AN INTER-CORRELATIONAL STUDY OF THE READING COMPONENTS IN PROFILING AND GENERATING A COGNITIVE EQUATION FOR THE READING PERFORMANCE OF STUDENTS WITH AUTISM

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Reading is a multifaceted process consisting of many interacting components. A plethora of research is available on reading. Yet, there is inadequate exploration, which ascertains the effects of the interaction of different reading components and how they affect the reading performance of students with autism. This inter-correlational research study examined how five different components, namely, Reading Experience, Word Reading, Sentence Reading, Reading Comprehension and Reading Attitude interrelate with each other. We proposed a cognitive equation of reading process that illustrated the effects of these components on 17 Primary 4 students (13 boys and 4 girls, aged between 9 and 10 years) with high-functioning autism, currently attending mainstream schools. Among the five components, the inter-correlation reliability coefficient between Word Reading and Sentence Reading showed significant and positive relationship. Word Reading and Reading Comprehension which showed moderate reliability followed this. Reading Experience correlated reliably with Reading Comprehension. However, Reading Attitude was least correlated with the other components of the reading process. We recommended pedagogical interventions based on the results of this study.

The hallmark features that distinguish students with autism are distinct and identified by a triad of impairments comprising social impairment; impairment in reciprocal communication; and narrow, restricted, and stereotyped patterns of behaviours and interests (American Psychiatric Association, 1994).

For typical children, the ability to make sense of print by and large progresses in tandem with their ability to grasp the meaning of what they read (Mirenda, 2003; Nation & Norbury, 2005). Conversely, students with high-functioning autism have deficits in comprehending written text (Wahlberg & Magliano, 2004). These students demonstrate effective and sometimes exceptionally good word-recognition skills but poor comprehension capabilities, termed as hyperlexic (Grigorenko, Klin, & Volkmar, 2003; Nation, Clarke, Wright, & Williams, 2006). Despite this, students with high-functioning autism can achieve academic success as their language and cognitive aptitude are less impaired (Minshew, Goldstein, Taylor, & Siegel, 1994). In fact, some of these students have successfully attained tertiary education and work (Burack, Root, & Zigler, 1997).

Undoubtedly, the ability to read and grasp text will enhance learning outcomes and expand communication skills (Nation & Norbury, 2005). This in turn will create the pathway for a better quality of life and ability to function independently in the community. Thus, it is pertinent for students with autism to be able to read and understand text (O'Connor & Klein, 2004). This underlying notion was the driving force that led us to examine the reading process in order to establish a cognitive equation for students with autism. It is our vision that this cognitive equation will shed light on specific reading components and corresponding interventions to enhance reading outcomes of students with autism.

Reading as a Process
Reading is a complex and multi-dimensional process (Alfassi, 2004; Siegel, 1993). It entails a multifaceted set of process components with their respective skills and abilities. According to Siegel

(1993), in acquisition of reading, five process components are crucial: phonology, syntax, semantics, orthography, and working memory (see Figure 1).
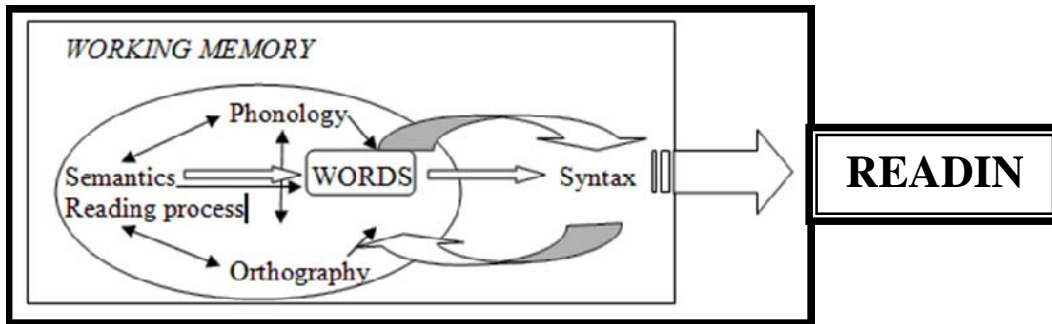

Figure 1. The Five Process Components of Reading (Siegel, 1993)

Moreover, reading is both a psycholinguistic process (Goodman, 1968), where the mind actively processes what is read and sociolinguistic process (Vygotsky, 1978), where several social related factors that have an impact on what one reads, how one reads and how much one understands from reading.

A search on past studies on reading process did not provide us with a cognitive equation specifically for students with autism. Consequently, our study was derived from and built upon the cognitive model of reading process (Chia, 2007a) which encapsulates in a cognitive equation (Chia, 2004, 2007, 2010):

$$RP \rightarrow S \{B[T(D + Cp) + M] + P\} \rightarrow RO$$

Where **RP**   is Reading Process
       S   is Setting (where the reading task takes place)
       B   is the Background Knowledge and Prior Experience of the Reader
       T   is Thinking
       D   is Decoding
       Cp   is Comprehension
       M   is Motivation
       P   is Purpose
       RO   is Reading Outcome

As shown in the afore-mentioned equation, reading is a complex process **comprising many interacting components. Figure 2 below shows the cognitive equation depicted in the form of a diagram.**
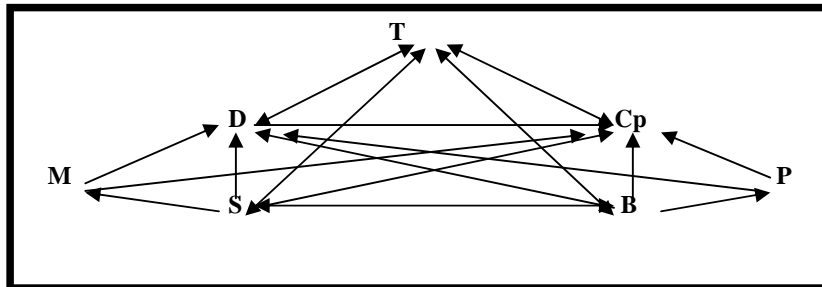

Figure 2. An Adapted Diagrammatic Representation of the Reading Process (Chia, 2004)

Thinking
Chia (2004) states that the fundamental component in the cognitive equation of reading process is Thinking (Decoding + Comprehension), that is, T (D + Cp). The knowledge and verification of one's understanding (*metacognition*) of the text are indispensably imperative to attain a competent level of reading (Mokhtari & Reichard, 2002). A competent reader is able to decode words correctly and fluently to understand the intended message of the text for both meaning of words in isolation or according to the context of the text (Huemer & Mann, 2010). Thinking **T** is fundamental for this process.

In the absence of thinking, comprehension is meaningless and the reader becomes hyperlexic. Children who are able to read but unable to derive meaning from what they have read will not benefit from their reading (Klinger, Vaughn, & Boardman, 2007). The thinking processes and the generated

representations form the cornerstone to boost background information that assists recalling or answering questions at a later stage.

Decoding

Decoding **D** involves aural-visual and visual-oral decoding processes (Chia, 2007a, p.4). A general consensus amongst several researchers (e.g., Frith, 2003; Mayes & Calhoun, 2003a, 2003b; Nation et al., 2006) is that children with autism are adept at decoding, given their strengths in rule-based and rote-learning but less skilled at comprehension which needs meaning-focused skills (Randi, Newman, & Grigorenko, 2010). These children decode words using similar phonological and orthographic representations as their typical counterparts (Newman et al., 2007). Yet, the language profile of children with autism diverges greatly in terms of expansion in vocabulary and word proficiency. Some of them have delays in acquiring their first words whilst others are able to achieve scores in vocabulary that are similar or above those scored by typical children (Lindgren, Folstein, Tomblin, & Tager-Flusberg, 2009). Other factors that impact on word learning in students with autism include social factors (Kuhl, 2007), joint-attention and ability to form a common visual point (McDuffie, Yoder, & Stone, 2006) and associative learning (Parish-Morris, Hennon, Hirsh-Pasek, Golinkoff, & Tager-Flusberg, 2007) influence word reading skills.

Comprehension

The competences required for effective reading comprehension **Cp** extends beyond word reading abilities. A wide array of vocabulary knowledge, background knowledge and usage of cognitive strategies such as summarizing, questioning and monitoring personal understanding help to assimilate key information to derive meaning from the text (Caccamise & Snyder, 2005).

For children with autism, reading with grasping the intended meaning of the text is particularly difficult. They have deficiencies in communication skills (Nation & Norbury 2005), struggles in a broad-spectrum of language areas (Tager-Flusberg & Joseph, 2003), challenges in verbal proficiencies (Mirenda & Erickson, 2000, pp.349–351) and problems in assimilating varied information in context of the material that they reading (Nation et al., 2006). Additionally, they are more literal in their interpretation of language activities (Tager-Flusberg, 1981) and are able to attend to reading comprehension questions that need factual answers. Children with autism had great difficulties in answering questions that require them to predict, deduce, or take perspective based on a given scenario (Griswold, Barnhill, Myles, Hagiwara & Simpson, 2002). However, reading comprehension expands beyond factual interpretations to ability to make inferences from the text.

The challenges that children with autism face corresponds to neuropsychological theories of theory of mind (Baron-Cohen, Leslie, & Frith, 1985), weak central coherence and weak executive functioning (Martin & McDonald, 2003). Their struggles with taking perspectives, understanding and predicting behaviours or expressions affect their ability to infer from a given text (Baron-Cohen et al., 1985). Weak central coherence limits their skills in drawing meaning from a particular context that require inferring capabilities (Martin & McDonald, 2003). The factor that helps one to adjust according to differing situations is executive function. To be proficient readers, children with autism need to adjust to varying scenarios in the text that they are reading with more flexibility (Martin & McDonald, 2003).

Motivation

Motivation M is another imperative component of the cognition reading process. The equation extends to T (D + Cp) + M. Besides capability, a competent reader needs the motivation to read. Children may be motivated to read for an external reward that they are anticipating or for sheer personal joy (Wigfield & Guthrie, 1997). Motivation to read can thus be termed as extrinsic or intrinsic motivation (Edmunds & Bauserman, 2006) respectively.

Children who have a choice to select their reading materials are more likely to focus better in reading (Worthy & McKool, 1996). In fact, utilizing self-determination strategy of choice making provides a sense of ownership and commitment to reading (Guthrie & Wigfield, 2000). Another key factor that boosts motivation to read is self-concept (Gambrell, Palmer, Codling, & Mazzoni, 1996). Children who are encouraged positively to read from early years will have a positive self-concept, including their views of reading mastery, the intricacy of reading, and their mind-set towards reading, and feel good about reading. They will in turn read more due to the affirmative stimulus as can be explained through the self-fulfilling prophecy. This will provide the pathway for these children to become effective readers.

A noteworthy inquiry using multiple regression analyses by Taboada, Tonks, Wigfield, and Guthrie (2009) reported statistically significant results while conceding with Pintrich's (2003) notion that internal motivation is the key enabler. They reckoned that internally motivated students are able to make rich connection with the text that they read whilst tapping on their repertoire of background knowledge.

Purpose of Reading

A reader does not read without an aim. Consequently, purpose P expands the equation into [T (D + Cp) + M] + P. Knowing about the purpose of reading helps a reader to focus, engage meaningfully and enhance concentration. **The reader reads a particular text with an end in mind to learn, expand knowledge and enhance his/her repertoire of vocabulary (Chia, 2007b).**

Background Knowledge

Besides the purpose of reading, a reader indubitably uses his/her prior knowledge B during the reading process. The cognitive equation broadens to B [T (D + Cp) + M] + P. The reader does not decipher every single word for its meaning when he or she reads, but processes the material in chunks and derive a bigger picture of what he or she reads. This is plausible as the reader uses his or her prior knowledge to gain meaning both consciously and sub-consciously. Background knowledge helps the reader to make predictions and synthesize the intent of the text (Salmero´n, Kintsch, & Can˜as, 2006).

Setting

Reading process takes place in a setting S (milieu) with varying conditions and the cognitive equation completes with S {B [T (D + Cp) + M] + P}. The reading process takes place within a particular domain such as the home or classroom and not in isolation. These environments may or may not nurture the reading process. Besides, the mood and experiences within these settings will vary depending on the purpose of reading, markedly, for formal assessment or for pleasure reading (Braunger & Lewis, 2001).

Thus far, we have expounded the entire equation **RP = S {B [T (D + Cp) + M] + P}** as mooted by Chia (2004, 2007 & 2010) for typical readers. The reading outcome (RO) will be contingent on *how well these factors (i.e., S, B, T, D, Cp, M and P) have been developed to play their respective parts* (Chia, 2007, p.7).

However, as the focus of our study was on readers with autism, we hypothesized that the cognitive equation of reading process for readers with autism would be very different from that for readers without autism. The various components of reading process that we chose to measure in our study include reading experience (RE), word reading (WR), sentence reading (SR), reading comprehension (RC) and reading attitude (RA). Hence, we modified the original cognitive equation of reading process put forth by Chia (2010) for the purposes of this study. The modified equation is as follows:

RP → RE {[WR (SR + RC)] + RA} → RO ...... *modified Chia's cognitive equation*

The omitted components in this new cognitive equation are S (Setting) and T (Thinking). It is difficult to measure Setting and Thinking. Furthermore, there is no known assessment tool to measure either of the two components.

Our proposed cognitive equation of reading process for students with autism is as:

RP → RE [(WR) (SR) + RC] + RA → RO …… *proposed/hypothetical cognitive equation*

Where   **RP**   is Reading Process
         RE   is Reading Experience (to replace Background Knowledge and Prior Experience of the Reader)
         WR   is Word Reading (also known as Word Recognition, to replace Decoding)
         SR   is Sentence Reading (also known as Contextualised Word Reading to extend Decoding)
         RC   is Reading Comprehension (same as Comprehension)
         RA   is Reading Attitude (to replace Motivation and Purpose)
         RO   is Reading Outcome

There is a slight difference between Chia's cognitive equation and our proposed cognitive equation. In Chia's (2010), WR correlates well with SR and RC, but SR does not correlate with RC. Also, RA stands apart from WR, SR and RC. Further, RE presumably correlates with WR, SR, RC and RA.

However, in our proposed cognitive equation for reading process, decoding is further divided into WR and SR – also known as contextualised word reading, where a sentence serves as a context to aid in deciphering of a new or unknown word. Together with RC, these three components form the core skills for the reading process. RE and RA are also included in the cognitive equation as important factors that can impact on the overall reading performance.

Reading attitude (RA) dissented further into two sub-categories: attitude towards recreational reading (ARR) and attitude towards academic reading (AAR). When both scores for ARR and AAR merged, they provided the overall percentile rank for the overall reading attitude (ORA) (see McKenna & Kear, 1990, for more details).

Focus of the Study: Students with Mild Autism in Mainstream Classrooms
More children with mild autism and Asperger syndrome are progressively educated in general education classrooms (Griffin, Griffin, Fitch, Albera, & Gingras, 2006). A similar trend is transpiring in Singapore. In 2004, the Prime Minister, Lee Hsien Loong, declared and unveiled the vision of the government in his inaugural speech, *Government that will be open and inclusive in its approach, toward all Singaporeans, young and old, disabled and able-bodied. ...* (Ibrahim, 2004). Thereafter, a hallmark step forward towards inclusion was seen when the Prime Minister urged for heighten mission to integrate those with mild disabilities into mainstream society, starting with the assimilation of students with mild disabilities into mainstream schools (Teo, 2004).

However, the challenges that students with autism face in acquiring reading mastery with understanding may affect their academic outcomes at the mainstream schools. Moreover, educators in the inclusive general classrooms are mostly uncertain on how to impart literacy skills to students with autism (Kluth & Darmody-Latham, 2003). In spite of these drawbacks, we envisage that students with autism can become adept at reading with well-targeted interventions in reading instruction as mooted by O'Connor and Klein (2004).

Purpose of Study
Studies from other regions (e.g., Nation et al., 2006; O'Connor & Klein, 2004) have explored only some of the proposed components in our reading equation. Also, analyses exploring the reading outcomes of students with autism are limited in Singapore. Particularly, no studies have investigated all the variables in the reading equation simultaneously or the reciprocal ways in which the different components interact in relation to the final reading outcomes.

Gaining insight about the different reading components and their effect on the reading outcomes of students with autism is of practical significance to special educators from mainstream and special schools in Singapore. Most importantly, distinguishing the patterns of students' strengths and difficulties in reading will certainly help us to ascertain the specific reading components that require interventions (Singer & Ruddell, 1985).

Method
Aims of the Study
The aims of this study were: firstly, to investigate how the following components of reading as a process – *reading experience, word reading, sentence reading, reading comprehension and reading attitude* – interact with and affect each other; and then to derive a cognitive equation for reading process in order to suggest appropriate interventions for students with autism.

Research Design
Since the study investigated the extent each of the five reading components corresponded with the others based on inter-correlation coefficients, we chose inter-correlational research design. The rationale behind the choice is twofold: firstly, the research method is most appropriate as these reading components are very complex and do not lend themselves to the experimental method and controlled manipulation (Isaac & Michael, 1997); and secondly, this research method permits the measurement of several reading components (variables) and their interrelationships simultaneously and in a realistic setting (Isaac & Michael, 1997; Schmidt & Launsby, 1994).

Participating Subjects
The participating subjects were 17 Primary 4 children (13 boys and 4 girls) diagnosed with autism. We selected the participants through convenience sampling as the latter were willing to partake in the study

and were readily available (Creswell, 2008). Moreover, convenience sampling allowed expeditious data collection. While we acknowledge that the subjects may not be representative of the entire population, this sample provides the essential information in addressing the purpose of our study.

The participants are currently attending mainstream primary schools in different parts of Singapore. Their parents belong to Help@AutismReality – an online parent support group for children with autism. Forty one parents emailed to express their interest to participate in the study. Among the 41 respondents, we selected only 17 children because of their age, average/above average intellectual ability and current level of mainstream primary education.

We obtained written parental consents. The children completed the entire reading assessment consisting of five reading measures at their respective residential homes in the presence of their parents over a period of three weeks.   We shared the test results with the parents of these children and gave them the relevant reports.

Instrumentation
We administered the following five formal reading tests:

Rating Scale of Reading Experience (Daniels & Diack, 1976)
This test is one part of the Standard Reading Tests (Daniels & Diack, 1960, 1976) and is the only test of its kind available in the world. It has since been out of print. The test can provide information about the participants' respective reading backgrounds and experience.

Although the instrument is not easily available, we managed to obtain the Rating Scale of Reading Experience that was norm-referenced on the British population in the 1960's and re-norm-referenced in the 1970's from the *Remedial Reading: A Handbook for Teachers* published in 1963 by the Guidance and Special Education Branch, Subiaco, Western Australia. The test-retest reliabilities given are in the range between .65 and .74.

Word Recognition and Phonics Skills Test-Second Edition (WRaPS-2) (Moseley, 2003)
The WRaPS-2 measured the participants' word recognition ability based on their word recognition standardized score expressed in terms of word recognition age equivalent, ten stages of word recognition and the length of a word that is recognized about 80 per cent of the time (Moseley, 2003).

The WRaPS-2 was chosen for test administration in this study because word recognition is *an important measure of children's developing knowledge about written language as well as the major route to meaning, a fundamental pre-requisite for comprehension* (Moseley, 2003:5). A second reason is that the WRaPS-2 provided a diagnostic profile of strengths and weaknesses in phonic skills which indicated whether the participants are sensitive to the appropriate range of cues at a given level of development.

The WRaPS-2 was standardized in 2002-3 on 4775 pupils in 111 schools, after extensive piloting to ensure good item discrimination and equivalence between Forms A and B. The internal consistency reliability of the test is very high, the overall Cronbach's (1951) alpha value being .97 in both Forms A and B. Even in the Reception year, where children are most likely to resort to guessing, the alpha values are .86 and .84. In addition, a word length score (WLS) was calculated to represent the length of word correctly recognized at least 80 per cent of the time. This too proves to be a reliable index, with an alpha value of .87. Its validity as a measure of progress in word recognition is confirmed because it is strongly correlated with performance on each test (r = .89 with Form A raw score and .93 with Form B).

Salford Sentence Reading Test-Revised (Vincent & Crumpler, 2002)
This updated, revised version of the Salford Sentence Reading test (Vincent & Crumpler, 2002) consists of Forms X and Y, each containing a series of 13 oral reading sentences of graded difficulty, designed to provide a quick and accurate measure of mechanical reading ability up to the age of 10 years 6 months. The graded sentence reading tests to which *the Salford provided a valid alternative gave reading ages up to 15 years of age, although, as Bookbinder (2000) pointed out, the actual tests in question were not directly standardised on samples or readers of such an age* (Vincent & Crumpler, 2002, p.2). The Salford manual reports correlations of .95 between Forms X and Y and predictive test-retest reliability of over .95.

GAP Reading Comprehension Test-Third Edition (McLeod, 1990)
This test determined the subjects' reading comprehension. This modified cloze test based on Taylor's (1953) cloze technique has proven to be a valid measure of reading comprehension and is more reliable and superior to conventional multiple-choice tests (Bormuth, 1967). Fries (1963), who identified three layers of language meanings, have showed the theoretical basis for the validity of the GAP Reading Comprehension Test (McLeod, 1990) that actually taps reading comprehension. They are meanings carried by the lexical items, meanings carried by the grammatical structures, and social-cultural meanings. Success in replacing words randomly deleted from passages relates to the first two layers and to some extent the third (McLeod, 1990).

According to the manual, *[R]eliabilities were calculated, using the split-half method, on samples of 250 children of three different age groups* (McLeod, 1990, p.3). Table 1 below shows the reliability coefficients.

Table 1: Reliability of the Revised GAP Tests (McLeod, 1990)

Year Group	Form B3 (Pre-Treatment)	Form R3 (Post-Treatment)
8+	.94	.91
9+	.90	.90
10+	.91	.92

Elementary Reading Attitude Survey (McKenna & Kear, 1990)
This chosen test for administration has *a pictorial format using the comic strip character Garfield with its natural appeal for children and because of its comprehensibility by the very young* (McKenna & Kear, 1990, p.627). It has two subscales: Recreational Reading and Academic Reading. Both subscales use the four-point rating scale with four points being best (Happiest Garfield) and 1 point being worst (Very upset Garfield).

The use of four points was grounded on an extensive body of research (e.g., Case & Khanna, 1981; Chi & Klahr, 1975; Nitko, 1983) suggesting that young children typically can discriminate among no more than five discrete bits of information concurrently. The measure *can be used to make possible initial conjecture about the attitudes of specific students, provide a convenient group profile of a class or a large unit, or serve as a means of monitoring the attitudinal impact of instructional programs* (McKenna & Kear, 1990, p.628).

A large-scale normative study involving 18,138 students in Grades 1 – 6, with the number of girls exceeded by only 5 the number of boys, was conducted in 1989. The proportion of Blacks (9.5%) was within 3% of the national proportion, while the proportion of Hispanics (6.2%) was within 2%.

Cronbach's alpha was calculated at each grade level for both subscales and for the composite score. These coefficients ranged from .74 to .89. It is interesting to note that there are only two exceptions, coefficients were .80 or higher for the Recreational Reading subscale at Grades 1 and 2. According to McKenna and Kear (1990), *it is possible that the stability of young children's attitudes towards leisure reading grows with their decoding ability and familiarity with reading as a pastime* (p.638).

Results of the 5 Reading Components (see Appendix 1)
Table 2 below depicts the summary of the results for RE, WR, SR, RC and RA (ORA):

Table 2. A Summary of Results of the 5 Reading Components

Components	RE	WR	SR	RC	RA (ORA)
Mean	124.06	138.59	137.65	101.65	17.35
SD	2.22	6.53	4.53	8.50	7.82
σ^2	4.93	42.63	20.49	72.24	61.12

Briefly, Table 2 shows the mean, standard deviation (SD) and variance for SD (σ^2) for each of the five components of the reading process. The mean RE age (in months) was 124.06 (SD=2.22; σ^2=4.93). Eight participants (47%) scored above the mean. Nine (53%) fell short of the mean. The mean WR age (in months) was 138.59 (SD=6.53; σ^2=42.63). Seven participants (41%) scored above the mean. Ten of them (59%) fell short of the mean. The mean SR age (in months) was 137.65 (SD=4.53; σ^2=20.49). Seven participants (41%) scored above the mean. Ten of them (59%) fell short of the mean. The mean RC age (in months) was 101.65 (SD=8.50; σ^2=72.24). Eight participants (47%) scored above the mean. Nine (53%) fell short of the mean. The mean RA percentile rank (based on the results of the overall reading attitude) was 17.35 (SD=7.82; σ^2=61.12). Nine participants (53%) scored above the mean. Eight (47%) fell short of the mean.

Inter-correlation Reliability Coefficients of the 5 Reading Components
Table 3 shows the inter-correlation Reliability Coefficients among the five components, i.e., RE, WR, SR, RC and RA, of reading process based on the results of this study.

Table 3. Inter-correlation Reliability Coefficients of the 5 Reading Components

	RE	WR	SR	RC	RA
RE	-	0.48	0.43	0.68	0.20
WR	0.48	-	0.91	0.82	0.27
SR	0.43	0.91	-	0.76	0.22
RC	0.68	0.82	0.76	-	0.06
RA	0.20	0.27	0.22	0.06	-

Reliability states the consistency and constancy of a measure. Cronbach Coefficient Alpha (Cronbach, 1951) measures internal consistency or reliability of a psychometric test score. Cronbach's alpha is a test reliability technique that requires only a single test administration, as in the case of this study, to give a unique estimate of the reliability for a given test. Cronbach's alpha will usually rise as the intercorrelations among test items increase, and hence is an internal consistency estimate of reliability of test scores. Table 4 provides a guide on Cronbach's Alpha Reliability Coefficient Index.

Table 4. Cronbach's Alpha Reliability Coefficient Index (George & Mallery, 2003)

Cronbach's alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Among the five components, the inter-correlation reliability coefficient $r = 0.91$ between WR and SR was very significant and showed a very strong positive relationship. That was followed by the inter-

correlation reliability coefficient $r = 0.82$ between WR and RC showing moderate reliability. The next to follow was the inter-correlation reliability coefficient $r = 0.76$ between SR and RC suggesting low reliability.

There was rather low reliability between RC and RE with $r = 0.68$. However, the inter-correlation reliability coefficients between WR and RE with $r = 0.48$ and SR and RE with $r = 0.43$ showed unacceptably low reliability.

The inter-correlation reliability coefficients between RA and each of the other four reading components were rather insignificant and showed unacceptably low reliability: between RA and RE with $r = 0.20$; between RA and SR with $r = 0.22$; and between RA and WR with $r = 0.27$. The most insignificant or poorest relationship noted was between RA and RC with $r = 0.06$. In other words, RA was least correlated with the other components of the reading process.

The inter-correlations among and between the five components of reading can be represented in the following Figure 3.

Figure 3. Inter-correlations among the Five Reading Components
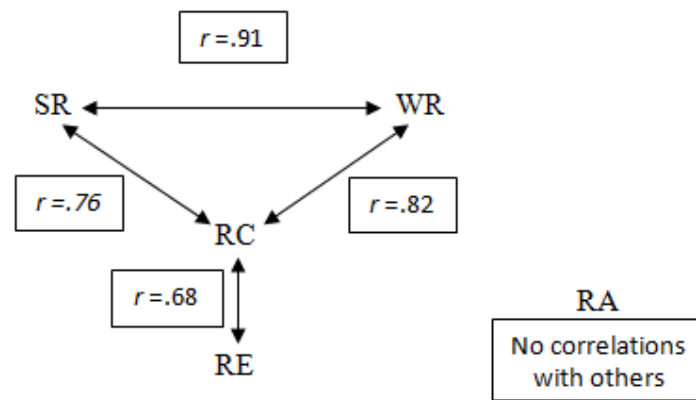
The inter-correlations among the five reading components can also be represented in the following cognitive equation:
RP → {RC [(WR) (SR) + RE] + RA} → RO …… *cognitive equation based on this study*
Where   RA   is Reading Attitude (to replace Motivation and Purpose)
           RC   is Reading Comprehension (same as Comprehension)
           RE   is Reading Experience (to replace Background Knowledge and Prior Experience of the Reader
           RO   is Reading Outcome
           RP   is Reading Process
           SR   is Sentence Reading (also known as Contextualised Word Reading to extend Decoding)
           WR   is Word Reading (also known as Word Recognition, to replace Decoding)

This cognitive equation for reading is very different from Chia's modified cognitive equation for neuro-typical readers without ASD as shown here:
RP → RE {[WR (SR + RC)] + RA} → RO ...... *modified Chia's cognitive equation*
It is also different from our proposed/hypothetical cognitive equation for readers with ASD as shown below.
RP → RE [(WR) (SR) + RC] + RA → RO …… *proposed/hypothetical cognitive equation*

Inter-correlation Reliability Coefficients of Reading Attitude
Within the RA component, the results suggested there were good inter-correlations, which range from .84 to .97, among its three constituent components: Attitude towards Recreational Reading (ARR), Attitude towards Academic Reading (AAR), and Overall Reading Attitude (ORA) (see Table 5).

Table 5. Inter-correlation Reliability Coefficients of the Reading Attitude

	ARR	AAR	ORA
ARR	-	0.84	0.97
AAR	0.84	-	0.94
ORA	0.97	0.94	-

Summary of the Results
Findings from this study suggested that Reading Attitude (RA) of the participating students with ASD did not appear to matter much on their performance in Reading Comprehension (RC). In fact, there was no reliable correlation with any of the other five reading components.

An interesting observation made in analysing the results was that Reading Experience (RE), which is often held as an important factor that would impact on the reading performance, did not correlate with Word Reading (WR) and Sentence Reading (SR), but it correlated with rather low reliability with Reading Comprehension ($r = .68$). However, Reading Comprehension (RC) correlated with Word Reading ($r = .82$) with moderate reliability and with Sentence Reading ($r = .76$), with low reliability. Both Word Reading and Sentence Reading correlated significantly with each other ($r = .91$).

Discussion
Correlation of Reading Attitude with the rest of the Reading Components
The inter-correlation reliability coefficients between Reading Attitude (RA) and each of the other four components were rather weak. The results of this study corresponded with findings from other studies (e.g., Colle, Baron-Cohen, Wheelwright, & van der Lely, 2008; Diehl, Bennetto, & Young, 2006) that showed that persons with autism face challenges in understanding narrative texts.

Narrative text may be particularly demanding for students with autism as it requires readers to interpret problems, find solutions and determine intents and views involving a whole chain of happenings and episodes pertaining to the plot of the story (Stein, 1986). The difficulties in attending to narrative text may be due to challenges in the development of theory of mind and inference skills (Colle et al., 2008).

Moreover, persons with autism (e.g., Grandin, 1995; Shore, 2000; Willey, 1999) have conveyed that their way of thinking is more literal than abstract. As such, non-fiction reading texts are easier to read than fiction texts which require 'abstract thinking' and 'out of the box' imaginative thought processes. Factual imagination results in imagining of facts (Chia, 2011a) which students with autism are adept at as they have strong visual memory.

Counterfactual imagination that depicts a scenario that has not happened but might with different permutations defy literal thinking (Chia, 2011a). According to Chia (2011a), children with autism have difficulties to generate options that are unconventional and different from reality due to inadequate counterfactual thinking. The counterfactual reasoning usually formulates when children partake in pretend play (Harris, 2000; Riggs & Peterson, 2000). However, this is an area of impairment in children with autism as they have challenges in untruthful belief activities (Baron-Cohen et al., 1985) and with pretend play (Wing, Gould, Yeates, & Brierley, 1977). In short, the difficulties that students with autism face in understanding narrative texts in turn affect their reading attitude.

Correlation between Reading Experience and Reading Comprehension
One of the important results is that Reading Experience (RE) correlated rather reliably with Reading Comprehension (RC) with $r = .68$. The results are in tandem with past studies which reported that reading comprehension can be enhanced when students' background knowledge and repertoire of reading experiences are effectively tapped (Carr & Thompson, 1996; Spires & Donley, 1998). Further, Carroll (1993) surmised that reading experience would inevitably increase vocabulary knowledge leading to a consequential effect on reading comprehension. Hence, in order for the students to have positive educational outcomes in schools, educators need to intervene and enhance their reading experiences to ensure better reading comprehension.

Correlation of Reading Comprehension with Word Reading and Sentence Reading
The results showed that Reading Comprehension (RC) correlated with Word Reading (r = .82) with moderate reliability and with Sentence Reading (r = .76) with low reliability. The findings of this research parallels to past studies (e.g., Nation et al., 2006; Patti & Lupinetti, 1993) that have reported the paradox of positive word reading with weak comprehension. Children with autism displayed strengths in single-word reading comprehension, for both abstract and concrete words (Eskes, Bryson, & McCormick, 1990). However, their degree of comprehension of the semantics of sentences is rather deficient as reflected in the results of this research study. These children have difficulty in integrating and synthesising text to understand the key message of a given text. The term 'hyperlexia' discussed earlier, where supreme decoding skills combined with poor comprehension is apparent in students with autism (Nation et al., 2006).

Yet, the reading comprehension abilities in these children are not totally deficient. Collectively, studies (e.g., Goldstein et al., 1994; Patti & Lupinetti, 1993) have reported a wide range of findings pertaining to reading abilities of children with autism that developed on a continuum. In general, decoding and reading comprehension were on a spectrum of performance scales with reading comprehension fairing below decoding skills (Snowling & Frith, 1986).

The participating children in this study are all currently studying in mainstream schools. In Singapore, children with mild autism are educated in mainstream schools. These children with average to above average intelligence are referred to as 'high-functioning' (Howlin, 2000) and tend to exhibit less acute deficits, especially in the area of language (Ozonoff, South & Miller, 2000). It is, therefore, not surprising that the results indicated Reading Comprehension (RC) as correlated with Word Reading with moderate reliability and with Sentence Reading with low reliability. This clearly indicates that children with autism who are presently studying in mainstream schools do not exhibit severe impairment in comprehension skills but that their comprehension skills are lower than word reading or sentence reading skills which matched earlier studies (Mirenda & Erickson 2000; Nation et al. 2006; O'Connor and Klein 2004).

Correlation between Word Reading and Sentence Reading
Word Reading and Sentence Reading correlated significantly with each other (r = .91). Congruent with past research (e.g., Grigorenko et al., 2003; Nation, 1999; Silberberg & Silberberg, 1967), children with autism are able to progress in the usage of phonemic structure of words and display an extraordinary obsession with letters and prints despite challenges in language and communication. Earlier researchers (e.g., Frith, 2003; Mayes & Calhoun, 2003a, 2003b; Nation et al., 2006) conceded that these students are adept at word reading. Good word reading would provide more opportunities for these students to gain higher levels of vocabulary and eventually sentence reading. Besides, results from neuroscience investigations have confirmed that children with autism are also able to manage text at the sentence level (Kana, Keller, Cherkassky, Minshew, & Just, 2006). Thus, timely interventions focusing on linguistic processing activities at the sentence level will facilitate children with autism in their learning in the mainstream schools.

Conclusion
Limitations of the Study
It was difficult to recruit 30 children with autism as initially proposed for sampling research (Creswell, 2008). Parents and schools were not receptive for their children and students respectively to partake in research. As a result, this study investigated a small number of students (N = 17) – selected based on convenience sampling – currently studying in mainstream schools. Hence, there is inherent sampling bias and this sample is not representative of the entire population comprising children with autism.

There is thus a need to generalize and infer about the whole population with caution. This is especially so given the heterogeneous pattern of reading skills in children with autism. Further study with a larger sample size is required to ascertain the external validity of the current findings.

Limitations of the Research Design
In order to measure complex variables (*reading components*) and their interrelationships concurrently, Isaac and Michael (1997) advocated employing correlational research design. However, they acknowledged the presence of the following limitations in using this study design (p.53): Firstly, it only identifies what goes with what – it does not necessarily identify cause-and-effect relationships. It is important to note that correlational research is not causal research. In other words, we cannot make

statements concerning cause and effect on the basis of this type of research. There are two major reasons why we cannot make cause and effect statements: The first reason is that we do not know the direction of the cause. The other reason is that there is a possibility of other variables' involvement which we are not aware. Secondly, it is less rigorous than the experimental approach because it exercises less control over the independent variables. Thirdly, it is prone to identify spurious relational patterns or elements which have little or no reliability or validity. Fourthly, the relational patterns are often arbitrary and ambiguous. Fifthly, it encourages a *shot-gun* approach to research, indiscriminately throwing in data from miscellaneous sources and defying any meaningful or useful interpretation.

Implications of the Study for Practitioners
The stated findings have practical implications for children with autism who have profiles similar to the 17 students in this study. To impart educational goals, educators need to take note of inherent abilities, cognitive and meta-cognitive abilities, sensory factors, adaptive behaviour capacities and socio-emotional behavioural abilities (Chia, 2007) of children with autism. These children will benefit from varied and comprehensive instructional interventions that match their literacy level (Mirenda, 2003). With better insight about the interactions among the five components in the cognitive equation for reading process for children with autism, we are able to propose specific interventions in relation to the components in the reading process.

Strategies to Promote Reading Experience
When children with autism have prior knowledge about a given text, they are more likely able to comprehend (Kintsch, 1998). These children do not have many opportunities to gain from experiences whether in school, home or community (Kluth & Chandler-Olcott, 2008). Educators can enhance background knowledge through various modes. Firstly, as children with autism are visual learners as explained by Grandin (1995), use of picture walks and visual maps promotes understanding (Harvey & Goudvis, 2000). American Speech-Language-Hearing Association (2006) recommends use of visual aids such as semantic maps and Venn diagrams to organize text and promote understanding. Secondly, providing content overview prior to reading (Colasent & Griffith, 1998) is a useful tool. Concrete titles and abstract can also help retrieve background knowledge (Wahlberg & Magliano, 2004).

Priming which is pre-practice has proven to be a valuable strategy to aid classroom learning of children with autism. Priming the background knowledge for a given reading text activates thinking process, since children gear towards linking to what they know to new data, details and information. Priming comprise reviewing salient information, data or activities that a child with autism will most likely face challenges before the task is presented (Wilde, Koegel, & Koegel, 1992). Priming lessens anxiety, promotes predictability and enhances the prospects of accomplishment and success (Myles & Simpson, 2003).

Providing opportunities to write scripts grounded on experiences from personal lives will develop reading experience (Staskowski & Creaghead, 2001). These scripts will create a pool of general and prior knowledge base that children with autism can retrieve when reading texts.

Strategies to Promote Reading Attitude
A positive experience with narrative text will enhance the reading attitude of children with ASD. They will benefit from shared book readings (Kamps, Barbetta, Leonard, & Delquadri, 1994). Repetitive and regular reading of texts will facilitate schema building that forms the cornerstone for positive narrative and expository text understanding (Englert & Hiebert, 1984; Mandler & Johnson, 1977). Shared book reading sessions can facilitate generalization through usage of everyday experiences that the children encounter.

Story retelling is another tool that can effectively harness the recognition of narrative schemas in a story (Roth & Baden, 2001), improve comprehension, organize oral narratives, and create positive reading attitude. Story retelling can be done creatively through use of visual cues like props, puppets, felt cutouts and pictures (Staskowski & Creaghead, 2001). As children with autism are strong in visual cognitive processing (American Speech-Language-Hearing Association, 2006; Lanter & Watson, 2008), educators can facilitate retelling of stories by dividing textual schemas and making them clear through visual aids and cues.

Strategies to Promote Word Reading and Sentence Reading Skills
One way to enhance word and sentence reading skills of children with autism is to encourage and stimulate phonological awareness. Many children with autism have innate abilities in sight word reading. They can effectively benefit from phonetic-analysis interventions and phonics instruction (Vacca, 2007). Phonics instruction teaches children to evaluate the structures of words and divide them into pronounceable sounds and syllables (Mastropieri & Scruggs, 2007). Hence, phonological awareness instruction in children with autism will facilitate word and sentence reading skills (Lanter & Watson, 2008).

Teaching approaches such as rhythm and movement, tactile letter recognition, alphabet books, word and letter sorts, and sight word recognition will also help to extend phonemic awareness skills in students with autism (Kluth & Chandler-Olcott, 2008). Grandin (1992a) mooted using associative letter-to-sound pictures to educate about grapheme-phoneme correspondences. Other studies (Eikeseth & Jahr, 2001; Fossett & Mirenda, 2006; Koppenhaver & Erickson, 2003) recommend picture-to-text matching. The linking of words to pictures strategy will expand sight word recognition, word reading and sentence reading.

Strategies to Promote Reading Comprehension
For children with autism to achieve successful educational outcomes in mainstream schools, strategies must be in place to assist them in Reading Comprehension, given the challenges that they face as discussed under literature review.

Children with autism tend to read through given passages rapidly with minimal pauses or rereading (O'Connor & Klein, 2004). Teachers working with these children need to develop text-monitoring skills in them. Think-aloud strategy is an effective tool to help students to make predictions, inquire, clarify and summarise (Baker, 2002; Gately, 2008; Lanter & Watson, 2008). Teachers can explicitly show to children with autism how the former derive meaning from text while they read. They can utilise the technique of supportive dialogue prior to, during and after reading. They can explain how they retrieve their background knowledge in order to infer by associating the text to their experiences. Moreover, they can also read the text aloud and model their own thinking process while reading. In order to demonstrate effective comprehension techniques, teachers can halt where necessary while reading the text to share specific ideas, meanings or thoughts.

Another way to enhance reading comprehension skills in children with autism is to use concrete poems (Chia, 1995, 1996b, 2009; Poh, 2009). The poems are articulated using letters that are visually depicted, arranged, and, even coloured. These pictures help those with autism and specifically hyperlexia to make links between the target word and its symbolism. O'Connor and Klein (2004) together with Wahlberg and Magliano (2004) found that text comprehension in children with autism can be improved with the technique of cueing to recall prior knowledge and working out the anaphora.

Graphic cues with the aid of visually cued instruction may improve reading comprehension (Quill, 1997). This is because visually cued instruction can tap on the strengths of children with autism. Mirenda (2003) recommended integrating multiple instructional approaches according to the stages of literacy progress of children with autism. These can include games, differentiated activities and use of technology. Similarly, Moore and Calvert (2000) suggested earlier that the use of information and computer technology tools like animations and graphics could enhance the interest and motivation of children with autism to learn vocabulary.

Further, to improve reading comprehension, Broun (2004) proposed that print materials should match as close as possible to experiences of children with autism. This will assist them to comprehend the text better. Besides, employing strategies like graphic organisers, concept maps and mind-maps could assist in comprehension. Additionally, Faggella-Luby and Deshler (2008) performed a review of interventions and reported that reading comprehension develops positively when readers explicitly learn specific tactics. These include triggering experiences and background knowledge, summarizing the gist of the text and using questioning techniques.

Finally, to harness their special interest, teachers could provide text that will invoke the children's personal interest and motivation. Nonetheless, these special interests should encompass age and socially appropriate texts (Kluth & Darmody-Latham, 2003).

Recommendations for Future Studies
To address the limitations in the current research design, we recommend multiple regression analyses for future studies in this area. This is to show causality and the extent of the relationship among the 5 components in the cognitive reading process. Multiple regression analyses would allow us to examine more sophisticated research hypotheses pertaining to the relationship of the 5 components in the cognitive reading process. Moreover, that also would provide us the flexibility of better analysis of the varied components in the cognitive reading process.

Qualitative data using semi-structured interview with the 17 participating children would provide the opportunity to explore the extent and nature of the children's feelings and thoughts about reading. The findings would certainly substantiate the data from this inter-correlational research.

Both quantitative and qualitative data collection methods may be utilised in future studies to promote the data triangulation of the methods. This will provide comprehensive and holistic data on the relationships among the five components of the reading process (Creswell, 2008).

Still, while planning and implementing the interventions, it is essential to bear in mind the heterogeneous pattern of reading skills in children with autism.

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Appendix 1
Results of the 5 Reading Components

Subjects (N = 17)	Chronological Age (in years & months)		Reading Experience (in years & months)		Graded Word Reading (in years & months)		Sentence Reading (in years & months)		Reading Comprehension (in years & months)		Reading Attitude (in %ile rank)		
	Yrs:Mths	Mths only	Yrs:Mths	Mths only	Yrs:Mths	Mths only	Yrs:Mths	Mths only	Yrs:Mths	Mths only	ARR	AAR	ORA
S1M	9:10	118	10:03	123	10:11	131	11:01	133	8:03	99	13	36	20
S2M	10:03	123	10:06	126	11:08	140	11:07	139	9:03	111	17	36	23
S3M	10:06	126	10:03	123	12:06	150	12:02	146	9:08	116	9	26	13
S4F	9:08	116	10:00	120	11:05	137	11:03	135	7:06	90	13	36	20
S5M	9:11	119	10:01	121	10:10	130	11:02	134	7:03	87	5	18	7
S6M	10:05	125	10:04	124	11:11	143	12:00	144	8:06	102	26	41	31
S7M	10:07	127	10:09	129	12:01	145	11:09	141	9:03	111	17	36	23
S8F	10:01	121	10:05	125	11:06	138	11:08	140	8:08	104	9	22	11
S9F	9:09	117	10:04	124	10:11	131	11:03	135	8:01	97	9	26	13
S10M	9:08	116	10:03	123	10:09	129	11:00	132	7:04	88	13	36	20
S11M	10:02	122	10:05	125	11:05	137	11:02	134	8:02	98	21	41	28
S12M	10:07	127	10:06	126	12:06	146	11:11	143	9:03	111	3	26	8
S13M	10:04	124	10:01	121	11:07	139	11:05	137	8:02	98	17	31	20
S14M	10:05	125	10:03	123	11:01	133	10:11	131	8:03	99	5	22	8
S15F	10:01	121	10:05	125	11:05	137	11:04	136	8:05	101	3	22	7
S16M	10:08	128	10:06	126	12:05	149	11:11	143	8:11	107	26	36	28
S17M	10:03	123	10:05	125	11:09	141	11:05	137	9:01	109	9	31	15
Mean		122.24		124.06		138.59		137.64		101.65	12.65	30.71	17.35
Standard Deviation		3.95		2.22		6.53		4.53		8.50	7.25	7.23	7.82
Variance (SD)		15.57		4.93		42.63		20.49		72.24	52.49	52.22	61.12

Key: M=Male; F=Female; ARR=Attitude towards Recreational Reading; AAR=Attitude towards Academic Reading; ORA=Overall Reading Attitude