Applying Pause Analysis to Explore Cognitive Processes Occurring During the Copying of Sentences Amongst 6 years old Children in Sekolah Kebangsaan Bandar Tasik Puteri

Putri Afzan Maria Zulkifli (putriafzan@oum.edu.my)
Azhar Md Adnan (azhar_adnan@oum.edu.my)
Cik Norazlina Mohamad (norazlina_mohamad@oum.edu.my)
Mahani Abdul Malik (mahani_abdulmalik@oum.edu.my)
Faculty of Languages & Education, Open University Malaysia.

Abstract

Pause analysis is a method that investigates processes of writing by measuring the amount of time between pen strokes. It provides the field of teaching and learning in the 21st century with insights of the cognitive processes underpinning the nature of writing in children. This study examined the potential of using free handwritten copying of sentences as a means of investigating components of the cognitive processes of children who have English as their Second Language (ESL). An experiment is conducted where 28 children of Sekolah Kebangsaan Bandar Tasik Puteri are asked to copy a sentence in Malay Language and a sentence in English. The handwritten activity is captured to study the pause lengths produced at different forms of chunking sizes (i.e. group of words, words and group of letters). Results are then associated to the Theoretical Model of Copying (MoC) in identifying the possible factors that might affect the chunking sizes. It was found that there is a clear chunk with long pauses that occur at letter level, group of letters and word level. This indicates that there is a possibility of language comprehension processes taking place during the copying of sentences.

Keywords: Writing; children; handwriting; automaticity; pause; low level cognitive process; copying; copying sentences.

Introduction

Pause analysis uses temporal aspects to represent the processes taking place during the activity of writing. Researchers have applied *pause analysis* in a number of studies involving different tasks, including: text productions (e.g. Schilperoord, 1996, 2001; Torrance & Jeffery, 1998; Spelman Miller, 2000a, 2000b, 2006; Spelman Miller & Sullivan, 2006; Wengelin, 2006); the drawing of simple geometric patterns (Cheng, McFadzean & Copeland, 2001); the writing of number sequences (Cheng & Rojas-Anaya, 2005); the writing of familiar and unfamiliar words (Cheng & Rojas-Anaya, 2006); the copying of mathematical equations by experts and novices (Cheng & Rojas-Anaya, 2007); schema and chunk production in drawings (Obaidellah & Cheng, 2009); writing from memory by dyslexic children (van Genuchten, Cheng, Leseman & Messer, 2009); writing multiple sentences (van Genuchten & Cheng, 2010); and finally, the studies of copying on children (e.g. Grabowski et al., 2010). All these studies have established the usefulness of the method. Given the potential of using pause analysis as a method, this study intends to explore the cognitive processes occurring during the activity of copying amongst 6 years old.

In pause analysis, pauses are captured at various levels; pause between marks or strokes in a letter, pause between letters in a word and pause between words in a sentence. In this study, pause can be defined as the time captured from the moment the pen is lifted in the air (pen-off) until the moment the pen touches the paper again (pen-down). By interpreting patterns of pauses between writing actions it can provide an insight into what happens at the cognitive level of the mind. It has been well established in Cognitive Science that durations of pauses between actions reflects the amount of mental processing that is needed to prepare the actions (Fayol, 1998; Kellogg, 1998; Torrance & Jeffery, 1998; Schilperoord, 2001).

Why Copying? There are indeed very few studies that focus on ‘copying’. Research on copying is normally related to the study of handwriting instruction. The earliest research was conducted in 1975 by

Askov and Greff, who examined the differences between copying and tracing, in order to determine which is the most effective type of practice. Their study reveals the advantages and disadvantages of both methods, as used by children in schools. It suggests that tracing is an easy enough task, while, by contrast, copying involves more meaningful processes, which affect learning. Gonzalez et al. (2011) compared tracing and copying in the reproduction of patterns. Their findings have shown that tracing is beneficial for short-term learning and encourages the provision of accurate and immediate feedback. Copying, however, requires greater use of memory and is found to be especially useful in the long-term learning of novel letter shapes. Kirk (1980) had already arrived at the conclusion that copying is a better method for teaching children new shapes. It could be that copying has the advantage of forcing individuals into remembering the shapes (Gonzalez et al., 2010) and, when combined with the actual movements of handwriting (kinaesthetic), facilitates the visual memory of graphic shapes and letters.

A gap exists in the literature after the 1970s, until the early 1990s, when Rieben, Meyer and Pervegaux (1991) studied copying from cognitive and instructional perspectives. They found seven strategies of copying in children, including syllables, letter writing and bigrams, among others. Even though the literature has been slow to realise the potential of linguistic features (e.g. phonemes and graphemes) in relation to copying and language processes, these features do have a role to play in the process of chunking when it comes to spelling (e.g. Rieben et al., 1991; Verhoeven et al., 2006; Kandel et al., 2009).

Research on copying was then carried further by the very recent work of Grabowski, Weinzierl and Schmitt (2010), who looked specifically into the performance of children in copying. Even though these studies involve children, there is nothing to suggest that the processes and strategies observed are not adopted by adults. The study by Grabowski et al. (2010) found that performance in copying improves as children get older, especially when recognition and handwriting become automatic.

As well as the application of the copying technique as a method to improve one's skills, it has been used in a number of studies, such as understanding the relationship between early reading and writing skills by investigating the copying strategies of children (Rieben et al., 1991; Saada-Robert &Rieben, 1993; Rieben & Saada-Robert, 1997), measuring the fluency of alphabet writing in schools in order to assess handwriting competence in children (e.g. Longcamp et al., 2003, 2005, 2006, 2008; Rosenblum, 2005), investigating chunking strategies at stroke, letter and word level (Cheng & Rojas-Anaya 2005, 2006), exploring the copying unit size of children (i.e. phonology and orthography effects) from a French elementary school (Kandel & Valdois, 2006a) and then comparing their findings with children from a Spanish school (Kandel & Valdois, 2006b), investigating the effects of syllables in the process of segmenting words during copying (Verhoeven et al., 2006), measuring the competence of four different participants in writing mathematical formulae (Cheng & Rojas-Anaya, 2008), and examining typing skills proficiency in adults (Grabowski, 2008). The most recent research is that by Grabowski et al. (2010) as described above. So far, there has been little discussion on the application of copying as a tool to study the underlying cognitive processes of children's writing.

Method

Participants

Twenty eight children aged 6 years old were involved in this study. These participants all had Malay Language as their first language, English as their second language and have no language impairments. English in Malaysia is a compulsory subject and is introduced to all Malaysian as early as from the kindergarten; however, most students uses English only during English classes.

Apparatus

A standard graphics tablet was used (Wacom, Intuous$_3$) connected to a personal computer. All writing activities were performed with a special graphics tablet ink pen. A piece of A4 paper with printed boxes is placed on the tablet. There were 20 x 13 boxes each sized 0.39”x0.39”. Each box is designated for one character only (letters or symbols). Every space between words in the sentences is omitted in the copy writing activity. The objective of using boxes is to establish single letter production. Joined up writing would make distinguishing each letter difficult, hence it is hard to define pauses between strokes. A specially written program, TRACE (Cheng & Rojas-Anaya, 2004), is used to record all writing actions and also used to extract all data producing pen positions, times of points and pauses. A program written by a colleague, ‘PLET-Pause Length Extraction Tool’ (Van Genuchten, 2009) was used to analyse the extracted data: pause and median values.

The Copying Tasks

The experiment uses a sentence in Malay Language and a sentence in English, both has the same meaning:

Sentence 1: Saya suka bola merah
Sentence 2 : I love the red ball

Overall, 28 participants were asked to write 2 sentences each, producing 56 sentences altogether. Each participant produced 9 words, totalling 32 characters, assuming no errors were made. These numbers excludes the name writing. Figure 1 below provides an example of a copying activity using TRACE. The light coloured line represents the pauses captured.

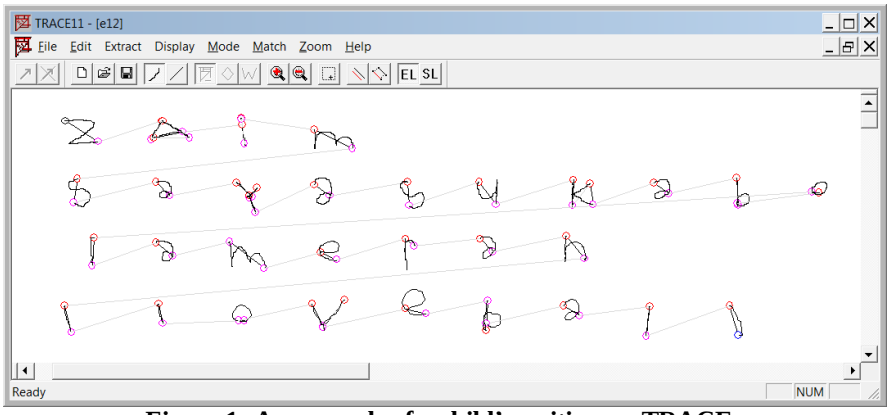
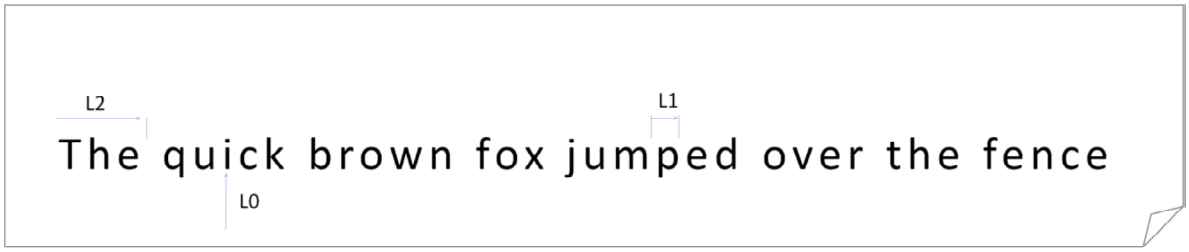


Figure 1: An example of a child’s writing on TRACE.

Outcome Measures: Pause Levels

The broad use of the term ‘pause’ is sometimes equated with temporal signal in writing. The primary outcome measure includes the various elements of pause value: pause between marks within a letter (stroke, L0), pause between letters in a word (letter, L1) and pause between words in a sentence (word, L2). The pause values (represented by hundreds of milliseconds, ms) that we took as a measure are in medians.



L0	Pauses within a letter (STROKE)
L1	Pauses between letters (LETTER)
L2	Pauses between words (WORD)

Figure 2: Illustration of the pause levels used in this study

Procedures

The first task was to capture written data by arranging a one-to-one session between the participants and the researcher. All 28 participants were asked to copy all sentence stimuli given to them at their own normal writing rate. The stimuli were visible at all time, but participants were not allowed to read them in advance. Only when the researcher said 'start', could the participants look at the stimuli and begin to write. Each new sentence must start with a 'hash' (#). This is to make sure that writing is well underway to capture a valid pause value.

Results

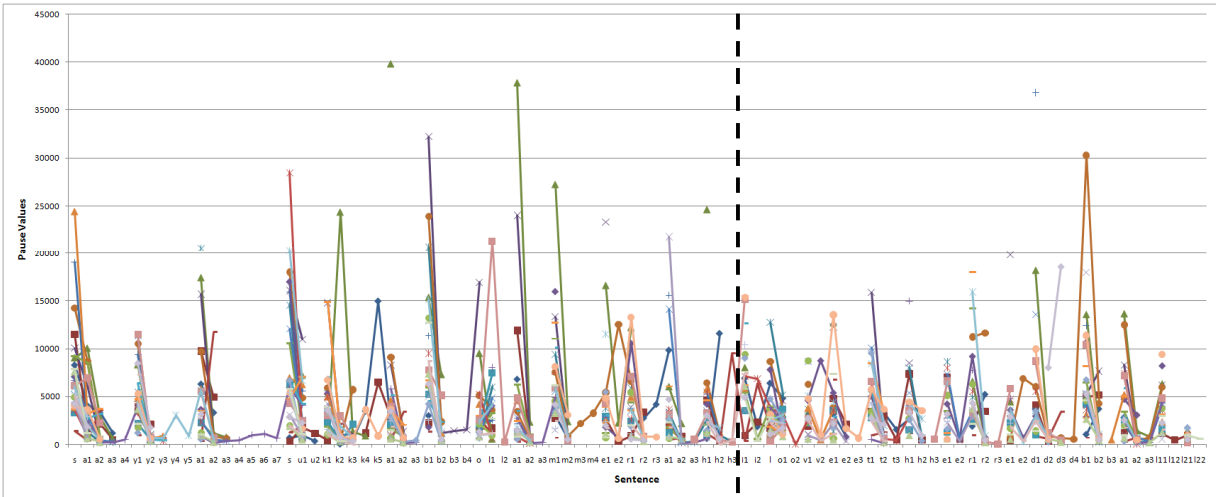


Figure 3: Pause distribution across the copying of the two sentences for all 28 children.

Figure 3 shows the pause distribution for all 28 children in copying the two sentences. The dashed line separates the two sentences. Sentence 1 on the left is in Malay Language, while Sentence 2 on the right is in English. As seen in the graph, Sentence 1 has got varied long pauses that are above 15000ms whereas; Sentence 2 is generally below 15000 ms pause value.

Pause Lengths of 6 years old Children Copying

In order to analyse the pauses in detail, the participants are grouped into top 5 and lowest 5, based on their reading and writing level in the classroom. The results are seen as in Figure 4. The two graphs clearly show a big difference in terms of the pause lengths in the copying of the two sentences. Top 5 Participants produces mostly pause lengths of below 5000ms. Lowest 5 Participants produces mostly pause lengths of above 5000ms.

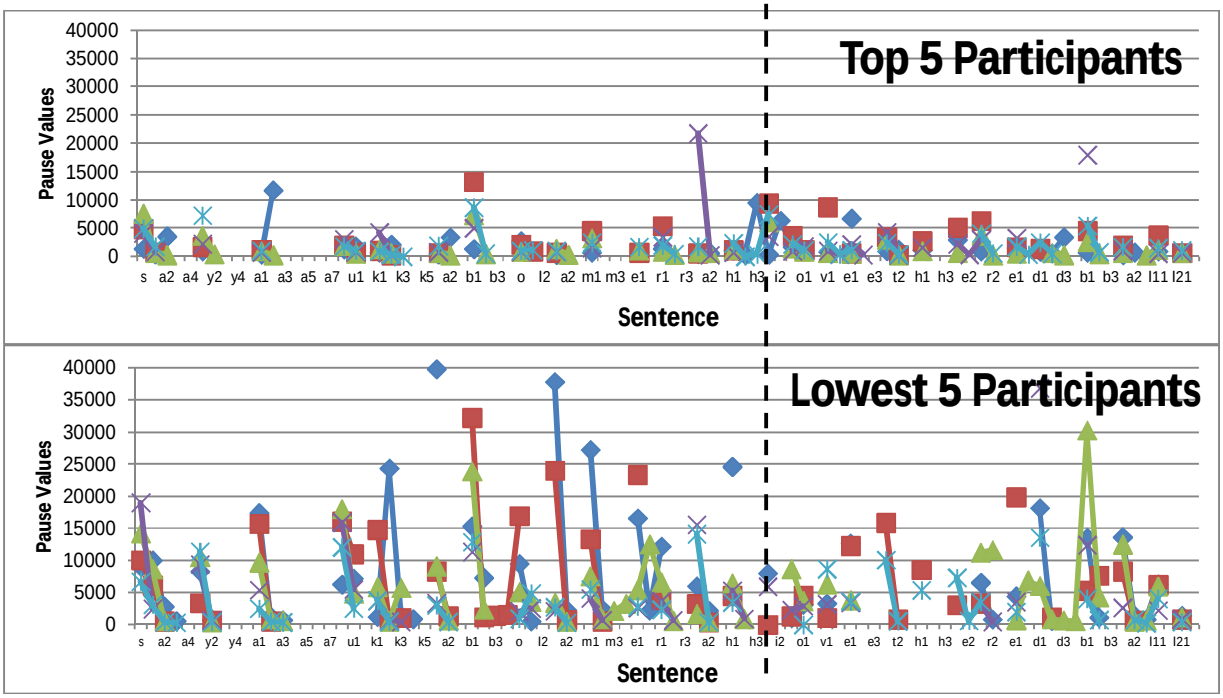


Figure 4: Pause distribution across the copying of the two sentences for Top 5 and Lowest 5 participants.

Table 1 provide a direct comparison of the approximate absolute values of the pauses associated with each level for this and the previous experiments. Data shows a huge different of pause lengths between previous and present study at all levels. The pause lengths are also different between the top 5 and the lowest 5 participants. The top 5 has similar pause lengths across all levels in copying both sentences. The lowest 5 has also similar pause lengths across L0 and L1, except for L2. The copying of Malay Language sentence provides a longer pause length compared to English. This could suggest that participants of the lowest 5 may or may not have familiarisation on one of the language.

	Experiment	Stimuli	L0	L1	L2
	Cheng & Rojas-Anaya (2005)	Number sequences	90	280	440
	Cheng & Rojas-Anaya (2006)	Familiar and jumbled phrases	90	270	400
	Cheng & Rojas-Anaya (2008)	Artificial sentence	90	250	440
	Van Genuchten & Cheng (2010	Natural language sentences	90	270	370
Top 5	Present	Copying Bahasa Malaysia	360	1970	4790
		Copying English	373	1710	4790
Lowest 5	Present	Copying Bahasa Malaysia	1576	6717	14043
		Copying English	1570	6542	8482

Table 1: Pauses (ms) for various stimulus levels over different stimulus types (rounded to 10 ms).

Chunking Patterns of 6 years old Children Copying

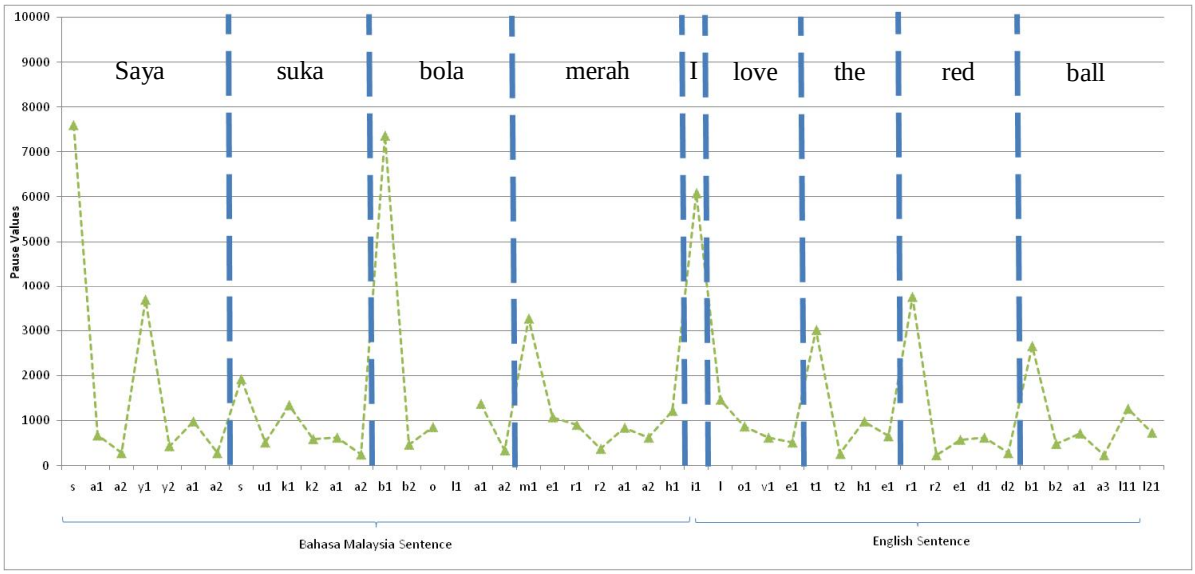


Figure 5: A chunking pattern profile of a participant among the Top 5.

Chunking pattern in copying usually demonstrates a longer pause at the beginning of a word (the first letter) and shorter pauses for the rest of the letter, or, another longer pause at another group of letters in a word. Figure 5 and 6 provide some examples of two participants, one from the top 5 and one from the lowest 5. The data shown in Figure 5 agrees to the normal chunking pattern that would normally occur. There exist long pauses at the very beginning of each word, both in Malay Language and English. However, the case is different with Figure 6, where there exist longer pauses within a word which is longer than the first letter, e.g. in 'merah' and 'red'. Figure 6 presents a missing word 'the'. Both participants also demonstrate chunking in a word or a group of letters: 'sa' + 'ya'. Overall, Figure 5 has an average pause length at 1420ms and Figure 6 has an average pause length at 5530ms. Participant of Figure 6 seems to take a longer time to copy compared to participant of Figure 5, which also explains the top 5 and lowest 5.

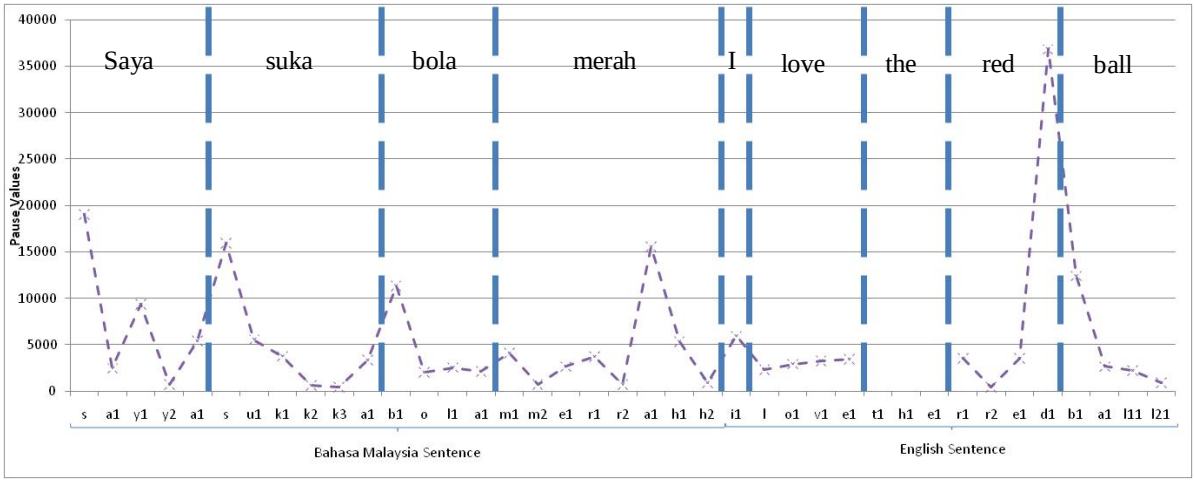


Figure 6: A chunking pattern profile of a participant among the Lowest 5.

General Discussions

This paper has investigated copying sentences as an approach to explore the underlying cognitive processes that occurs amongst children of 6 years old. The results provide some insights such as the pause lengths and the chunking patterns in the copying processes. In this research work, we had presented our exploration on two sentences in two different languages: Malay Language and English.

In this study, we chose copying sentences as an approach to capture freehand writing data. More precisely, we purposely asked the children to immediately copy as a practical technique to study the underlying cognitive processes of children's copying. For example, when a participant wrote "Saya suka bola merah" exactly as being shown, what cognitive processes occurred here? Typical main stages of cognitive processing would involve perception, learning & memory storage, retrieval and transformation of information. The time taken for these processes could be represented as the pause. The length of words produced (copied) per each transformation can be represented as a 'chunk'. The cognitive capacity constraints were tested with this immediate copying approach. Participants were forced to read, remember words, and write under great time pressure. Hence, participants were made to focus only at the copying activity, thus avoiding the interference of high level cognitive processes of writing. One of the reasons for using the immediate copying approach is to obtain a genuine pause value that occurs in the processes of copying. Another factor that should be taken seriously is the automaticity of handwriting.

Fayol (1998) discusses automaticity and its limitations in his paper. He agrees that when a component skill is automated, it becomes faster, effortless and non-interfering, hence does not overload the cognitive capacity. With children, this *automaticity* is still developing hence you can see the huge pause length differences between the present study (focuses on children) and previous studies (focuses on adults) at all levels (Table 1). It is generally acknowledged that handwriting is a complex skill and with years of practice, the automaticity of handwriting can be mastered (Fayol, 1998; Longcamp et. al., 2005). La Berge and Samuels (1974, as cited in Medwell & Wray, 2007) define automaticity as having been achieved when a process can be affected swiftly, accurately and without the need for conscious attention. Therefore, with handwriting being an automatic process, cognitive resources can be fully utilised for capturing language comprehension by copying sentences. Children of 6 years old may have just learned the automaticity of writing letters, in which, we could assume that there is some possibilities that they are able to chunk syllables or a group of letters, whether or not they could comprehend it. It is for this reason; we conclude that the method of copying is applicable.

In terms of writing tasks, we aimed to test participant's understanding of what is being copied by comparing the pause lengths and the chunking patterns between the two sentences. It is predicted that pause lengths varies for sentence that they understood or are familiar with, where as pause lengths are constant when there are difficulties in comprehending what is being copied. In Torrance and Jeffery (1998), they explained text production theories of 'why is writing difficult?' For writing to be labelled as difficult, effects from factors associated with a writer's expertise, content knowledge, the nature of the writing task and even the complexity of text production must be taken into consideration (Torrance & Jeffery, 1998). It was found that their claims could support the fact that the two sentences are in two different languages; hence there are some complexity in terms of understanding one of the language. The attempt of relating the factors with the two sentences in this experiment seems to fit in. One factor that could relate to this study is the term, 'familiarisation' (Kellogg, 1998). It is assumed that familiarisation of the words would affects the fluency of immediate copying. Let us take an example of the word 'saya'. A participant who is familiar with the word would take shorter pause duration to complete copying, but, participants who are not familiar with the word would require a longer duration pause. Memory retrieval and thinking processes engaging search of the words from the memory could be the reason to the long pause length.

It is interesting to see that the study managed to provide some input to how a child copies sentences as given. Further research work is encouraged to provide more data towards understanding the profiling of children copying in these two different languages.

Acknowledgments

The research is supported by the tools of Professor Dr. Peter Cheng, Director of Cognitive Science from the University of Sussex, Brighton, England and the data collected by Nurul Hazwani Zolkipli (2012). We would also like to take this opportunity to thank all participants for contributions in this study and those involves in morally supporting this research work.

References

Askov, E.N. (1975) Handwriting: copying *versus tracing as the most effective type of practice*. J Educ Res 69:96–98

Cheng, P. C.-H., McFadzean, J., & Copeland, L. (2001). Drawing out the temporal structure of induced perceptual chunks. In J. D. Moore & K. Stenning (Eds.), *Proceedings of the Twenty Third Annual Conference of the Cognitive Science Society* (pp. 200-205). Mahwah, New Jersey: Lawrence Erbaum.

Cheng, P.C-H., & Rojas-Anaya, H. (2004). *TRACE User Guide*. (Unpublished Representational Systems Laboratory report).

Cheng, P. C. H., & Rojas-Anaya, H. (2005). Writing out a temporal signal of chunks: patterns of pauses reflect the induced structure of written number sequences. In B. G. Bara, L. Barsalou& M. Bucciarelli (Eds.), *Proceedings of the Twenty Seventh Annual Conference of the Cognitive Science Society* (pp. 424-429). Mahwah, NJ: Lawrence Erlbaum.

Cheng, P. C. H., & Rojas-Anaya, H. (2006). A temporal signal reveals chunk structure in the writing of word phrases. In *Proceedings of the Twenty Eighth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Lawrence Erlbaum.

Cheng, P. C. H., & Rojas-Anaya, H. (2007). Measuring mathematical formula writing competence: an application of graphical protocol analysis. In D. S. McNamara & J. G. Trafton (Eds.), *Proceedings of the Twenty Nineth Annual Conference of the Cognitive Science Society* (pp. 869-874). Austin, TX: Cognitive Science Society.

Fayol, M. (1998). From on-line management problems to strategies in written composition. In G. Rijlaarsdam & E. Esperet (Series Ed.) & G. Jefferey (Vol. Eds.) *Studies in Writing: Vol. 3. The Cognitive Demands of Writing*. (pp. 13-23). Amsterdam: Amsterdam University Press.

Grabowski, J. (2008). The internal structure of university students' keyboard skills. *Journal of Writing Research*, 1, 27–52.

Grabowski, J., Weinzierl, C., & Schmitt, M. (2010). Second and fourth graders' copying ability: From graphical to linguistic processing. *Journal of Research in Reading*, 33, 39-53.

Gonzalez, C., Anderson, J., Culmer, P., Burke, M.R., & Mon-Williams, M. (2011*).* Is tracing or copying better when learning to reproduce a pattern? *Experimental Brain Research, Vol. 208* (3) 459-465.

Kandel, S. & Valdois, S. (2006a). Syllables as functional units in a copy task: A visuo-orthographic and graphomotor approach. *Language and Cognitive Processes*, 21, 432–452.

Kandel, S. & Valdois, S. (2006b). French and Spanish-speaking children use different visual and motor units during spelling acquisition. *Language and Cognitive Processes*, 21, 531–561.

Kandel, S., Herault, L., Grosjacques, G., Lambert, E., Fayol, M. (2009). Orthographic vs. phonologic syllables in handwriting production. *Cognition* 110. 3 : 440-444.

Kellogg, R.T. (1998). Components of working memory in text production. In G. Rijlaarsdam& E. Esperet (Series Ed.) & G. Jefferey (Vol. Eds.) *Studies in Writing: Vol. 3. The Cognitive Demands of Writing*. (pp. 43-62). Amsterdam: AmsterdamUniversity Press.

Kirk, U. (1980). *Learning to copy letters: a cognitive rule-governed task*. Elem Sch J 81:28–33

LaBerge, D., & Samuels, SJ. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 6, 293-323.

Longcamp, M., Anton, J.L. & Velay, J.L. (2003). Visual presentation of single letters activates a pre-motor area involved in writing. *Neuroimage*, 19, 1492–1500.

Longcamp, M., Boucard, C., Gilhodes, J.C. & Velay, J.C. (2006) Remembering the orientation of newly learned characters depends on the associated writing knowledge: a comparison between hand writing and typing. *Human Movement Science* 25:646–656

Longcamp, M., Boucard, C., Gilhodes, J.C., Anton, J.L., Roth, M.,Nazarian, B. & Velay JL (2008). Learning through hand or type-writing influences visual recognition of new graphic shapes: behavioural and functional imaging evidence. *Journal Cognitive Neuroscience* 20:802–815

Longcamp, M., Zerbato-Poudou, M.T. & Velay, J.L. (2005). The influence of writing practice on letter recognition in preschool children: a comparison between handwriting and typing. *Acta Psychologica* 119:67–79

Medwell, J. & Wray, D. (2007). Handwriting: What do know and what do we need to know? *Literacy, Vol. 41, No. 1. Handwriting* (pp. 10-15). Blackwell Publishing.

Nurul Hazwani, Z. (2012). Menggunakan “Pauses” dalam melihat kelancaran kanak-kanak menyalin ayat (Degree dissertation). Universiti Pendidikan Sultan Idris, Tanjung Malim, Perak.

Obaidellah, U.H. & Cheng.P.C.H. (2009). Graphical Production of Complex Abstract Diagrams: Drawing Out Chunks and Schemas. *Proceedings of the Thirty First Annual Conference of the Cognitive Science Society*. Amsterdam, Netherlands.: Cognitive Science Society.

Rieben, L. & Saada-Robert, M. (1997). Relations between word-search strategies and word-copying strategies in children aged 5 to 6 years old. In C. A.Perfetti, L.Rieben & M.Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages*. (pp. 295–318). Mahwah, NJ: Lawrence Erlbaum Associates.

Rieben, L., Meyer, A. & Perregaux, C. (1991). Individual differences and lexical representations: How five 6-year-old children search for and copy word. L. Rieben, C. Perfetti, Editors. *Learning to read—Basic research and its implications*, Erlbaum, Hillsdale, NJ (1991), pp. 85–101.

Rosenblum, S. (2005). *Using the Alphabet Task to Differentiate between Proficient and Non-proficient Hand-writers In Perceptual and Motor Skills* (pp. 629-639).

Saada-Robert, M. & Rieben, L. (1993*).* Evolutions des stratégies d'écriture-copie et unités graphiques du français. *Etudes de Linguistique Appliquée*, 90, 84–96.

Schilperoord, J. (1996) *It's about time. Temporal aspects of cognitive processes in text production*. Amsterdam: Rodopi.

Schilperoord, J. (2001). On the cognitive status of pauses in discourse production. In: G. Rijlaarsdam (Series ed.) & T. Olive & C.M. Levy (Vol. eds.), *Studies in Writing: Volume 10: Contemporary Tools and Techniques for Studying Writing*. Kluwer Academic Publishers: Netherlands.

Spelman Miller, K. & Sullivan, K. P. H. (2006). Keystroke logging: an Introduction. In G. Rijlaarsdam (Series Ed.) and K.P.H. Sullivan, & E. Lindgren. (Vol. Eds.), *Studies in Writing, Vol.18, Computer Keystroke Logging: Methods and Applications*. Oxford; Elsevier.

Spelman Miller, K. (2000a). Academic writers on-line: Investigating pausing in the production of text. *Language Teaching Research*, 4(2), 123–148.

Spelman Miller, K. (2000b). *Writing online: Temporal features of first and second language written text production*. Unpublished doctoral thesis. University of Reading, UK.

Spelman Miller, K. (2006). The pausological study of written language production. In G. Rijlaarsdam (Series Ed.) and K.P.H. Sullivan, & E. Lindgren. (Vol. Eds.), *Studies in Writing, Vol.18, Computer Keystroke Logging: Methods and Applications*. Oxford; Elsevier.

Torrance, M. & Jeffery, G. (1998). Writing Processes and Cognitive Demands. In G. Rijlaarsdam& E. Esperet (Series Ed.) & G. Jefferey (Vol. Eds.) *Studies in Writing: Vol. 3. The Cognitive Demands of Writing*. (pp. 1-12). Amsterdam: AmsterdamUniversity Press.

Torrance, M. & Jeffery, G. (1998). Writing Processes and Cognitive Demands. In G. Rijlaarsdam& E. Esperet (Series Ed.) & G. Jefferey (Vol. Eds.) *Studies in Writing: Vol. 3. The Cognitive Demands of Writing*. (pp. 1-12). Amsterdam: AmsterdamUniversity Press.

Van Genuchten, E. (2009). *Pause Length Extraction Tool (PLET), Computer software*. University of Sussex. Brighton, UK.

Van Genuchten, E., & Cheng, P. C.-H. (2010). Temporal chunk signal reflecting five hierarchical levels in writing sentences. In S. Ohlsson& R. Catrambone(Eds.), *Proceedings of the 32nd Annual Conference of the Cognitive Science Society*. (pp. 1922-1927). Austin, TX: Cognitive Science Society.

Van Genuchten, E., Cheng, P. C-H., Leseman, P. P. M., & Messer, M. H. (2009). Missing working memory deficit in dyslexia: Children writing from memory. In N. A. Taatgen, & H. van Rijn (Eds.*), Proceedings of the 31st Annual Conference of the Cognitive Science Society* (pp. 1674-1679). Austin, TX: Cognitive Science Society.

Verhoeven, L., Schreuder, R., Baayen, R.H. (2006) Learnability of graphotactic rules in visual word identification. *Learning and Instruction*, 16 (6), pp. 538-548.

Wengelin, Å. (2006). Examining pauses in writing: theory, methods and empirical data. In G. Rijlaarsdam (Series Ed.) and K.P.H. Sullivan, & E. Lindgren. (Vol. Eds.), *Studies in Writing, Vol.18*, Computer Keystroke Logging: Methods and Applications (pp. 107-130). Oxford; Elsevier.