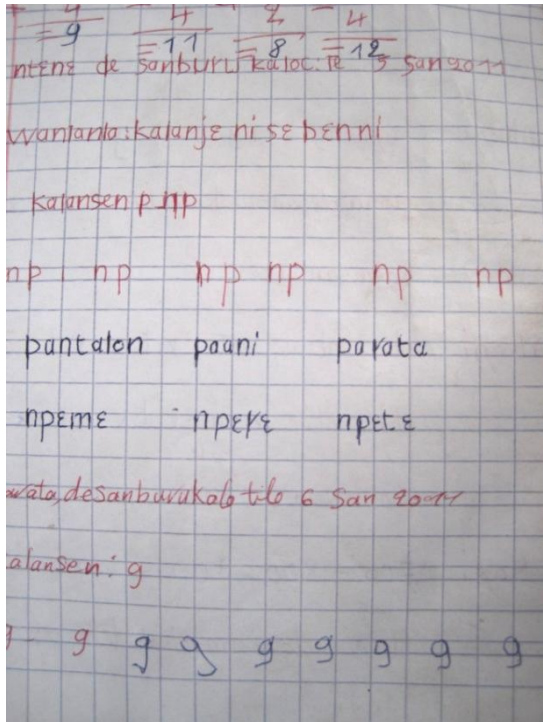
size: 16/32 variance, 50%

spacing: 2/4 variance, 50%

alignment: 10/32 variance, 68.7%

**dictation: ( symbols, spaces) na**





ntene[n] desanburu kalo tile 5 san 2011  
 Monday, December month day 5 year 2011  
 walanda: kalanje ni se benni  
 today's lesson: reading and writing

(month 4)

**letters: (7 symbols)**

formation: 100%

size: 3/7 variance, 57.1%

spacing: 100%

alignment: 4/7 variance, 42.8%

**copied from board: symbols (49)**

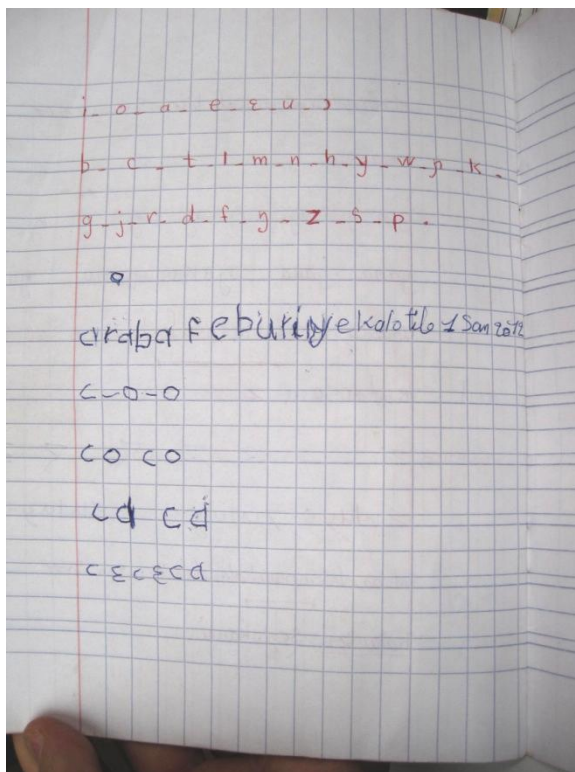
formation: 5/49 variance, 89.7%

size: 19/49 variance, 61.2%

spacing: 4/9 variance, 55.5%

alignment: 15/49 variance, 69.3%

**dictation: ( symbols, spaces) na**



(month 5)

**letters: (17 symbols)**

formation: 3/17 variance, 82.3%

size: 15/17 variance, 11.7%

spacing: 5/9 variance, 44.4%

alignment: 11/17 variance, 35.2%

**copied from board: symbols (24)**

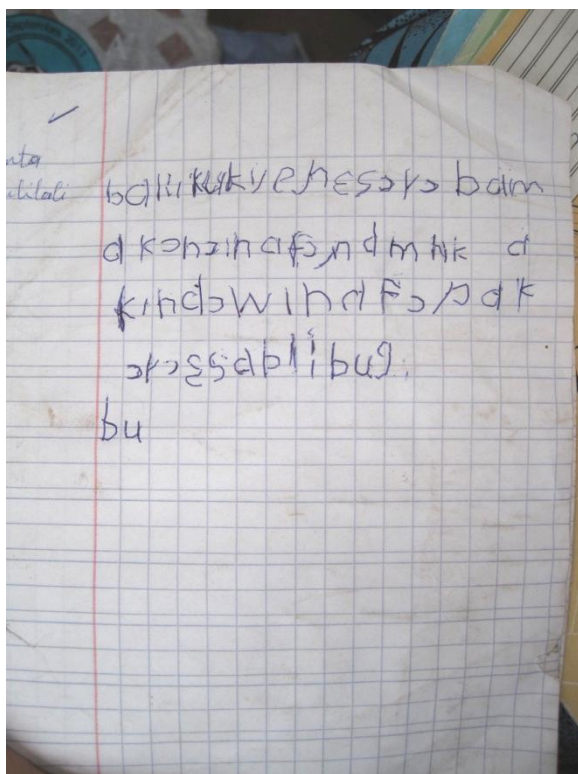
formation: 6/24 variance, 75%

size: 21/24 variance, 12.5%

spacing: 2/6 variance, 66.6%

alignment: 17/24 variance, 29.1%

**dictation: ( symbols, spaces) na  
 see following sample**



balii/lkuk ye nesoro bam[*line break*]ako  
[baliku] ...

adulthood was attained Bamako (possibly trying to write, “this was important”: no nin nafa, but that is only a guess. After this, the letters no longer form words, or even follow predictable spelling in the Bambara sound system for nonsense words.)

noin afō n[ɲ?] dmN/hk a/d

kindowindFɔɲ/ɲdk

ɔɔesdblibug

bu

### (connected text writing)

Again, learner performance in letter formation dips in form and in size uniformity. Left-to-right orientation of the text is clear, but lines on the page wander. Letters are situated with less relationship to one another; some letters are partially or completely malformed. Three or perhaps four words can be discerned in the first line, but one word continues to the second line without regard for the line break. From the second line of the text, meaningful words are no longer discernible in the text and letter formation worsens.

symbols: 63

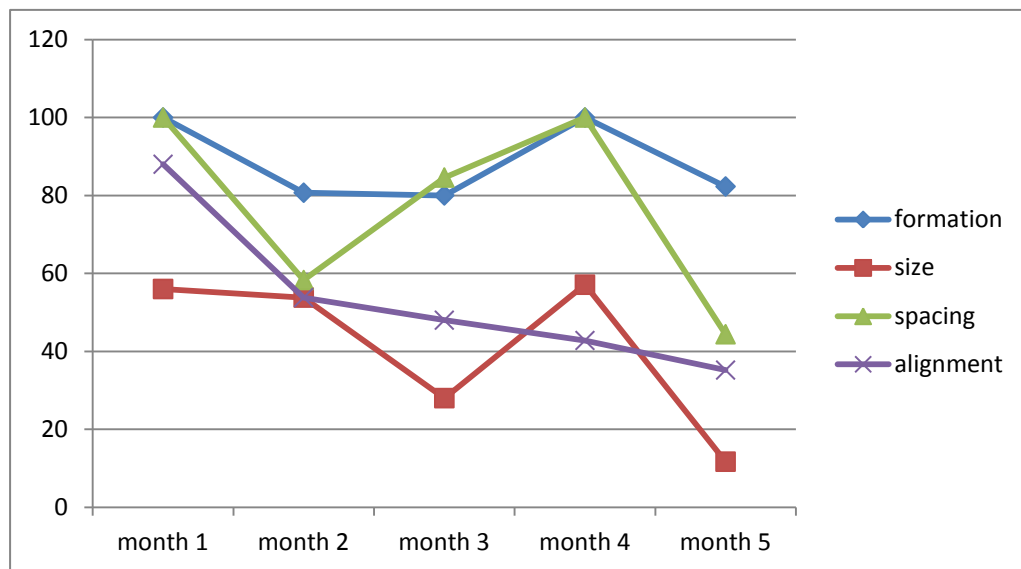
formation: 33/63 variance, 47.6%

size: 60/63 variance, 4.7%

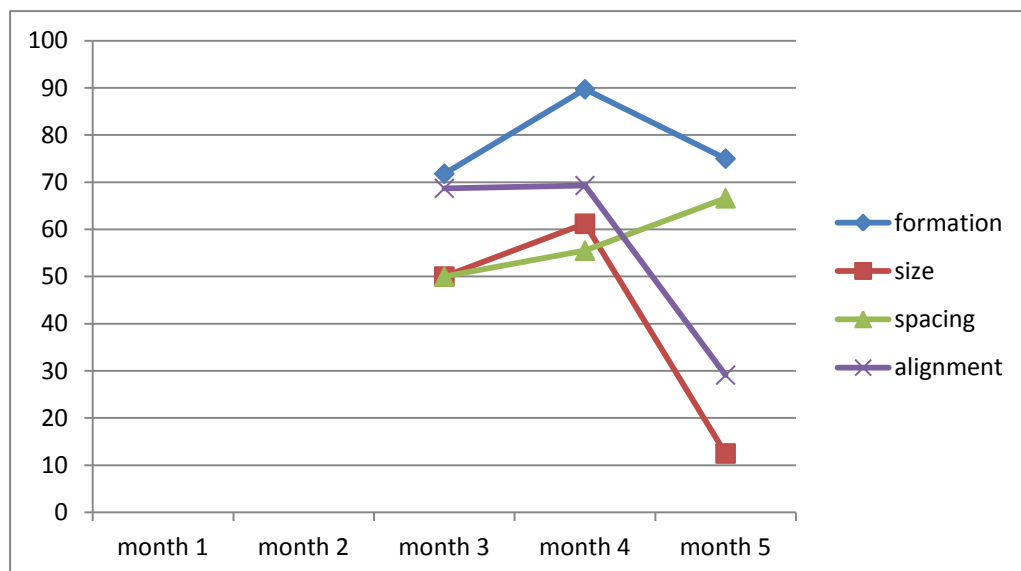
spacing: 3 /4 of first phrase, 25%

alignment: 51/63 variance, 19%

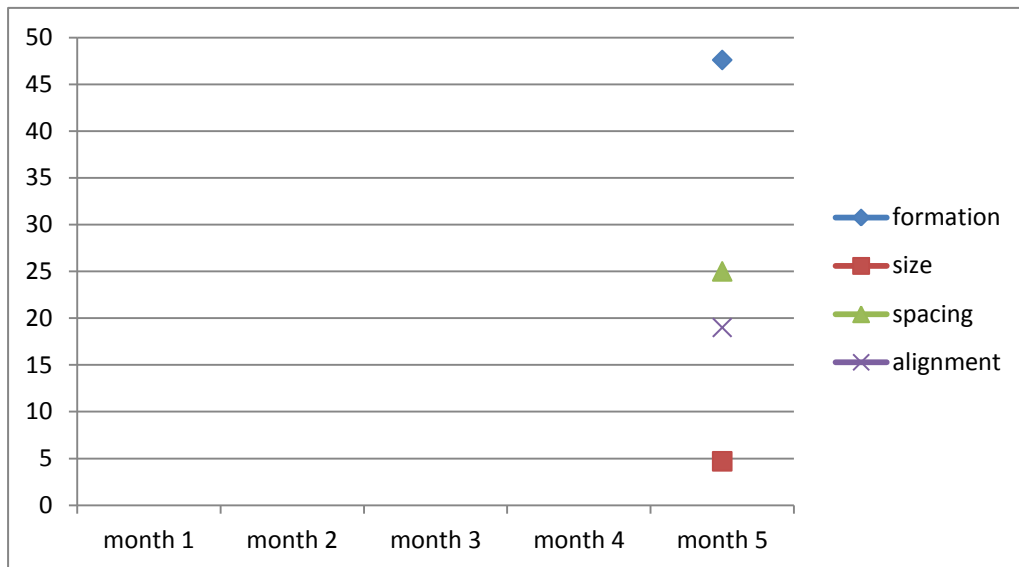
18. Fanta Coulibaly, age 50, N, letters



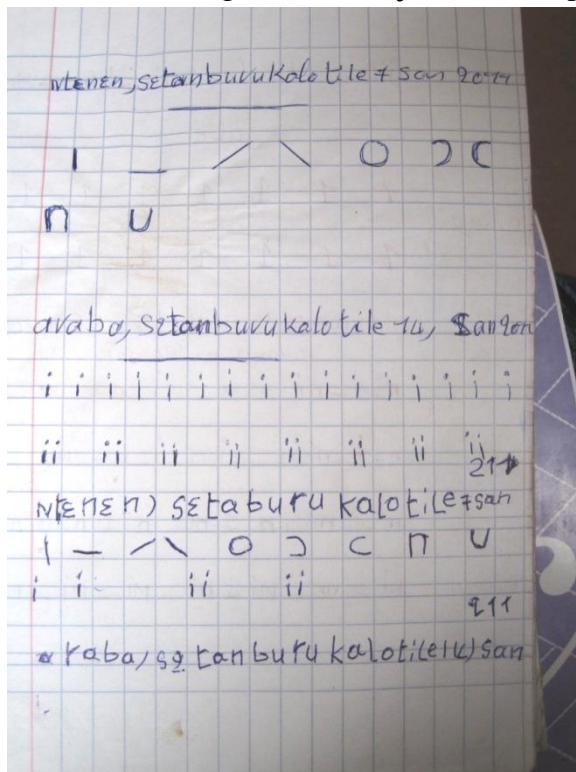
18. Fanta Coulibaly, age 50, N, copied



18. Fanta Coulibaly, age 50, N, dictation



19. Tene Kone, age 59, Centre Netaa (5 samples, 5 mo)



ntenen, setanburu kalo tile 7 san  
Monday, September month day 7 year  
araba, setanburu kalo tile 14, san  
Wednesday, September month day 14, year

(**month 1**) (Practicing drawing shapes – the top half of the page is a model written in by the class facilitator)

**letters: (34 symbols)**

formation: 4/34 variance, 88%

size: 24/34 variance, 29.4%

spacing: 100%

alignment: 19/34 variance, 44.1%

**copied from board: symbols (51)**

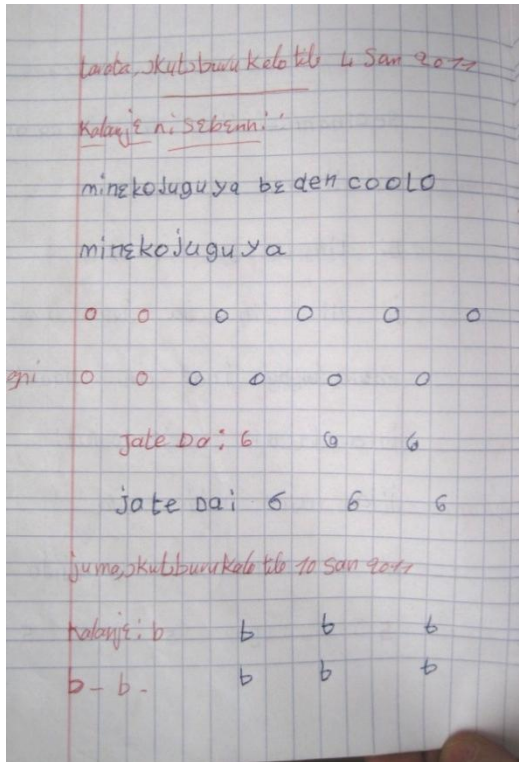
formation: 9/51 variance, 82.3%

size: 39/51 variance, 23.5%

spacing: 6/10 variance, 40%

alignment: 36/51 variance, 29.4%

**dictation: ( symbols, spaces) na**



jate da: number

Minkojuguya be den coolo

“Too many restraints make a child wander.”

(**month 2**) (red text written by the facilitator; numbers not included)

**letters: (14 symbols)**

formation: 4/14 variance, 71.4%

size: 7/14 variance, 50%

spacing: 100%

alignment: 8/11 variance, 27.2%

(last 3 letters omitted from count)

**copied from board: symbols (7)**

formation: 2/7 variance, 71.4%

size: 5/7 variance, 28.5%

spacing: space added, 50%

alignment: 4/7 variance, 42.8%

**dictation: (34 symbols, 3 spaces)**

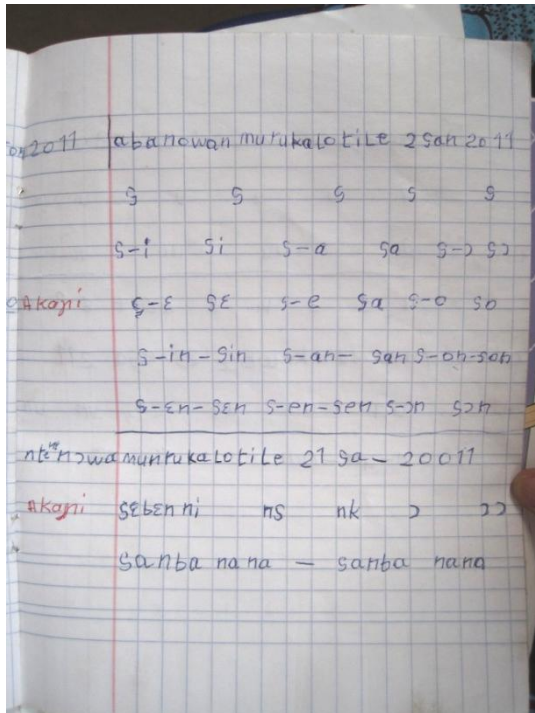
formation: 6/34 variance, 82.3%

size: 16/34 variance, 52.9%

spacing: 2 added w/in words, 50%

alignment: 21/34 variance, 38.2%





aranowanmuru kalo tile 2 san 2011  
 araba nowanburu kalo tile 2 san 2011  
 Wednesday, November month day 2 year 2011  
 ntenenowanmunruka lotile 21 sa\_ 20011.  
 ntenen nowanburu kalo tile 21 san 2011  
 Monday, November month day 21 year 2011  
 sebenni – writing  
 Sanba nana. A storm [big rain] came.

(month 3)

**letters: (72 symbols)**

formation: 14/72 variance, 80.5%

size: 42/72 variance, 41.6%

spacing: 3/39 variance, 92.3%

alignment: 41/72 variance, 43%

**copied from board: symbols (50)**

formation: 9/50 variance, 82%

size: 28/50 variance, 44%

spacing: 7/12 variance, 41.6%

alignment: 31/50 variance, 38%

**dictation: (25 symbols, 3 spaces)**

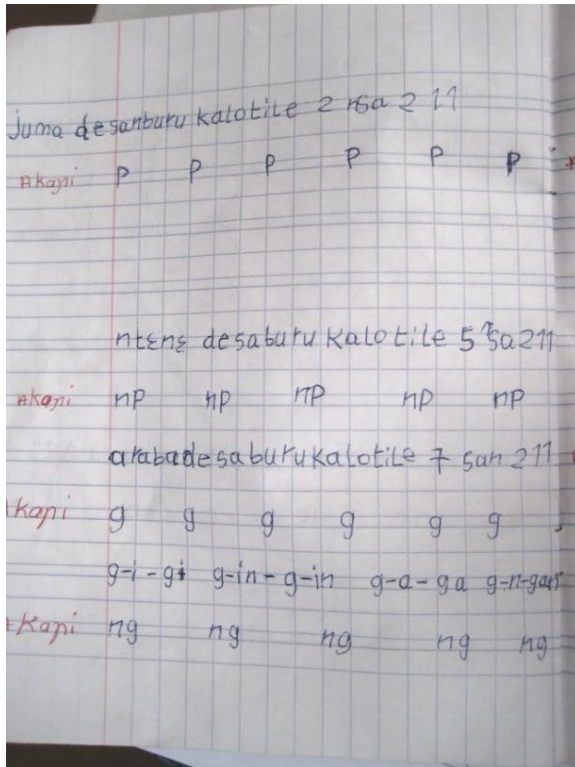
formation: 2/25 variance, 92%

size: 13/25 variance, 48%

spacing: 2 spaces added w/in words, 33%

alignment: 15/25 variance, 40%

a syllable missing from the copied word 'araba' (Wednesday), still a lot of variation in size, but a distinct effort to write on the line. Substitution of 'nm' for 'nb' in the word 'November', indicating an effort at phonological representation. Inconsistent word-break spacing. Some trouble with verticality on the 's' letter formation



juma desanburu kalo tile 2 nsa 2 11

Friday December month day 2 year 2011

ntene desaburu kalo tile 5 sa 211

Monday December month day 5 year 2011

arabadesaburukalotile 7 san 211

Wednesday December month day 7 year 2011

(month 4)

**letters: (51 symbols)**

formation: 4/51 variance, 92.1%

size: 30/51 variance, 41.1%

spacing: 1/29 variance, 96.5%

alignment: 22/51 variance,  
56.8%

**copied from board: symbols  
(72)**

formation: 9/72 variance, 87.5%

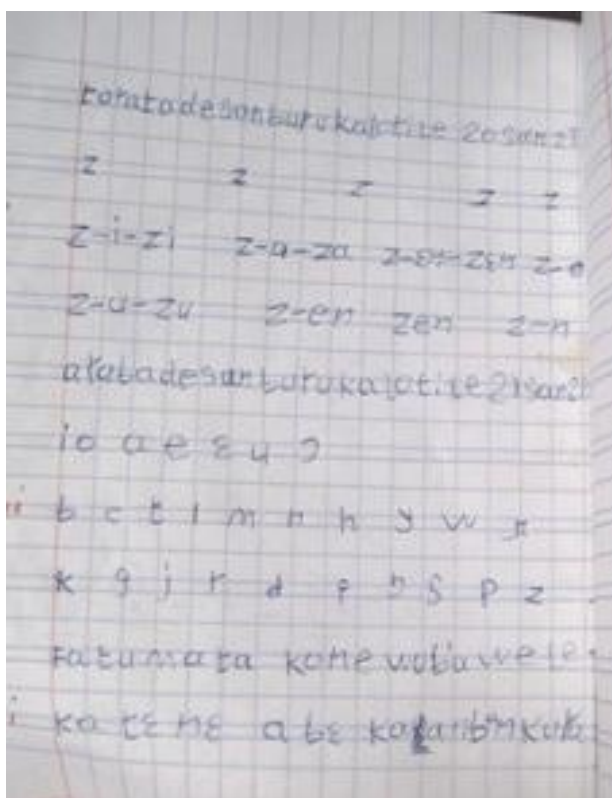
size: 40/72 variance, 44.4%

spacing: 6/18 variance, 66.6%

alignment: 36/72 variance, 50%

**dictation: ( symbols, spaces)  
na**

Suspected increased ease of  
letter formation may be leading  
to less care in order and in  
inclusion of all symbols.



tarata desanburu kalo tile 20 san

Tuesday December month day 20 year

arabadesanburukalotile 21 san

Wednesday December month day 21 year

Fatumata Kone (a woman's name) stopped today to announce that it is forbidden for her to do a big new study.

(month 5)

**letters: (60 symbols)**

formation: 8/60 variance, 86.6%

size: 31/60 variance, 48.3%

spacing: 4/46 variance, 91.3%

alignment: 33/60 variance, 45%

**copied from board: symbols (51)**

formation: 5/51 variance, 90.1%

size: 25/51 variance, 50.9%

spacing: 9/12 variance, 25%

alignment: 24/51 variance, 52.9%

**dictation: (41 symbols, 11 spaces)**

formation: 6/41 variance, 85.3%

size: 30/41 variance, 26.8%

spacing: 3/11 variance, 72.7%

alignment: 26/41 variance, 36.5%

no spaces between words, but continued progress with letter formation.

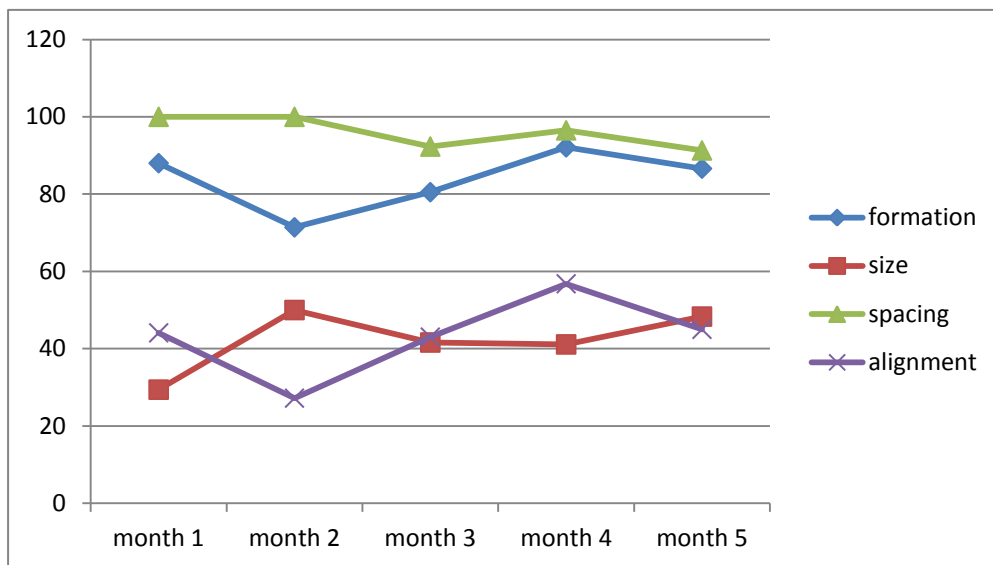
Wednesday, December 21, 2011:

letter review and first sentence:

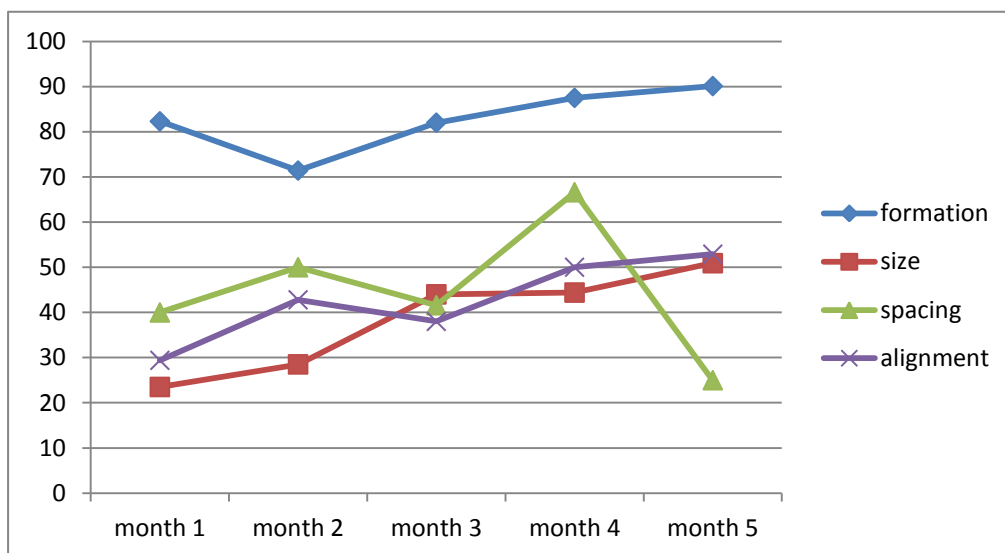
“Fatumata Kone wo`bi wele ka tene a be kalan bon kura.”



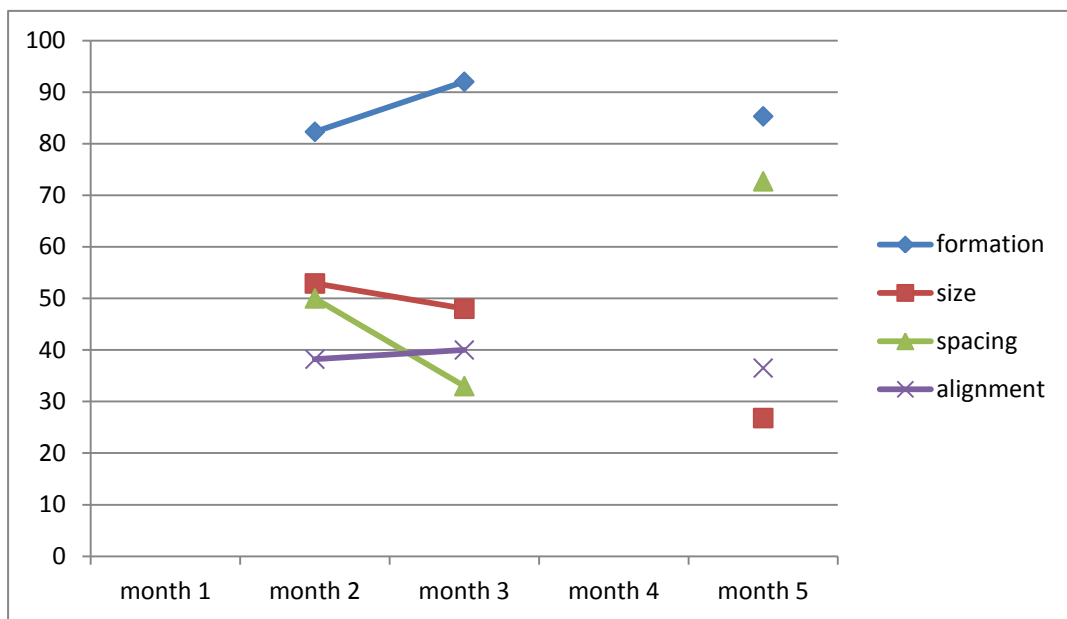
19. Tene Kone, age 59, N, letters



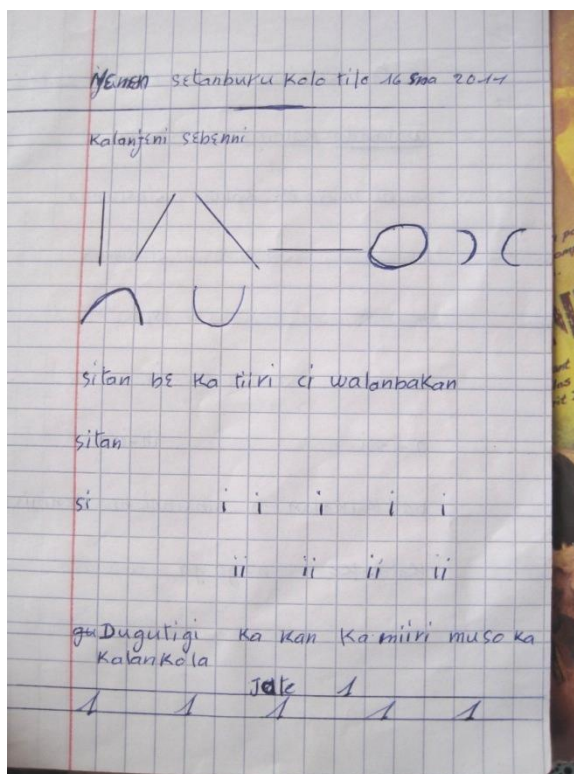
19. Tene Kone, age 59, N, copied



19. Tene Kone, age 59, N, dictation



20. Kadjatou Sangaré, age 34, Diallobougou (6 samples, 6 mo)



(month 1)

**letters: (15 symbols)**

formation: 100%

size: 4/15 variance, 73%

spacing: 1/7 variance, 85.7%

alignment: 7/15 variance, 53.3%

**copied from board: symbols (46)**

formation: 10/46 variance, 78.2%

size: 32/46 variance, 30.4%

spacing: 2/8 variance, 75%

alignment: 19/46 variance, 58.6%

**dictation: (61 symbols, 13 spaces)**

formation: 12/61 variance, 80.6%

size: 40/61 variance, 34.4%

spacing: 3/13 variance, 76.9%

alignment: 18/61 variance, 70.4%

Ntēnen setanburu kalo tile 16 san 2011

Monday, September month day 16 year

Kalanje ni sebenni - reading and writing

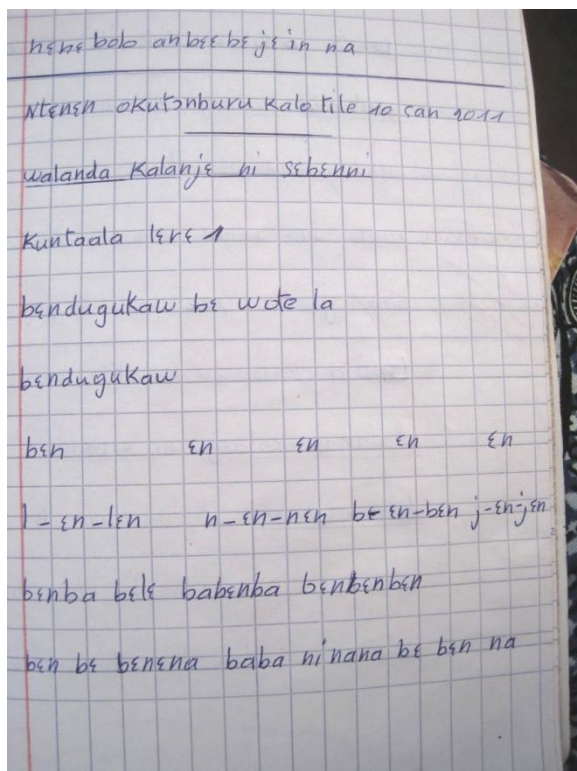
sitan bē ka tiiri ci walanba kan

Sitan traces a line on the board.

Dugutigi ka kan ka miiri muso ka kalanko la.

The chief must think about women's study issues.

Jate – numbers



ntenen okutoburu kalo tile 10 san 2011

Monday, October month day 10 year 2011

walanda kalanje ni sebenni – today's lesson  
reading and writing

kuntaala lere 1 1<sup>st</sup> hour period

bendugukaw be wote la. The people of  
Bendugu are voting.

baba ni mama be ben.

Father and mother agree.

(month 2)

**letters: (71 symbols)**

formation: 6/71 variance, 91.5%

size: 36/71 variance, 49.2%

spacing: 4/22 variance, 81.8%

alignment: 24/71 variance, 66.1%

***copied from board: symbols (62)***

formation: 6/62 variance, 90.3%

size: 35/62 variance, 43.5%

spacing: 0/11, 100%

alignment: 21/62 variance, 66.1%

***dictation: (35 symbols, 8 spaces)***

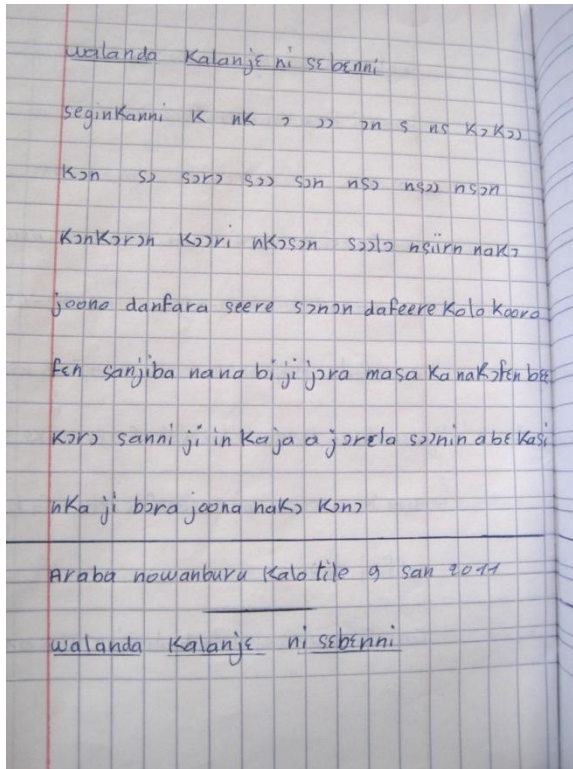
formation: 6/35 variance, 82.8%

size: 23/35 variance, 34.2%

spacing: 1/8 variance, 87.5%

alignment: 13/35 variance, 62.8%

*Obviously not completely  
illiterate before beginning this  
literacy class.*



walanda kalanje ni sebenni – today’s lesson  
reading and writing

seginkanni – review

araba nowanburu kalo tile 9 san 2011

Wednesday, November month day 9 year

connected text:

joona danfara seere son dafere kolo koro  
fen sanjiba nana bi ji jora masa ka nakofen  
be

koro sanni ji in ka ja a jorela sonin a be kasi  
nka ji bora joona nako kon

(month 3)

**letters: (76 symbols)**

formation: 13/76 variance, 82.8%

size: 57/76 variance, 25%

spacing: 1/20 variance, 95%

alignment: 22/76 variance, 71%

***copied from board: symbols (81)***

formation: 9/81 variance, 88.8%

size: 50/81 variance, 38.2%

spacing: 2/12 variance, 83.3%

alignment: 25/81 variance, 69.1%

***dictation: (133 symbols, 34 spaces)***

formation: 11/133 variance, 91.7%

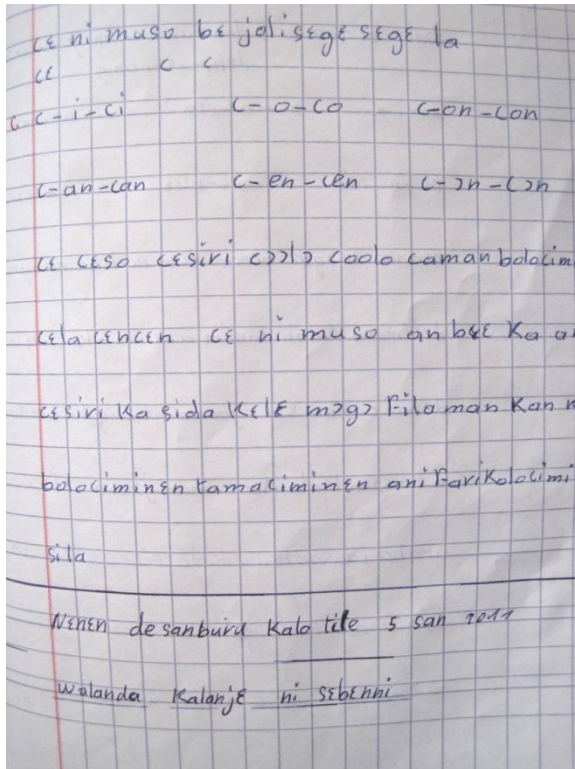
size: 97/133 variance, 27%

spacing: 7/34 variance, 79.4%

alignment: 30/133 variance, 77.4%

connected text translation:

Soon we will witness the difference in the selling price of essential things. A big rain came today. Water disturbed the king’s vegetables before the water could dry. He was soon worried. He cried but the water soon left the garden.



ntenen desanburu kalo tile 5 san 2011

Monday, December month day 5 year 2011

walanda kalanje ni sebenni

today's lesson reading and writing

ce ni muso be joli sege sege la?

ce ni muso an bee ka an cesiri da sida kele  
mogo fila man kan ka bolociminen  
tamaciminen and farikolociminen si la

(month 4)

**letters: (82 symbols)**

formation: 9/82 variance, 89%

size: 52/82 variance, 36.5%

spacing: 1/25 variance, 96%

alignment: 19/82 variance, 76.8%

**copied from board: symbols (49)**

formation: 7/49 variance, 85.7%

size: 33/49 variance, 32.6%

spacing: 3/9 variance, 66.6%

alignment: 11/49 variance, 77.5%

**dictation: (114 symbols, 24 spaces)**

formation: 13/114 variance, 88.5%

size: 85/114 variance, 25.4%

spacing: 5/24 variance, 79.1%

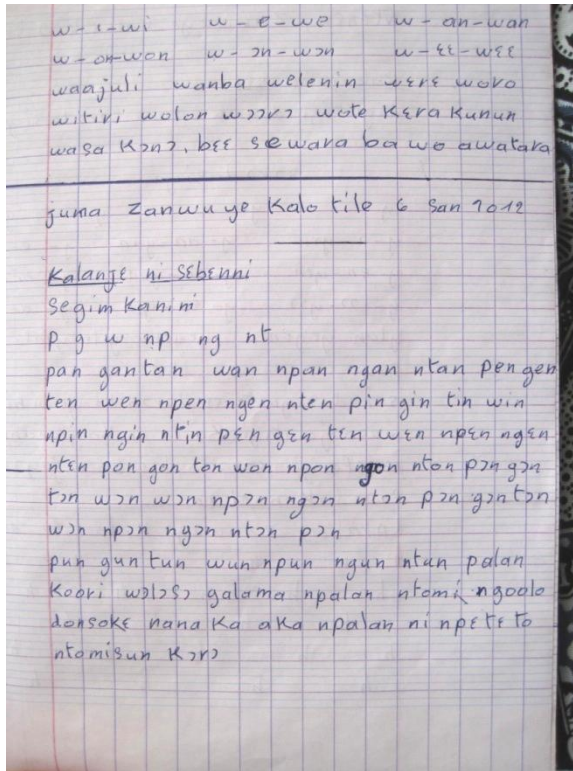
alignment: 32/114 variance, 71.9%

dictation translation:

How much did the man and woman get on their exam?

Men and women, all of us must work hard to fight AIDS. Two people [a few] cannot do all the vaccinations, shots and physical exams alone.





juma zanwuye kalo tile 6 san 2012

Friday, January month day 6 year 2012

kalanje ni sebenni – reading and writing

seginkanni [sic] - review/revision

donsoke nana ka aka npalan ni npete to  
ntomisun kono.

(month 5)

**letters: (246 symbols) separate  
letters and words dictated singly  
to practice those letters**

formation: 14/246 variance, 94.3%

size: 87/246 variance, 64.6%

spacing: 6/62 variance, 90.2%

alignment: 81/246 variance, 67%

**copied from board: symbols (48)**

formation: 6/48 variance, 87.5%

size: 24/48 variance, 50%

spacing: 3/8 variance, 62.5%

alignment: 22/48 variance, 54.1%

**dictation: (43 symbols, 9 spaces)**

formation: 5/43 variance, 88.3%

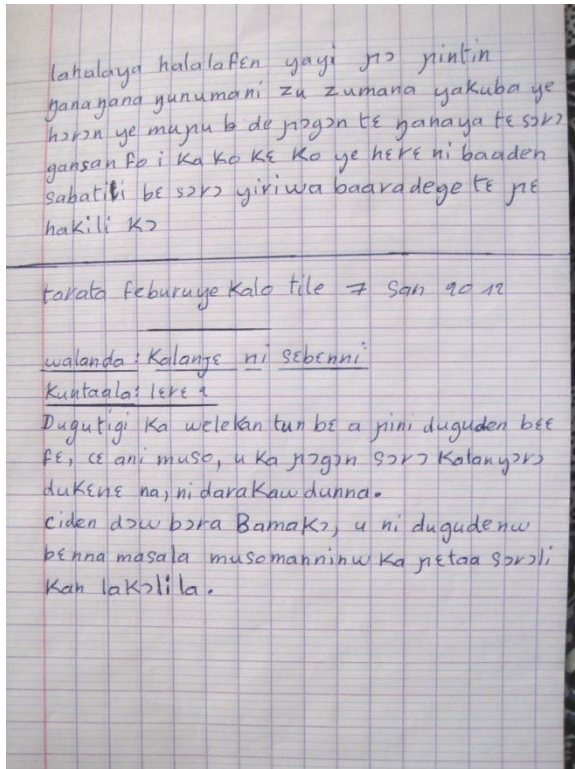
size: 22/43 variance, 48.8%

spacing: 3/9 variance, 66.6%

alignment: 14/43 variance, 67.4%

Dictation translation:

“The hunter came to leave his bag  
and snuffbox in the tamarind tree  
trunk.”



tarata feburuye kalo tile 7 san 2012

Tuesday February month day 7 year 2012

walanda: kalanje ni sebenni

today's lesson: reading and writing

kuntaala: lere 2 – period: hour 2

Dugutigi ka wele k'an tun be a jini duguden  
 bee fe, ce ani muso, u ka jigon soko  
 kalanyoro dukene na, ni darakaw dunna.

Ciden daw bora Bamako, u ni dugudenw  
 benna masala musomanninw ka jetaa soroli  
 kan lakoli la.

(month 6)

symbols: 231 (below the line only)

letters: ( symbols) na

**copied from board: symbols (60)**

formation: 5/60 variance, 91.6%

size: 24/60 variance, 60%

spacing: 1/10 variance, 90%

alignment: 30/60 variance, 50%

**dictation: (171 symbols, 35 spaces)**

formation: 20/171 variance, 88.3%

size: 80/171 variance, 53.2%

spacing: 5/35 variance, 85.7%

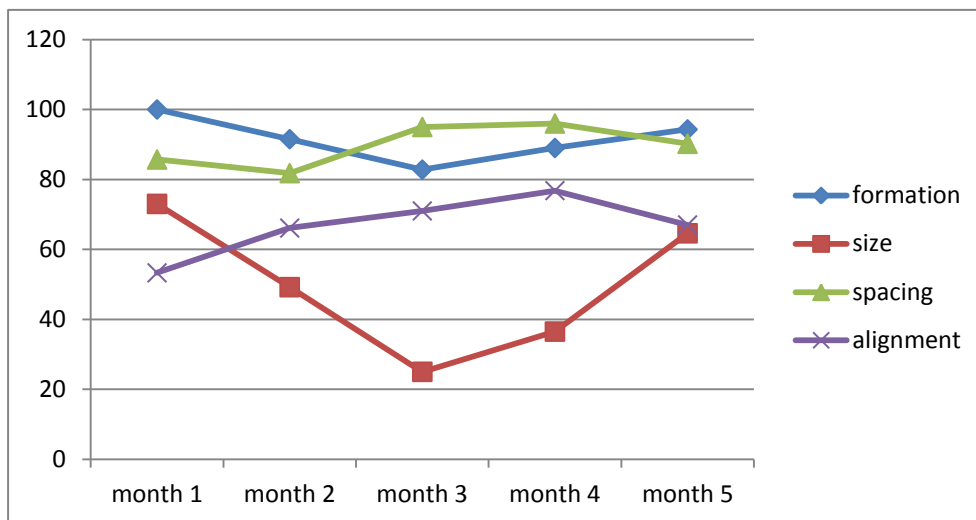
alignment: 48/171 variance, 76%

Dictation translations:

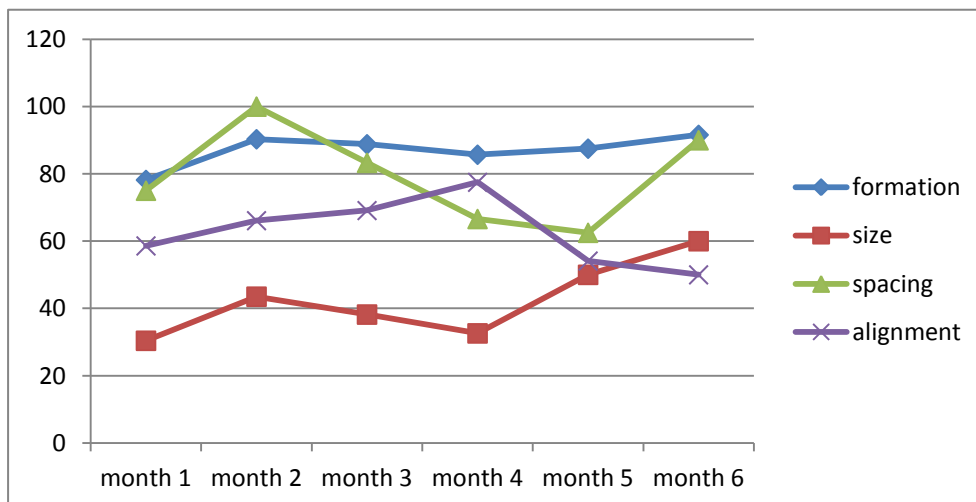
“The village chief must call that we all seek with all villagers, men and women, they must find themselves together [meet] in the study place in the courtyard, once breakfasts are eaten.”

“Other messengers went out from Bamako, they and the villagers agreed in conversation that girls must succeed [look forward at victory] at school .”

20. Kadjatou Sangaré, age 34, D, letters



20. Kadjatou Sangaré, age 34, D, copied



20. Kadjatou Sangaré, age 34, D, dictation

