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Relations between awareness of morpho-syntactic structures in Chinese compound words and reading abilities: a short report

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Abstract

This is a short report of an experiment conducted to investigate the relationship between awareness of morpho-syntactic structures in Chinese compound words and reading abilities on 268 fourth graders studying in three mainstream schools in Shenzhen. All children were assessed using reading tasks and cognitive tasks including rapid automatized naming, phonological awareness, orthographic awareness and morphological awareness. A compound production task using pseudo complex compound words with different morpho-syntactic structures in the first and second levels as stimuli was also conducted. Results of ANOVA indicated that main effect of first level morpho-syntactic structures, main effect of second level morpho-syntactic structures and interaction effects between the two were all significant. Children's awareness of different morpho-syntactic structures were observed to be affected by frequency of usage of individual morpho-syntactic structures in the language. Results of hierarchical regression analyses revealed that the awareness of morpho-syntactic structures in Chinese compound words is strongly associated with Chinese reading abilities. Theoretical and clinical implications were discussed.

Keyword
Morphological awareness, Chinese, Reading, Morpho-syntax

Background

Learning to read is an important task that children have to master in school. Better reading abilities not only allow one to gain better academic achievements, but also enable individuals to learn new things and to communicate effectively with others. Difficulties in learning to read results in serious academic, psychological, social, and financial impacts on individuals (Gibson & Kendall, 2010; Glazzard, 2010; Snowling, Adams, Bowyer-Crane, & Tobin, 2000).

Deciphering how children learn to read has become a major research direction in the last few decades. One approach has explored different cognitive abilities that are essential to learning to read (e.g., Carlisle & Nomanbhoy, 1993; Lau, Leung, Liang, & Lo, 2015; McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003; Nagy, Berninger, & Abbott, 2006; Tong & McBride-Chang, 2010; Wang, Yang, & Cheng, 2009). It has been reported that metalinguistic awareness such as phonological awareness (Goswami, 2002; Mimran, 2006), orthographic awareness (Ho, Chan, Lee, Tsang, & Luan, 2004), and morphological awareness (Casalis, Colé, & Sopo, 2004; Nagy, Berninger, & Abbott, 2006) are essential to learning to read. Other cognitive skills such as rapid automatized naming (RAN) (Manis, Seidenberg, & Doi, 1999; Wolf, 1997) and visual perceptual skills (Ho, et al., 2004) are also important in learning to read. In general, phonological awareness and RAN are essential in predicting the reading abilities of individuals learning to read transparent scripts (Manis, et al., 1999). On the other hand, morphological awareness and orthographic awareness are better predictors of opaque script reading abilities (Ho, et al., 2004; Lau, et al., 2015; McBride-Chang, et al., 2003).

Morphological awareness refers to the "knowledge about the pairing of sound and meaning in a language and the word formation rules that guide the possible combination of morphemes" (Kuo & Anderson, 2006, p. 161). Given its critical role in predicting reading abilities among children, researchers have used different tasks to measure morphological awareness so as to truly reflect the morphological awareness possessed by children at different ages. To facilitate the understanding of different measures of morphological awareness, a brief review of morphology is essential.

Morphology is the study of morphemes, the smallest units in language that carry meaning. For example, there are three morphemes in the English word "unchangeable"—the prefix "un-", the stem word "change", and the suffix "-able"—and each morpheme contributes part of the meaning of the whole word. Morphemes can be classified as free morphemes and bound morphemes based on whether or not the morphemes can be used alone as words. Free morphemes can be used alone as word (e.g., "cry", "forgive"), while bound morphemes cannot (e.g., "re-", "-ness"). Morphemes, therefore, are the basic building blocks for constructing words.

Words can be categorized into two types, namely monomorphemic, consisting of one morpheme only (e.g., "dinner", "lady"), and multimorphemic, consisting of more than one morpheme (e.g., "winner", "salesman"). Multimorphemic words are constructed in terms of inflections, derivations, and compounding (Carlisle, 2003). Inflectional morphology refers to marking grammatical functions on word stems according to syntactic rules (e.g., adding "-s" to nouns as a plural marker and adding "-ed" to regular verbs as a past tense marker). Derivational morphology adds morphemes to a base morpheme to change its part of speech or meaning (e.g., adding the morpheme "-ment" to the base word "improve", changing it from a verb to a noun). Compounding involves the combination of two or more words to form new words (e.g., joining the words "fire" and "arm" to form the new word "firearm").

The morphology of Chinese is a bit different from that in alphabetic languages. In most cases, one syllable corresponds to one morpheme. For example, the Chinese word 月餅盒, *jyut6 beng2 hap2*, "mooncake box" consists of three morphemes: the first morpheme 月, *jyut6* means "moon"; the second morpheme 餅, *beng2* means "cake"; and the third morpheme 盒, *hap2* means "box". Under this construction, Chinese words can be either monomorphemic (e.g., 頭, *tau4*, "head"; 牛, *ngau4*, "cow") or multimorphemic (e.g., 頭髮, *tau4 faat3*, "hair"; 牛肉, *ngau4 juk6*, "beef"). The three word-formation rules, namely inflection, derivation, and compounding, are also employed in constructing Chinese words. An example of a Chinese inflected word is 他們, *taa1 mun4*, "them", in which the suffix 們, *mun4* (plural marker) is attached to the pronoun 他, *taa1*, "he". An example of a Chinese derived word is 電腦化, *din6 nou5 faa3*, "computerize", in which the grammatical marker 化, *faa3* is added to the noun 電腦, *din6 nou5*, "computer" to convert it into a verb. Finally, an example of a Chinese compound word is 頭痛, *tau4 tung3*, "headache", in which the morpheme 頭, *tau4*, "head" is simply connected to the morpheme 痛, *tung3*, "ache" to form the compound word.

It has been reported that inflectional morphology and derivational morphology are highly productive word-formation rules in English, while compounding is highly productive in forming new words in Chinese (Kuo & Anderson, 2006). Compounding is such a productive word-formation rule in Chinese that morphemes can also be attached to compound words to form new complex compound words. For example, 月餅盒, *jyut6 beng2 hap2*, "mooncake box" is a complex compound word, as the compound word 月餅, *jyut6 beng2*, "mooncake" is connected with the morpheme 盒, *hap2*, "box" to form the complex compound word 月餅盒, *jyut6 beng2 hap2*, "mooncake box".

Different morphosyntactic structures of compound words in Chinese govern the semantic relationship between the morphemes in compound words. The most common types of morphosyntactic structures, in descending order of frequency of occurrence in the language, are modifier-head, subject-predicate, coordinative, verb-object, and verb-complement. Examples of each morphosyntactic structure are given in Table 1 below.

Insert Table 1 about here.

Different morphosyntactic structures may be combined to form complex compound words. For example, the complex compound word 地震帶, *dei6 zan3 daai3*, "seismic belt" is a modifier-head first-level structure, in which the compound word 地震, *dei6 zan3*, "earthquake" modifies the head noun 帶, *daai3*, "belt". The compound word 地震, *dei6 zan3*, "earthquake", on the other hand, is a subject-predicate second-level structure, where the morpheme 地, *dei6*, "earth" is the subject and the morpheme 震, *zan3*, "quake" is the predicate.

In short, compounding is the most productive word-formation rule in constructing words in Chinese, but the morphosyntactic structures can be sophisticated. Morphological awareness of Chinese compound words, including awareness of morphemic meanings in compound words and the ability to parse and manipulate morphosyntactic structures in compound words, is essential for children in learning new words.

Measures of Morphological Awareness in Chinese

The most widely used tasks to measure morphological awareness in Chinese reported in the literature are the homophone awareness and the morphological construction tasks (McBride-Chang et al., 2003). The homophone awareness task is usually conducted in the form of an odd-man-out task. In each trial, children are presented with a sequence of three bisyllabic words containing homophonous characters (e.g., 紙杯, *zi2 bui1*, "paper cup"; 紙袋, *zi2 doi2*, "paper bag"; 指甲, *zi2 gaap3*, "fingernail") and are asked to identify the one that differs in its constituent morpheme from the other items. In order to successfully identify that 指甲, *zi2 gaap3*, "fingernail" is different from the other two bisyllabic words, the children must be aware that although 紙, *zi2*, "paper" and 指, *zi2*, "finger" are homophonous, they refer to different morphemes. The homophone awareness task, therefore, assesses children's awareness of morphemic meanings in compound words.

The morphological construction task is a production task. In each trial, children must construct a pseudo-compound word using morphemes based on an analogy given (e.g., ''綠色的葉子叫做「綠葉」，那白色的葉子叫甚麼？'', "Leaves that are green in color are called green leaves. Then, what do we call leaves that are white in color?"). In order to choose the correct answer (白葉, "white leaves"), the children must be aware of the morphemic meanings in the compound words together with the ability to imitate the morphosyntactic structures in the example given.

To further assess children's abilities in manipulating different morphosyntactic structures in compound words, Liu & McBride-Chang (2010) modified the morphological construction task by removing the sample morphosyntactic structures in the questions and adding different morphosyntactic structures for the target stimuli. They called this task "compounding production." The morphosyntactic structures used in their target stimuli included modifier-head, coordinative, subject-predicate, and verb-object. They reported that third graders studying in mainstream schools in China showed awareness of these morphosyntactic structures. Furthermore, they reported that the children's scores on the compounding production test uniquely predicted their Chinese reading abilities. They further suggested that this task, which offered minimal clues to the children, is more suitable for older children to avoid the ceiling effect.

The Current Study

In the current study, we tested a group of fourth graders using a compound production task that involved complex compound words with or without conflicting morphosyntactic structures in the first and second levels as the stimuli. Instead of merely increasing the level of difficulty in the morphological awareness task, the aim was to investigate how Chinese children developed their awareness of morphosyntactic structures in compound words. In the first-level structure, the most frequently occurring structure (i.e., modifier-head) was used. The pseudoword stimuli were constructed in the structure of either a disyllabic modifier-head or a modifier-disyllabic head. In the second-level structure, the two most frequently occurring structures (i.e., modifier-head and subject-predicate) were used. Using a 2 (first-level structure) x 2 (second-level structure) design, the factors that affected the children's awareness of morphosyntactic structures were investigated.

Method

Participants

A total of 268 Grade 4 children (gender balanced, mean age = 9.77 years) studying in three different mainstream schools in Shenzhen were recruited. All of the children had achieved normal academic performances in their respective schools.

Tasks

The tasks used to assess the participants' cognitive abilities and the corresponding measurements obtained are described below.

Raven's Standard Progressive Matrices (Raven, 1986). Based on 60 multiple-choice questions, this task involved the identification of missing items that could be substituted in a logical pattern in the form of a 4x4, 3x3, or 2x2 matrix.

Chinese reading abilities. The participants' accuracy in naming 180 Chinese two-character words with frequencies of occurrence ranging from low to high[1] was obtained.

Rapid automatized naming (RAN). This timed digit-naming task was comprised of seven rows of five digits (2, 4, 6, 7, and 9) arranged in different orders on A4 paper as the stimuli, and the participants' average time required to name all the digits over two trials was obtained.

Phonological processing. Three tasks were used to assess the phonological processing abilities of the participants.

- **Rhyme awareness task.** In this odd-man-out task, 18 trials were prepared. In each

[1] The frequency of occurrence of the Chinese characters used in the current study was based on the counts in school textbooks published by Renmin Jiaoyue Publisher.

trial, the participants were presented with a sequence of three monosyllabic words and were asked to identify the one that differed in rhyme from the other items.

- **Onset awareness task.** In this odd-man-out task, 14 trials were prepared. In each trial, the participants were presented with a sequence of three monosyllabic words and were asked to identify the one that differed in onset from the other items.
- **Syllable deletion task.** In this task, 15 trials were prepared. In each trial, the participants were asked to identify the product of a deleted target syllable in a trisyllabic word (e.g., "「月餅盒」唔講個「餅」字係咩?", "how to say", *jyut6 beng2 hap2*, "without the" *beng2*?)

Orthographic awareness task. This pencil-and-paper lexical decision task was comprised of 50 characters, including five non-characters with mirror-image radicals, five non-characters with mirror-image logographemes, five non-characters with radicals at illegal positions, five non-characters composed by joining two phonetic radicals, five non-characters composed by joining two semantic radicals, and 25 real characters that shared the same internal components with the non-characters. All of the characters were arranged in random order on five pages of A4 paper, and the participants' accuracy in lexicality judgment for each printed character was obtained.

Homophone awareness task. In this odd-man-out task, 20 questions were prepared. For each question, the participants were presented with a sequence of three bisyllabic words containing either homophonous (e.g., 紙杯, 紙袋, 指甲) or homographic (e.g., 足球, 足夠, 足跡) characters and were asked to identify the one that differed in its constituent morpheme from the other items.

Compounding production task. In this task, 40 trisyllabic pseudowords were prepared. A 2 (first-level structure) x 2 (second-level structure) design was used. In the first-level structure, half of the stimuli had a structure of disyllabic modifier-head and the other half had a structure of modifier-disyllabic head. In the second-level structure, half of the stimuli had a structure of modifier-head and the other half had a structure of subject-predicate. Examples of each condition are shown in Table 2 below. For each question, the participants were asked to construct a pseudo-compound word based on the description of the meaning of the target word (e.g., "「强烈的泥沙降落下来」, 我們叫它甚麼?", "What do we call the heavy fall of sand?").

Insert Table 2 about here.

The participants were tested individually in a quiet room in their respective schools. On average, each participant finished all of the tasks within two hours. Between each task, the participants were given breaks of three to five minutes to prevent them from becoming overwhelmed by the tasks.

Results

Compounding Production Task with Complex Compound Words

A 2 (first-level structure) x 2 (second-level structure) ANOVA was conducted on the data obtained from the compound production task. The main effect of the first-level structure was significant ($F(1) = 128.9$, $p < .001$). As shown in Figure 1 below, the participants performed better on pseudowords with the disyllabic modifier-head structure than pseudowords with the modifier-disyllabic head structure.

Insert Figure 1 about here.

The main effect of the second-level structure was significant ($F(1) = 127.2$, $p < .001$). As illustrated in Figure 2 below, the participants performed better on modifier structures than on subject-predicate structures in the second level. The interaction effect was also significant ($F(1) = 84.1$, $p < .001$).

Insert Figure 2 about here.

The results of the post-hoc analysis using the Tukey HSD test showed that the participants' scores were significantly lower than those where the disyllabic heads were in the subject-predicate structure (see Figure 3 below).

Insert Figure 3 about here.

Relationship between the Compounding Production Task and Reading Ability

The results of the correlations among all measures using *Pearsons r* are summarized in Table 3 below. The results show that all the cognitive measures, including phonological awareness, orthographic awareness, morphological awareness, and RAN, were significantly correlated with reading ability.

Insert Table 3 about here.

To further investigate the unique contribution of the participants' compound production performances to their reading abilities, a hierarchical regression analysis was conducted. The results are summarized in Table 4 below. As shown in Table 4, the compounding production task uniquely predicted the participants' reading abilities even after phonological awareness, orthographic awareness, RAN, and homophone awareness were entered into the regression.

Insert Table 4 about here.

Discussion

The participants' performance in the compounding production task yielded interesting results. The significant main effect of the first-level structure, in which the participants showed better performance on the disyllabic modifier-head structure compared with the modifier-disyllabic head structure, indicated that processing compound words is more than simply concatenating the meanings of the constituent morphemes. This observation suggests that awareness of morphosyntactic structures is an important facet in the sophisticated morphological awareness of Chinese.

Regarding the observation of a significant main effect of the second-level structure, in which the participants showed a better performance on the modifier-head structures compared with the subject-predicate structures, there are two possibilities for these results. The first possibility is that the participants found the conflicting morphosyntactic structures in the first and second levels to be particularly more difficult. Although there were two conditions in the first-level structures, the stimuli in both conditions were modifier-head first-level structures. Therefore, it is possible that when different morphosyntactic structures were used in the first and second level structures, the participants found it difficult to process the words. Alternatively, it is also possible that the participants' performance was affected by the frequency of usage of the two morphosyntactic structures in the language (Tomasello & Tomasello, 2009). The participants may have found that it was easier to process the modifier-head structure, which is the most frequently used morphosyntactic structure in Chinese, compared with the relatively less frequently used subject-predicate structure. The results of the interaction effect verify these two possibilities.

The results of the interaction effect showed that the participants performed significantly worse on compound words with the modifier-disyllabic head structure when the disyllabic head was in the subject-predicate structure. If the participants' processing of compound words was simply affected by the conflicting morphosyntactic structures in the first and second level structures, this should have resulted in poorer performances in processing compound words with the disyllabic modifier-head structure, where the disyllabic modifiers were in the subject-predicate structure. However, the absence of such an observation rejects the first possibility. Instead, it is highly likely that the participants' processing of morphosyntactic structures of compound words was affected by the frequency of usage of the individual morphosyntactic structures. In other words, the findings from the current study provide support for the usage-based account of language learning (Tomasello & Tomasello, 2009).

Finally, the results of the hierarchical regression analyses echoed the findings that higher-level explicit awareness of morphosyntactic structures in compound words uniquely predicted the participants' reading abilities after controlling for other cognitive predictors, including RAN, phonological awareness, orthographic awareness, and homophone awareness (Liu & McBride-Chang, 2010). It is suggested that future studies investigating Chinese reading development and disorders should not overlook the importance of awareness of morphosyntactic structures in compound words. More studies in this area should help in understanding why and how awareness of morphosyntactic structures in compound words is associated with Chinese reading abilities.

Clinical Implications

The results of the current study indicate a strong association between awareness of morphosyntactic structures in compound words and Chinese reading abilities. Children with poorer awareness of morphosyntactic structures in compound words are probably more prone to developing poorer reading abilities in Chinese. Therefore, the compounding production task used in the current study may serve as a good screening tool to identify older children at risk of developing late-emerging reading difficulties in Chinese (Leach, Scarborough, & Rescorla, 2003). Future studies in this area will help to verify the diagnostic accuracy of this task.

Conclusion

The current study briefly reported the strong association between awareness of morphosyntactic structures in compound words and Chinese reading abilities. It is suggested that this morphosyntactic awareness, as an important facet in the sophisticated morphological awareness of Chinese, should be emphasized in future studies of Chinese reading development and disorders. A detailed analysis of the participants' performance in the compounding production task indicated that their awareness was possibly affected by the frequency of usage of individual morphosyntactic structures in the language. Further studies will be needed to confirm this hypothesis.

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Table 1
Examples of different morpho-syntactic structures of Chinese compound words

Morpho-syntactic structures	Examples
Modifier-head	白馬 /baak6 maa5/ [white horse]
Subject-predicate	地震 /dei6 zan3/ [earthquake]
Coordinating	東西 /dung1 sai1/ [stuffs]
Verb-object	拍手 /paak3 sau2/ [clap hands]
Verb-complement	撞低 /zong6 dai1/ [knock down]

Table 2

Examples of pseudoword stimuli in each condition of the 2 X 2 design

	Second level structures	
First level structures	Modifier-head	Subject-Predicate
Disyllabic modifier – head	長嘴樹 [long-beak-tree]	聲輕人 [voice-soft-man]
Modifier – Disyllabic head	土飯碗 [muddy-rice-bowl]	強沙降 [heavy-sand-fall]

Table 3
Pearson *r* correlations among all variables

Measures	1	2	3	4	5	6	7
1. Chinese Word Reading	--						
2. Rhyme awareness	.354**	--					
3. Onset awareness	.224**	.691**	--				
4. Syllable deletion	.225**	.529**	.515**	--			
5. Homophone awareness	.258**	.378**	.398**	.164**	--		
6. Compounding production	.322**	.439**	.379**	.224**	.296**	--	
7. Orthographic awareness	-.218**	-.094	-.107	-.026	-.039	-.063	--
8. RAN	-.453**	-.335**	-.294**	-.283**	-.146*	-.203**	.053

* $p < .05$, ** $p < .01$

Table 4

Hierarchical Regressions Explaining Chinese reading abilities

Block and variable	R^2	R^2 change
1. Raven, Age	.004	.004
2. RAN	.220	.216***
3. Rhyme awareness Onset awareness Syllable awareness	.369	.149***
4. Orthographic awareness	.392	.023**
5. Homophone awareness	.404	.012*
6. Compounding production	.413	.009*

* $p < .05$, ** $p < .01$, ** $p < .001$

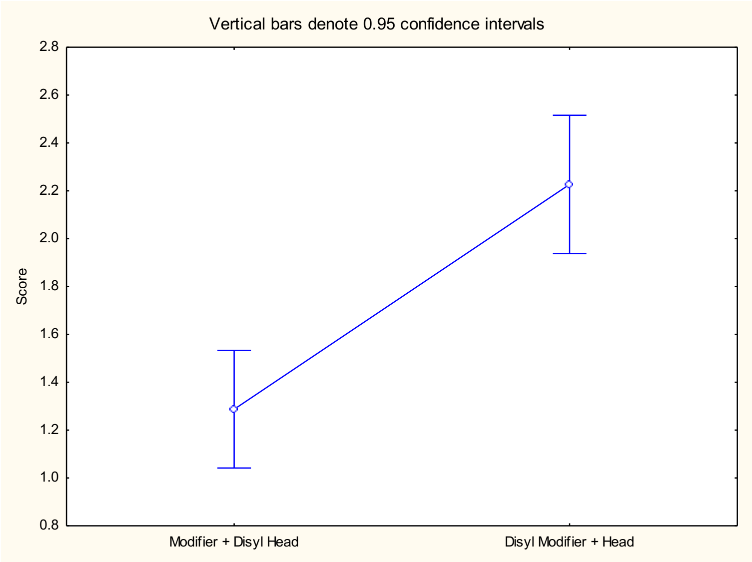

Figure 1. Main effect of first level structure

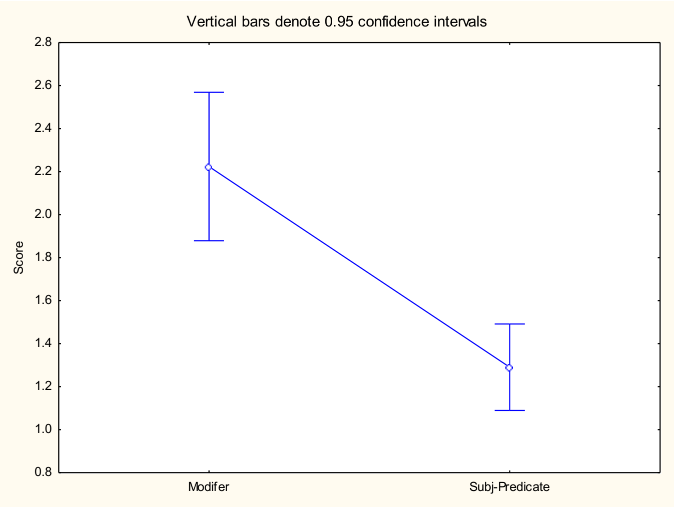

Figure 2. Main effect of second level structure

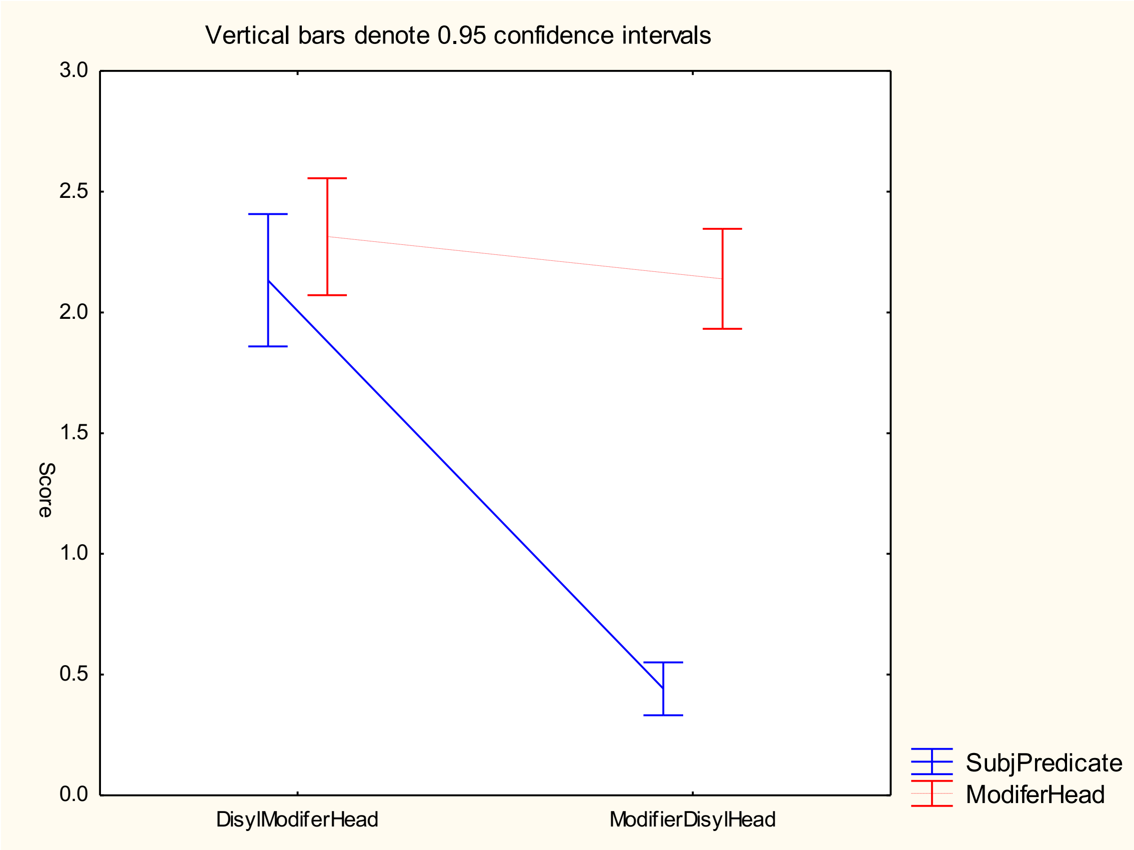

Figure 3. Interaction effect between first and second level structures