Lexical Context Effects on Speech Perception in Chinese People with Autistic Traits

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Abstract

One theory (weak central coherence) that accounts for a different perceptual-cognitive style in autism may suggest the possibility that individuals with autism are less likely to be affected by lexical knowledge on speech perception. This lexical context effects on speech perception has been evidenced by Ganong (1980) by using word-to-nonword identification test along a VOT dimension. This Ganong effect (which suggests that people tend to make their percept a real word) can be seen as one kind of central coherence. However, the boundary of the VOT contrast in Chinese is different from English, so the present study firstly explores the Ganong effect in Chinese and then adopts this effect in a neurotypical population of Chinese with different degrees of autistic traits in order to test the hypothesis. Seventeen graduate students of Chinese from Taiwan took part in the present experiment with the Autism-Spectrum Quotient (AQ) as their index of autistic traits and word-to-nonword identification task (die2-tie2 and tiao2-diao2). Other factors, such as auditory sensitivity and slower lexical access that may potentially influence reduced lexical context effects in autism are considered. The result indicated that Ganong effect was significant in Chinese as well and an inverse relationship between the identification shift (Ganong effect) and one of the subsections of AQ ('attention to detail') was significant. The AQ score or word-to-nonword identification task did not correlate with scores on tasks (that examined auditory sensitivity and slower lexical access). It suggested that those extraneous factors can be ruled out.

1. Introduction

1.1 Background information

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by a triad of deficits in socialization, communication and imagination (American Psychiatric Association, 1994; Wing and Gould, 1979). Although genetic factors play an important role in autism (Smalley, et al., 1988), the diagnosis of autism is currently still made by behavioral criteria. Understanding the nature of cognitive processes that may cause these behaviors in autism has been one of the primary purposes of study on autism over the last decades. Many psychological accounts have appeared to provide potential explanations on the nature of autism. In recent decades, three accounts are noted to explain different aspects of autism: a theory-of-mind deficit (Baron-Cohen, Leslie, and Frith, 1985; Baron-Cohen, 1989b), executive dysfunction (Pennington and Ozonoff, 1996; Russell, 1997) and a weak central coherence (Frith, 1989b; Frith and Happé, 1994).

Taken these three separate psychological accounts together (theory of mind, executive dysfunction and weak central coherence), they have given us a better understanding of the nature of Autism Spectrum Disorder. For example, a theory-of-mind account suggests that autistic individuals have impairment in the development of social cognition and it can also explain many of the behavioral symptoms of autism in social, communicative and imaginative activities (Jarrold, Bulter, Cottington and Jimenez, 2000). Despite the fact that theory of mind hypothesis can account for many of a triad of deficits, it struggles to offer the explanation of some characteristics of autism: repetitive behaviors and a preference for stereotyped routines. Executive dysfunction has been proposed to explain this aspect of the impaired behaviors (Turner, 1997; Jarrold, 1997). This is the failure to regulate or control one's own acts so that autistic individuals reproduce repetitive behaviors and show bias for stereotyped routines. In addition, people with autism present more difficulties in switching from previous attention to anything else also due to this lack of control or regulation of behavior at will (Ozonoff, Pennington and Rogers, 1991).

In addition to those two psychological accounts (theory of mind and executive dysfunction) which characterize the aspects of a triad of impairments and control of action in autism, recent research has put its focus on an aspect of exceptional feature shown in autism: the assets in this disorder. People with autism present savant skills in math, music and drawing (Happé, 1999). One theory, weak central coherence (WCC) claims that these savant skills shown in autism result from their different perceptual-cognitive processing style. Individuals with autism tend to show a local bias for incoming information processing (Frith, 1989b). This preference for local bias becomes a superiority shown in autistic individuals when they are asked to do the tasks that require the detail-focusing processing; however, it would be the deficit when the tasks need the global meaning in context.

Weak Central Coherence (WCC) has received a number of empirical evidence, including resilience to visual illusion (Happé, 1996), high rate of absolute pitch (Heaton, Hermelin and Pring, 1998) and high accuracy in Embedded Block Task (Shah and Frith, 1983). Weak Central Coherence has also been shown in linguistic tasks in which people with autism do not tend to use semantic context to decide the pronunciation of ambiguous homographs (Happé, 1997) or sentences (Jolliffe, Baron-Cohen, 1999). These existing findings imply that the local-context dissociation in lower-level linguistic processing, such as speech perception, may be found in people with autism as well. As for speech perception, it is notable to see that the knowledge of words has the influence on the perception of phoneme when listeners listen to sounds. In other word, it suggests that lexical knowledge affects word perception. This top-down processing of lexical effects on phonetic categorization seems to be able to be regarded as one kind of central coherence.

The renowned experimental paradigm that has been developed for supporting this is in Ganong (1980). In Ganong's experiment, the result revealed that listeners shift their auditory categories to make the percept a real word (e.g. kiss vs. giss). This phenomenon occurred in speech perception is named 'Ganong effect'. Ganong employed acoustic word-and-nonword continua varying in Voice Onset Time (VOT) in order to investigate this effect. For example, one continuum ranged between the word 'dash' and nonword 'tash', while the other used the word 'task' and nonword 'dask'. 'Ganong effect' is also considered to be a simple form of higher level linguistic processing that would influence the interaction between word level processing and phonetic level processing. This 'Ganong effect' has been evidenced in English, but it may raise a question about whether it is possible that lexical knowledge affects auditory word perception in Chinese Mandarin. Since lexical knowledge influences auditory word perception in English, it is assumed that this top-down phonetic processing appears in another language as well when perceiving ambiguous sounds of that certain language. However, due to the fact that the boundary of the VOT contrast in Chinese Mandarin is different from English, it needs to be investigated if this Ganong effect occurs in speech perception of Chinese.

1.2 Aim and Focus of the study

The present study aims to replicate and extend this Ganong effect on Chinese people with autistic traits. It will explore the Ganong effect in Chinese phonetic perception and investigate the degree to which lexical knowledge shift phonetic category a real word in individuals with varying degrees of autistic traits.

Participants are asked to take their Autism-Spectrum Quotient (AQ) as the index of degrees of autistic traits (Baron-Cohen, Wheelwright, Skinner, Martin and Clubley, 2001). Since the Ganong effect can be seen as a form of central coherence, a negative correlation between the Ganong effect and autistic traits is expected. Moreover, it may be the case that individuals with high autistic traits are connected to high auditory sensitivity and slower lexical access, both of which may lead to reduced lexical effects. Therefore, these extraneous factors that might attenuate lexical effect will also be considered.

1.3 Research Question

In this dissertation I will thus look into the following questions:

1. Does context lexical effect (the Ganong effect) exist in Chinese phonetic perception? I will examine whether this effect can be found in Chinese native speakers, which would suggest that lexical knowledge of Chinese can bias their phonetic categorization.

2. Is there a negative correlation between the Ganong effect and different degrees of autistic traits? That is, individuals with lower autistic traits may be more likely to be influenced by lexical status when asked to identify ambiguous stimuli, while people with higher autistic traits tend not to be affected by lexical status.

3. Is there any difference in correlation between each subsection of AQ and context lexical effect? Since AQ test is composed of five subsections: ‘social skill’, ‘attention switching’, ‘attention to detail’, ‘communication’ and ‘imagination’, I shall examine whether there is any difference in correlation from one another.

4. Do other extraneous factors influence lexical context effects on speech perception? I shall examine whether the auditory sensitivity and status of lexical knowledge might reduce lexical effect in people with autistic traits.

1.4 Layout of the Dissertation

In the next chapter, I will review previous study of autism and present the underlying background that develops the present experiment. I shall introduce those potential accounts (theory of mind, executive dysfunction and weak central coherence) that explain the profile associated with Autism Spectrum Disorder. Of these three accounts, I will discuss the weak central coherence which suggests a phenomenon shown in autism that individuals with autism tend to have the preference for local bias. In other words, they are less likely to be affected by global / top-down processing. This present study sought to offer a potential test of this weak central coherence in the aspect of speech perception. I will present Ganong's experiment, which is the fundament of designing the present experiment. The third chapter specifies the experiments that were administered for this research: methodology. The fourth chapter includes results and statistical analysis. Lastly, the fifth chapter will discuss the consequence of the experiments and provides the possible accounts. Then, I will conclude of this dissertation (in 'general discussion and conclusion').

2. Literature review

In this section, I will provide a background about autism to the present study and examine how the underlying theories developed. I will firstly look at the previous research with different theories (theory of mind, executive dysfunction and weak central coherence) which illustrate different aspects of autism. Given the number of empirical evidence, it indicates that recently weak central coherence accounts for one peculiar nonsocial feature shown in autism: a different perceptual-cognitive style from normally developing people. This cognitive style in autism is regarded to result in both savant skills (in math, music and drawing) and deficits (in tasks that need detail-focused processing). It claims so because individuals with autism tend to show the preference for local bias in incoming information. The abundant empirical evidence from weak central coherence also suggests that local-context dissociation in lower-level linguistic processing, such as speech perception, may also be observed in people with autism too. In the following part of this literature review I will discuss that this process (i.e. context lexical effects previously demonstrated in Ganong's experiment) can be seen as a form of central coherence.

2.1 Theory-of-Mind (ToM)

It is believed that the success of the human social life relies on the 'social intelligence' (Frith and Frith 1999). One aspect of the social intelligence is the ability to understand others' mental states (i.e. the ability of mind-read) and then alter behavior. Leslie (1987) proposed that this 'metarepresentational' capacity, such as appreciation of beliefs plays a critical role in the development of social skills. The deficit of theory of mind in autism has been developed out of this notion that understanding the other's mind is crucial in social life. However, individuals with autism fail to represent this mental states of others — the ability to understand others' thoughts or feelings in order to predict their behaviors within the social communication (Baron-Cohen, Tager-Flusberg and Cohen, eds, 1993).

Among some accounts of autism spectrum disorder, a Theory-of-Mind (ToM) deficit has been noticeably successful in explaining many of the impaired behavioral symptoms of autism in the social, communicative and imaginative development (Jarrold, Bulter, Cottington and Jimenez, 2000). For example, it is claimed that social withdrawal, which is a comprehensible result of lacking theory-of-mind, results in the inability to aware that beliefs and desires of others are different from his/her own (Baron-Cohen, 1989; Frith, Happé and Siddons, 1994). Thus, this inability to engage in metareprepresentation (Leslie, 1987) also decreases the motivation to communicate with others since the capacity to communicate needs the appreciation of others' knowledge in order to be relevant within the conversation (Sperber and Wilson, 1986). Finally, a theory-of-mind deficit can also account for the imaginative impairment or at least pretend play since this skill requires the same representation of mental states of others.

This ability of representing others' mental states has remarkably been tested by 'false belief' (Baron-Cohen, Leslie, Frith, 1985; Baron-Cohen, Tager-Flusberg, and Cohen, eds, 1993). Take the Sally-Anne task for example. The children are presented the scenario illustration that can be played by real people or puppets. When one character, Sally, leaves her ball in her basket and then goes away; the other character, Anne, moves this ball into her box. At the end of the test, the children are asked the question about where Sally should look for her ball when she comes back. Most normally developing children will respond the correct answer: it is in the basket, which represents what Sally really thinks. However, for most children with autism, they may fail to understand others' thinking and then answer that Sally will look for the ball in the box, where the ball really is. Therefore, this failure of understanding Sally's mistaken belief has been regarded to be the evidence of a theory-of-mind deficit.

This mentalizing account has given us the understanding about the nature of the impairments in autism. Yet, the triad of impairments does not include some other features in autism (Frith and Happé, 1994). That is to say, the account of ToM struggles to provide explanations in some aspects of autistic behaviors, such as repetitive activities and preference for stereotyped routines (Russell, 1997; Jarrold, Bulter, Cottington and Jimenez, 2000). Therefore, it has been argued that executive dysfunction can account for this aspect of the impaired behaviors in autism (Turner, 1997; Jarrold, 1997).

2.2 Executive Dysfunction

In order to understand the reason why executive dysfunction has been provided the explanation of the impairments in autism, one has to know what 'executive function' is. Executive function refers to those high-level cognitive abilities that guide behavior to specified goals (Norman and Shallice, 1986). Besides, executive function has been defined by Welsh and Pennington (1988, p.201) as 'the ability to maintain an appropriate problem-solving set for attainment of a future goal'. There is also a number of empirical evidence that suggests individuals with autism are often impaired on executive function (Hugh, Russell and Robbins, 1994; Ozonoff, Pennington and Rogers, 1991; Prior and Hoffman, 1990; Hugh and Russell, 1993; Onzonoff and Strayer, 2001).

Researchers have been trying to specify these cognitive abilities of executive function, including planning, set-shifting, inhibiting automatic actions and holding a mental representation on-line in working memory (Pennington, Bennetto, McAleer, and Roberts, 1996; Roberts and Pennington, 1996; Griffith, Pennington, Wehner and Rogers, 1999). Besides, those relevant researches also received empirical study in which they pointed out that those individuals with autism did show the deficits on the executive tasks that required the working memory, inhibition and set-shifting (Pennington, Bennetto, McAleer, and Roberts, 1996; Roberts and Pennington, 1996; Ozonoff, 1997; Ozonoff and Jensen, 1999; Ozonoff et al., 2004). Moreover, executive dysfunction is thought to be an alternative to some of the limitations of the theory-of-mind. Ozonoff, Rogers and Pennington (1991) indicated that in the experiment all of the subjects with autism/ Asperger's syndrome were impaired on the typical tests of executive function: Wisconsin Card Sorting Test and Tower of Hanoi, whereas not every individual with autism/ Asperger's syndrome fails in theory-of-mind task.

However, despite the fact that executive dysfunction offers the complementary account to theory-of-mind deficit, it still remains unclear whether executive dysfunction and theory-of-mind impairment are primary in autism (Russell, 1998). One peculiar nonsocial feature shown in autism that has been found in autism is that individuals with autism exhibit superior performance in math, music and drawing. It occurred in nearly one in ten people with autism (Rimland and Hill, 1984; Happé, 1999) so that the other account, Weak Central Coherence (WCC) was therefore put forward by Frith (1989b; Frith and Happé, 1994).

2.3 Weak central coherence

The 'central coherence' was first defined by Frith (1989b) and the further extensive view was presented by Frith and Happé (1994) and Happé (1994a,b) too. Frith defined non-social features, 'central coherence', as an everyday tendency to integrate the local incoming information for high-level meaning. It is a natural tendency to process on the whole rather than segmented parts of information. For example, Bartlett (1932) has proposed that people are likely to recall the gist of the story, whereas the detail is quickly lost and difficult to retain:

> [A]n individual does not normally take such a situation detail by detail… In all ordinary instances, he has an overmastering tendency simply to get a general impression of the whole; and, on the basis of this, he constructs the probable detail. (Bartlett, 1932, p. 206.)

In addition, this preference of global processing is also shown in the young children and adults with non-autistic mental problems (Hermelin, O'connor, 1967), even in infants of three months old (Bhatt, Rovee-Collier and Shyi, 1994; Freedland and Dannemiller, 1996).

Frith (1989b) and others suggested that this natural global information processing, in contrast, was disturbed in individuals with autism. The notion of the Weak Central Coherence theory is also similar to Kanner (1943), who named autism, in that the tendency for the detail-focused processing was clinically found in people with autism in relation to their resistance to change. Kanner viewed this common feature of autism as the 'inability to experience wholes without full attention to the constituent parts', a depiction that is similar to Weak Central Coherence theory proposed by Frith (Happé, 1999).

In addition, Frith (1989b) also predicted that the lack of Central Coherence theory better applied to both excellent and poor performance in autism. That is, a weak drive for central coherence predicts the superiority shown by individuals with autism in the tasks that need the detail-focused processing, as contrasted to the deficits where the tasks require the global meaning in context. In recent years, the weak central coherence has received empirical evidence from a number of sources. Those sources have been shown at different levels: perceptual coherence, visuospatial-constructional coherence and verbal-semantic coherence (Happé, 1999). Take the perceptual coherence deficit found in the previous tasks. For example, Happé (1996) suggested that individuals with autism succumb to the misperception to a lesser degree. In this test, individuals with autism were asked to discriminate the differences within the standard visual illusions. Some of those illusions can be divided into a ‘to-be-judged’ figure and inducing context. The hypothesis would be that if individuals with autism tend to focus more on featural parts, they may succumb to those visual illusions to a lesser degree. The consequence indicated that the group of the participants with autism concentrated more on the to-be-judged parts without integrating them within the whole illusion-inducing figure. It seems individuals with autism relatively do not succumb to visual illusions.

Similarly, other studies also presented the same bias of the local-level processing at the perceptual level. Jarrold and Russell (1997) investigated whether individuals with autism would quickly count dots that were presented in a canonical form or they would enumerate dots independently to get the sum. The result suggested that decreased benefit from canonical form in autism supported the previous hypothesis in autism. Heaton, Hermelin and Pring (1998), on the other hand, also suggested one excellent skill in perceptual level: absolute pitch. Heaton and others presented their participants the notes of individual pitches; the musically naive individuals with autism were better than the controls at the capacity of underlying absolute pitches. Gepner, Mestre, Masson and de Schonen (1995) have shown that basic movement perception in autism is impaired and different from the normal controls; namely, attenuated susceptibility to visual motion can be observed in autistic individuals.

Moreover, the McGurk effect, the influence of the visual over the auditory perception is smaller in autism (de Gelder, Vroomen and Van, 1991).

At visuospatial-constructional level of coherence, Shah and Frith (1983) found that individuals with both high- and low-functioning autism were more accurate on the Embedded Figures Test (Witkin, Oltman, Raskin and Karp, 1971). In this test, children are asked to distinguish individual shapes, such as a triangle (Tent) and a triangle attached to the top of the rectangle (House) in cut-out cardboard models. The result showed that the mean score of the autistic group was 21 out of 25, while the other two controls got 15 or less; that is, children with autism excelled at searching these individual shapes, Tent and House, which are regarded to be the low-level part of the models embedded in the high-level and coherent cut-out cardboard models. In addition, the Wechsler Block Design task (Wechsler, 1974, 1981) is regarded to be the test on which individuals with autism have excellent performance. This block-design task, first invented by Kohs (1923), requires constructing each whole figure into constituent units as quickly as possible. However, it is difficult for most of the people to break up the design into separate or logic segments since most of people have the strong tendency to see the design as a whole or Gestalt. Shah and Frith (1993) support this asset found in autism that the superior performance is also shown on their Wechsler Block Design task and individuals with autism are less aided by the pre-segmentation of the designs, while non-autistic subjects benefit from pre-segmented design condition. This is also akin to Embedded Figure Test (Shah and Frith, 1983) that individuals with autism do not succumb to the gestalt. Furthermore, the weak drive for central coherence has also been presented in a savant study that shows EC's talented three-dimensioned drawing of objects (Mottron and Belleville, 1993). On around ten tasks, this artist with autism, E.C., demonstrated his detail-focused method of drawing style. It was observed that a professional artist as a control started to draw by constructing the outlines and then focus on the details. As opposed to this professional artist, E.C. ‘began his drawing by a secondary detail and then processed by adding contiguous elements’ and presented ‘no privileged status of global form…but rather a construction by local progression’. Due to E.C.’s extreme precision for graphic details, it was therefore concluded that the lack of the hierarchization in E.C. prevents him from global interference and results in a benefit in precision (Mottron and Belleville, 1993). The other extensive experiment on outstanding drawing style, including copying of impossible figures is also shown by Mottron, Belleville and Menard (1999).

Individuals with autism are thought to have difficulty in appreciating ‘meaning’ in terms of verbal-semantic level (Jolliffe and Baron-Cohen, 1999). Prior and Hall (1979) showed that the comprehension of phrases is weak in the individuals with autism, while their comprehension of single words is intact. Additionally, people with autism tend to get lower scores on reading comprehension than reading accuracy scores (Loker and Rutter, 1969; Frith and Snowling, 1983). Hermelin and O’Connor (1967) demonstrated that autistic people do not benefit from meaning in memory tasks. The same phenomenon is also supported by Tager-Flusberg (1991) that autistic people tend not use semantic cues, nor the grammatical relations. Difficulty in appreciating meaning has also been found in homographs (Frith and Snowling, 1983). Homographs stand for words with one spelling, two meanings and two pronunciations and one must integrate the meaning of the whole sentence in order to get the context appropriate pronunciation of the last word: “In her eye there was a big tear”; “In her dress there was a big tear”. Thus, if people with autism are weak at central coherence, then words within the sentences would be read like unconnected words and the context can not help for disambiguating the homographs at the end of the sentence. Frith and Snowling (1983) and other related studies with high-functioning children and adult (Happé, 1997) do suggest that individuals with autism tend not to employ preceding-sentence context to decide the pronunciation of homographs. Findings such as these are similar to Kanner's depiction of his previous cases (1943): '…the children read monotonously, and a story… is experienced in unrelated portions rather than its coherent totality'.

So far, these results indicated that autistic individuals tend to use the analytical or local, rather than the global processing and the rate of the semantic information employed within a context is much less in people with autism. Since findings suggest that the effects are obvious in the areas where the top-down semantic cues are important, the present study would like to focus on another lower level linguistic processing, speech perception, where its top-down influence of lexical knowledge has been evidenced (Ganong, 1980). One prediction would be that local-context dissociation in speech perception may be shown in autistic people as well.

2.4 Ganong effect

2.4.1 *Biasing Effect of Words in Speech Perception*

Linguistic context has long been known to influence speech processing. Take Miller, Heise and Lichten (1951) for example. They demonstrated that the words that can form sentences are easier for people to identify in noise. Warren (1970) also pointed out the phoneme restoration effect, which says that context can bias the perception of the segmented sounds. That is, when a segmented sound of a word is replaced by noise, participants are less likely to notice this change. This biasing effect has been proposed to occur both in previous and following context (Warren and Sherman, 1974). In addition to the semantic effect of words in the sentences, the frequency of word's use also takes part in the identification of speech perception. Broadbent (1967) showed that the word-frequency effect is significantly presented in the identification of speech perception in noise. Ganong (1980) demonstrated, instead, the influence on the identification of phonetic categorization of a rather lower-level linguistic aspect, lexical status of a phonetic sequence.

2.4.2 *The Underlying Theory and Result of Ganong's Experiment*

It has been well accepted that there is a stage of processing word perception that phonetic categorization is getting involved. Liberman, Harris, Hoffman and Griffith (1957) once used the synthesized stop consonants and indicated that listeners can easily discriminate those stimuli only when those are belonging to the different phonetic categories. Stimuli of the same phonetic categories were also proposed to be quite difficult for listeners to discriminate. This was so-called 'categorical perception'.

An auditory continuum between different stop consonants has been tested on the basis of categorical perception. Voice Onset Time (VOT), acting as an auditory cue for voicing in syllabic-initial stop consonants and existing in many languages (Lisker and Abramson, 1964), is known to distinguish one stimulus from the other within auditory continua. Perception of an acoustic continuum is usually characterized by labeling numbers. For example, the phoneme boundary of'd' and't' is about 35 msec VOT with the 'da-ta' continuum to an English native speaker (Ganong, 1980). Therefore, an English native speaker would regard stimuli with VOT of greater 40 msec as't' sound, while consider stimuli with VOT of less than 30 to be'd' sound.

Based on this VOT dimension, Ganong (1980) employed word-to-nonword (and vice versa) continua to investigate if there is a lexical bias to make the percept a real word rather than a nonword; that is, there is a lexical effect on altering VOT perception of words. Take two combined continua as stimuli in his experiment for example. Ganong used one continuum, ranging from the word 'dash' to the nonword 'tash'; another one was the continuum between the word 'dask' and the nonword ‘task’. The effect of the opposite direction is therefore predicted since‘d’ is the word in the former continua, whereas it is not in the latter one. Participants were asked to respond whether they head was‘d’,‘t’ or ‘g’, ‘k’ when listening to stimuli. The result indicated that listeners shifted their identification along a VOT dimension to make phonetic categorization a real word.

2.5 Conclusion of Literature Review

In first part of this chapter I have discussed the autism spectrum disorder and its empirical work within different theories: theory-of-mind deficit, executive dysfunction and weak central coherence. The literature reviewed above has revealed that weak central coherence (WCC) is able to account for the nonsocial feature in autism: a different perceptual-cognitive style from normally developing people. This different perceptual-cognitive style in autism would become an asset when the task required detail-focused processing, whereas it would be a deficit when the task asked global processing. Weak Central Coherence has also received a number of empirical evidence, from which has led to the suggestion that individuals with autism may show local-context dissociation in lower-level linguistic processing, such as speech perception. That is to say, Ganong effect (1980) (such a top-down lexical effect on speech perception) may be less likely to occur in people with autism.

The present study will focus on this Ganong effect in Chinese phonetic perception and examine it on the Chinese individuals with “autistic traits”. Baron-Cohen, Wheelwright, Skinner, Martin and Clubley (2001) developed a self-administrated and short scale, Autism-Spectrum Quotient (AQ), for distinguishing the degree to which normally developing individual has ‘autistic traits’. It is due to the continuum view of social communication disability in autism that the difference between autism and normality is the degree of the social communication disability (Baron-Cohen, 1995; Frith, 1991; Wing, 1981, 1988); therefore, it has been considered to be a useful test in that both normal individuals or people with autism can be diagnosed in this same manner. Since the Autism-Spectrum Quotient (AQ) was designed to identify the autistic traits of both individuals with autism and those in general populations, it suggests the possibility of using AQ in the present study. Additionally, it is also due to the notion of WCC that the tendency of using local and global processing is regarded to be a different style rather than a deficit (Happé, 1999; Happé and Frith, 2006); therefore, the fundamental mechanism associated with weak central coherence in autism should also keep within neurotypucal individuals. Therefore, Autism-Spectrum Quotient (AQ) will be used for a predictor of autistic traits in the current experiment.

2.5.1 *Implications of the Experiment*

According to context lexical effects on speech perception based on Ganong effect (1980), the result that lexical effect is reduced in people with autism would confirm WCC, suggesting that this top-down auditory processing influences speech perception in individuals with high autistic traits. It is also possible that the different subsections of AQ test (i.e. social skill, attention switching, attention to detail, communication and imagination) will show different degree of correlation with lexical effect, which may be displaying the question as to why different aspects of autistic traits are more likely to influence the lexical effects on speech perception. If the decreased lexical effect is not found in people with higher autistic traits, it could be assumed that autistic traits may not affect the way people perceive sounds. If so, the possibility that the lack of context lexical effects is due to the limitation of the methodology in the present experiment should be considered.

However, if it is indeed found the reduced lexical effects in people with higher autistic traits, additional factors that could cause the attenuated lexical effect in phonetic processing, which is characterized by high AQ individuals, should be considered: high auditory sensitivity, slower lexical access. First, it is probable that high AQ individuals may hold high auditory sensitivity so that this strong phonetic discrimination capability makes them free from lexical effects. Thus, participants' phonetic discrimination capacity is going to be examined. Second, it may be that high AQ is linked to slower lexical access, which may lead to the reduced lexical effects of stimuli. To examine this possibility, a lexical decision task is used to test participants' language status. In sum, these two extraneous factors (high auditory sensitivity and slower lexical access) are also going to be examined, along with the main Ganong effect, in order to confirm potential effects from these two extraneous factors on lexical knowledge and phonetic information.

3. Methodology

This study was a replication and extension of that by Ganong (1980), which is going to be applied and tested in Chinese Mandarin. The method includes word-to-nonword continuum identification which examines lexical effects on speech perception through participants' identification of sounds.

According to Ganong (1980), the different length of VOT is manipulated in order to form the continua from word to nonword. VOT stands for the length of voice onset region that ranges from the release of a stop to the onset of the vowel. Stops in Chinese Mandarin have the features of aspiration in which it is usually measured by Voice Onset Time as well. Additionally, voice onset time of voiceless consonant'‘t' is acoustically longer than that of voiced consonant‘d' in English (Ganong, 1980), while it is similar in Chinese Mandarin that voice onset time of aspirated ‘t' is also longer than that of unaspirated ‘d'. Besides, Chinese Mandarin is a tone language (four tones), in which one word contains one syllable and meaning. Unlike other intonation language, same sounds with different tones alter meanings of words in Chinese (ma1: ‘mother', ma2: ‘trouble', ma3: ‘horse' and ma4: ‘scold'). The same tone within the word-to-nonword pair is going to be under controlled. Therefore, only the initial stops within the word-to-nonword pair are different (die2 vs. tie2).

Other potential factors, auditory sensitivity discrimination and lexical knowledge (by nonword ABX discrimination and auditory lexical decision task respectively) that may influence lexical effects on speech perception in high AQ individuals are going to be examined. Also, the possibility of influence from participants' own dialects on lexical decision is considered (by the questionnaire).

3.1 Design

This experiment tested Chinese native speakers from Taiwan. The independent variables were total scores of AQ, five sub-sectional scores of AQ, while the dependent variable was context lexical effect (Ganong effect). The results and statistical analysis are presented in the following chapter.

3.2 Participants and general procedure

Twenty-three graduate students of Chinese native speakers from Taiwan at Edinburgh University took part in this present experiment. They ranged in age from 24 years to 37 years. There were 18 females and 5 males in this experiment. Their general proficiency in English is good (ielts 6.5-7). All participants were given word-to- nonword identification, an ABX discrimination test, lexical decision task and pen-and-paper AQ test. Since one participant failed to complete the entire AQ test and other five replied what they heard was neither'd' or't' for some stimuli, results from 17 participants are going to be analyzed (13 females and 4 males). The further details of those tasks are illustrated as follows.

3.3 Word-to-nonword continuum identification

The integration of lexical knowledge and phonetic information is going to be explored through the Ganong effect. In Ganong's experiment (1980), the results indicated that lexical status influences listeners' discrimination of sounds by a VOT dimension. For example, Ganong employed nonword-to-word 'dask vs. task' and word-to-nonword 'dash vs. tash' in which those two continua only differ in the last consonant(s). I adopted Ganong's method and chose four words in Chinese Mandarin for two pairs: real word, die2 (to pile) vs. nonword tie2; real word, tiao2 (to adjust) vs. nonword, diao2. Then, those two minimal pairs (word-nonword) in Chinese Mandarin (die2 vs. tie2; tiao2 vs. diao2) were manipulated by their VOT to form the seven-step continua, ranging from die2 to tie2 and tiao2 to diao2. Then, participants decided whether they heard /t/ or /d/ within those 7-step continua. In this task, we expect that listeners will tend to show higher /d/ identification in the die2(word)-tie2(nonword) continuum and higher /t/ identification in the diao2(nonword)-tiao2(word) continuum. But this bias will be weaker in listeners with high AQ.

3.3.1 *Material*

Those tokens used in the present experiment were read by a Taiwanese female and they were recorded at a rate of 48 kHz. Due to the fact that mainlanders, monolinguals in Taiwan, speak quite well-accepted Chinese Mandarin, this female descendant of mainlanders is elected to be the talker of the present experiment. Two word-to-nonword VOT continua were produced by cross-splicing spoken tokens of 'die2' vs. 'tie2' and 'tiao2' vs. 'diao2' through the wave analysis software, Praat. As for manipulating VOT dimensions to form seven-step continua, what was first to do was to replace the first initial 100 ms parts of 'tie2' and 'die2' by those of 'tiao2' and 'diao2' respectively in order to make the initial acoustic parts of those endpoint pairs the same. Then, those endpoint pairs started to be cross spliced to form two equal 7-step continua from die2 to tie2 and diao2 to tiao2. Firstly, VOT of 'tiao2' was measured as 84.247 ms and that of 'diao2' was calculated as 19.291ms (see Figure 1). After measuring these two, VOT of 'tiao2' was going to subtract that of 'diao2' and the result was 64.956 ms. Therefore, each VOT step was approximately 10.826 ms when the result (64.956 ms) was divided into 6. The VOTs of each stimulus are presented in Table 1. To make the second stimulus, the initial 30.117 ms proportion of 'diao2' was replaced by the initial 30.117 ms proportion of 'tiao2'. The following third to sixth stimuli were produced in the same way. Some minor adjustments were made in order to make splicing at zero-crossings. Next, the same procedure of making

7-step continuum was applied to the other word-to-nonword continuum (die2 vs. tie2). Before those stimuli were mounted to E-Prime and randomly played on the computer, they should be converted into 22 kHz.

Table 1: Stimuli for the identification task

Stimuli	VOT (ms)
1	19.291
2	30.117
3	40.943
4	51.769
5	62.595
6	73.421
7	84.247

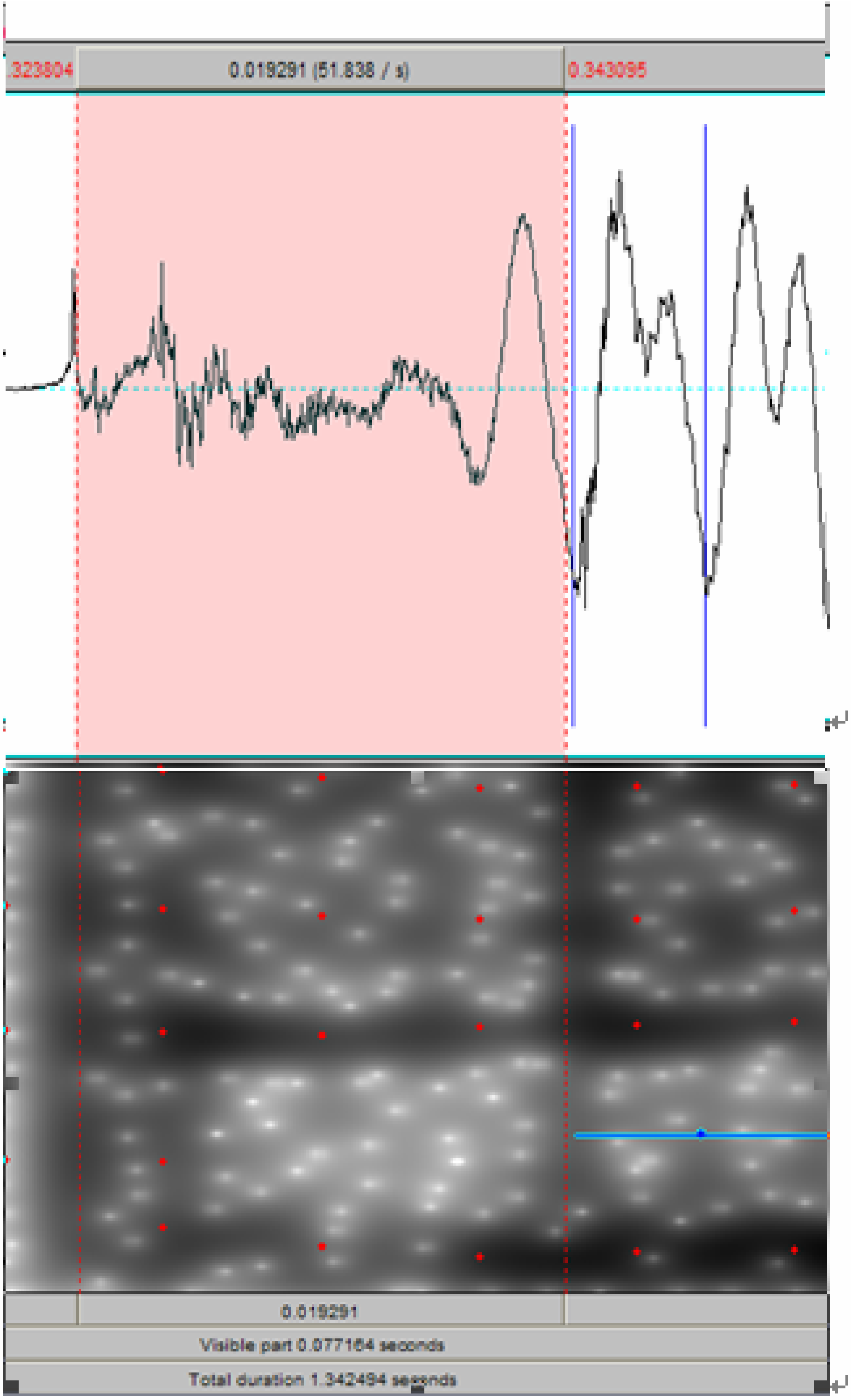


Figure 1: Spectrogram showing that the voice onset time (VOT) of 'die2'/ 'diao2' in Chinese Mandarin is measured as 19.291 ms.

3.3.2 *Procedure*

Participants were instructed to listen to those stimuli and to circle 'd' or 't' on the answer sheets in order to respond what they heard from those fourteen stimuli. After participants finished answering each question by circling'd' or 't', they pressed the 'enter' key to continue the next stimulus. Each stimulus was randomly played for four times within a block and after completing one block, participants could take a little break as they want until they were ready for the next block. In total, participants listened to two blocks for this task. Therefore, each stimulus was presented for eight times in this identification task.

3.4 Nonword ABX discrimination

A reduced lexical effect could results from a possible factor that high auditory sensitivity may lead to strong discrimination capacities that make people with high AQ free from lexical effect. Although definitive evidence has not been confirmed in support of such auditory sensitivity in people with autism, this potential factor is still chosen to be examined. In order to rule out the case that speech perception is influenced by lexical effect so that the individuals with high AQ were less likely to present their real auditory sensitivity, nonwords in Chinese were used as stimuli. That is, the possible auditory sensitivity was going to be tested by participants' phonetic discrimination with nonword-to-nonword continuum. Two nonwords (diu2 and tiu2) in Chinese Mandarin were elected to be the stimuli. I adopted ABX discrimination where participants decided the third sound they heard was the same as the first or the second one that was previously played.

3.4.1 *Material*

A seven-step nonword continuum was produced by cross-splicing naturally spoken tokens of 'diu2' and 'tiu2' using the wave analysis program, Praat as well. The initial proportions and the tone of ‘diu2’ and ‘tiu2’ were similar to those in word-to-nonword identification task (die2 vs. tie2; diao2 vs. tiao2). That is, what the difference between them is only the last segment. Similarly, this nonword-to-nonword continuum was firstly created by cross-splicing. VOT of ‘diu2’ was measured as 19.712 ms and that of ‘tiu2’ was 71.249 ms. Next, VOT of ‘tiu2’ was going to minus that of ‘diu2’ and the result was 51.537 ms. In order to get each length of VOT within a seven-step continuum, the result (51.537 ms) was divided into six (for seven steps). The VOTs of the stimuli are given in Table 2. For making the second stimulus, the length of 28.301 ms (see the table 2) from the very beginning of ‘d’ (in ‘diu2’) was first measured and then this length (28.301 ms) should be deleted. See parallel passage above. The following third to sixth stimuli were produced in the same way. Some minor adjustments were made in order to make splicing at zero-crossings.

Table 2: Stimuli for the nonword ABX discrimination

Stimuli	VOT (ms)
1	19.712
2	28.301
3	36.890
4	45.479
5	54.068
6	62.657
7	71.249

3.4.2 *Procedure*

Participants were asked to listen to those 7 stimuli randomly played on the computer and wrote down '1' or '2' on the answer sheet. There were three sounds for each question and participants would first hear two different stimuli and then they were asked to respond whether the third stimulus they head was identical to the first or second stimulus. This task comprised two blocks. After finishing the first block, participants were allowed to take a rest and to continue the next block when they were ready by pressing the 'enter' key. In each block, all four permutations of the six sets of ABX stimuli were randomly given once (eg. step1-step2-step1; step1-step2-step2; step2-step1-step1; step2-step1-step2). Therefore, there were 48 questions within these two blocks and each set of ABX stimuli was thus examined eight times.

3.5 Auditory lexical decision

Lastly, there is the possibility that high AQ is linked to slower lexical access, which may attenuate lexical effects on speech perception. Language delay is often observed in children with autism, so it is also assumed that the underlying mechanisms in autism are likely to influence the ability of process words. To test this possibility, a lexical decision task was administered.

3.5.1 *Material*

The forty-eight tokens of words and nonwords were read by a Taiwanese female. Half of those stimuli (twenty-four) were formed to be similar with the word-to-nonword pairs employed in the identification task. They were word-nonword minimal pairs where the place of articulation, the voice/ voiceless and tones within each minimal pairs were controlled (see the table 3 below). The rest of the stimuli (twenty-four) were fillers. Half of those fillers were other real words and the other half were nonwords (see the table 4 below).

Table 3 Stimuli for the auditory lexical decision task

Real word	**Nonword**
pian2 (‘便’宜) the first one of the bound word, ‘cheap’	bian2
ping2 (瓶)‘a bottle’	bing2
bie2 (別)‘don’t’	pie2
ba3 (把)‘the handle’	pa3
tiao2 (調)‘to adjust’	diao2
tui3 (腿)‘legs’	dui3
die2 (疊)‘a pile of (paper, etc.)’	tie2
diu1 (丟)‘to throw’	tiu1
ka3 (卡)‘cards’	ga3
kui2(‘葵’花) the first one of the bound word ‘sunflower’	gui2
gui4 (貴) ‘expensive’	kui4
guo2 (國)‘country’	kuo2

Table 4 Stimuli for the auditory lexical decision task (Fillers)

Fillers	
Real word	**Nonword**
ji2 (吉) 'luck'	bia2
tong4 (痛) 'hurt'	piu2
sian3 (想) 'to think'	gi2
dui4 (對) 'yes'	gian4
gui4 (貴) 'expensive'	kia4
zha4 (炸) 'to explode'	tiu2
nian2 (年) 'year'	kian4
fei1 (飛) 'to fly'	biu2
ting2 (停) 'to wait'	pia2
jian4 (件) 'a piece of (clothes, etc.)'	diu2
gong4 (更) comparative 'more'	duang3
kai1 (開) 'to open'	tuang3

3.5.2 *Procedure*

Participants were asked to listen to those forty-eight stimuli and to respond whether the stimulus they heard was real word or not by pressing '1'(for real words) or '2' (for nonwords) on stimulus response box (SRB). They were also instructed in advance that those would be real words only if those were in Chinese Mandarin (not in any other dialect used in Taiwan). They were also informed that they should press the bottom ‘1’ or ‘2’ as soon as they got the answer on mind. Since most of the participants replied after finishing that a few of nonwords were legal words for them in their dialect, an additional questionnaire was designed to confirm whether their accuracy on this task would be affected by their own dialects.

3.6 Questionnaire

This was an on-line questionnaire, which participants were asked to fill in after taking part in the experiment. The forty-eight words (spelling in Zuyin system, eg. “ㄎㄧㄚˋ” for ‘kia4’) in the questionnaire were those stimuli of lexical decision task. They were also requested to mention in this questionnaire about what their own dialects are. As for the answering method, there were two options (‘this is a word’, and ‘this is not a word’) for participants to choose for each word by ticking the box belonging to each option. They were informed to send it back when they completed.

3.7 AQ test

This was a pen-and-paper test of a Chinese Mandarin version. Participants were requested to do in the end of the experiment. There are fifty questions in AQ test in which it is composed of five subsections: social skill, attention switching, attention to detail, communication and imagination; therefore, each subsection contains ten questions randomly occurred in the test (e.g. for social skill: ‘I prefer do things with others rather than on my own’ or ‘I find it easy to work out what someone is thinking or feeling just by looking at their face’; for attention switching: ‘I prefer to do things the same way over and over again’ or ‘In a social group, I can easily keep track of several different people’s conversations’; for attention to detail: ‘I often notice small sounds when others do not’ or ‘I usually concentrate more on the whole picture rather than on the small details’; for communication: ‘Other people frequently tell me that what I’ve said is impolite, even though I think it is polite’ or ‘I know how to tell if someone listening to me is getting bored'; for imagination: 'When I am reading a story, I can easily imagine what the characters might look like' or 'When I am reading a story, I find it difficult to work out the characters' intentions'). For each question, there are four options: 'definitely agree', 'slightly agree', 'slightly disagree' and 'definitely disagree'. Half of the items are described to produce a 'disagree' reply and half of them are worded to answer an 'agree' response in order to avoid biasing in either way. Participants scored in the range from 0 to 50 after the results were calculated by hand.

3.8 Predictions

My predictions were:

1. Since it has been a well known phenomenon in speech perception that context lexical knowledge has influence on phonetic categorization, a Ganong effect is also expected to be found in these two word-to-nonword continua of Chinese Mandarin.
2. Since Ganong effect can be viewed as a form of weak central coherence in processing, a varying degree of Ganong effect is predicted among individuals with different autistic traits. Additionally, there will be a negative correlation between lexical effects and AQ scores. That is to say, individuals with lower AQ will achieve higher lexical effects, while people with higher AQ are going to present fewer lexical effects.
3. Those other potential factors, such as nonword ABX discrimination and auditory lexical effect are not expected to be correlated with Ganong effect and AQ test.

4. Results

I shall present the results by each experiment: first I will provide the results from the word-to-nonword continuum identification then I will give the results from nonword ABX discrimination. Next, the results from auditory lexical decision task will be presented including their reply to the questionnaire. Finally, I shall provide a discussion of each experiment.

4.1 Word-to-nonword continuum identification

In this experiment, participants were asked to circle‘d’ or ‘t’ in response to the beginning of the sound they heard. Therefore, I shall see the number of response‘d’ for example within these 112 sounds (each stimulus repeated eight times). Presumably, the number of‘d’ was higher on one word-to-nonword continuum (die2 vs. tie2) than another nonword-to-word (diao2 vs. tiao2) and the correlation between AQ score and lexical effects are observed.

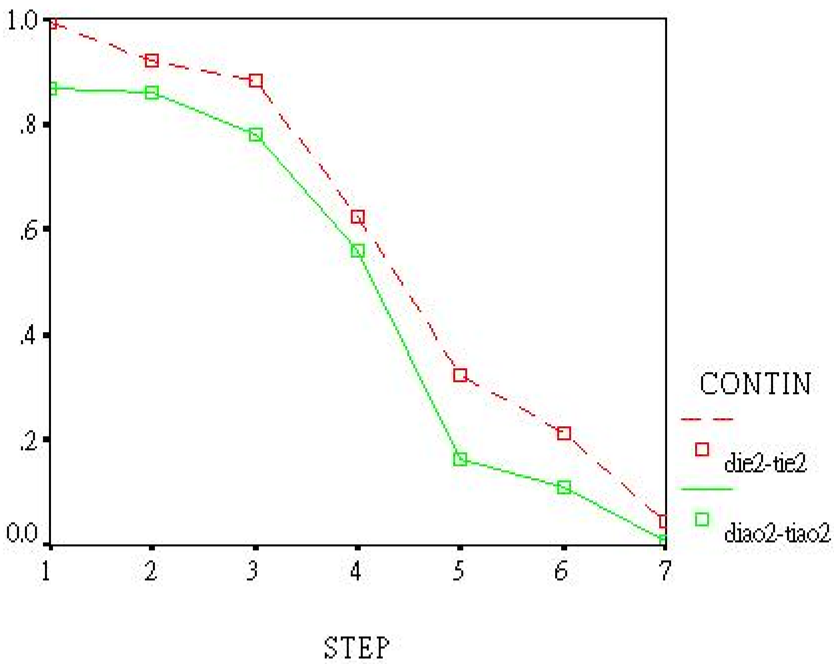
4.1.1 *Results from a repeated measures ANOVA (the analysis of variance)*

Results from a repeated measure ANOVA on the mean proportion of‘d’ response indicated a significant main effect of continuum, $p= .035$ and a main effect of step, $p= .000$ (see Table 5). The interaction between the two sources did not ($p= .479$). That is, the effect of the mean proportion of‘d’ responses between the continua through the steps is not significant. But, those two significant main effects indicate that the different mean proportion of‘d’ responses between two continua and seven steps are observed. As demonstrated by Figure 2, the proportion of‘d’ response was higher in die2-tie2 continuum than in the diao2-tiao2 continuum. This suggests that the context lexical effects (Ganong effect) are indeed observed in Chinese Mandarin, supporting the previous prediction of this current study.

Table 5: Source of variance due to two continua (die2-tie2 vs. diao2-tiao2) and steps (seven steps for each continuum)

Source	**df**	**MS**	**F**	**p**
Continuum	1	.520	5.329	.035
Step	6	4.851	134.047	.000
Continuum × Step	6	1.558	.729	.479

Figure 2: Mean proportion of‘d’ responses for two continua



4.1.2 *Results from the correlations*

In this test, the correlations between total AQ score and context lexical effects are examined as well as the correlations between five subsections of AQ and lexical effects. As for the lexical effects, the mean identification shift between the two continua was log-transformed. The correlation between total AQ score and log mean shift does not show a significant result (r= .091, N= 17, p= .730). Then, what should be tested are the other correlations of five subsections (see Table 6). Among those subsections, 'attention to details' shows the inverse correlation with log mean shift (r= -4.89, p= .047∗, n= 17). However, there is no significant relationship among the other four (see Table 6). In order to look into this discrepancy between 'attention to detail' and other rest of the subsections (i.e. 'social skill', 'attention switching', 'communication' and 'imagination') of AQ, the relationship between each subsection need to be examined (see Table 7).

Table 6: Correlation between log mean shift and each subsection of AQ

	Social Skill	Attention Switching	Attention to Detail	Communication	Imagination
Log Mean Shift					
Pearson Correlation	.252	.167	-.489∗	.351	-.041
Sig. (2-tailed)	.330	.521	.047	.168	.876
N	17	17	17	17	17

Table 7: Correlations between each subsection of AQ

	2	3	4	5	6
1	.711** P= .001 N= 17	.546* P= .023 N= 17	-.094 P= .720 N= 17	.542* P= .025 N= 17	.847** P= .000 N= 17

2		.520* P= .032 N= 17	-.216 P= .406 N= 17	.488* P= .047 N= 17	.764** P= .000 N= 17
3			.106 P= .686 N= 17	.150 P= .567 N= 17	.712** P= .001 N= 17
4				.341 P= .180 N= 17	.289 P= .261 N= 17
5					.724** P= .001 N= 17

1= 'social skill'; 2= 'communication'; 3= 'imagination'; 4= 'attention to detail'; 5= 'attention switching'; 6= total AQ score

4.1.3 *Discussion*

The word-to-nonword continuum identification task failed to find out the significant correlation between log mean shift and total AQ score. However, a negative significant correlation between 'attention to details', one of the five subsections of AQ, is observed. One explanation for this significant correlation is that Ganong effect (the context lexical effect) requires integration between lexical knowledge and auditory information, and the high tendency of focusing on details is less likely to facilitate this phonetic integration. Therefore, a negative correlation is significant in the aspect of 'attention to details'. Additionally, every subsection, except 'attention to detail', is highly positively correlated to total AQ score, indicating that when those four subsections ('social skill', 'communication', 'imagination', 'attention switching') increase /decrease, they will influence the increase/ decrease of the total

AQ score. On the other hand, the degree of ‘attention to detail’ can not affect the total AQ score according to the statistical result in this present experiment. Moreover, ‘attention to detail’ is not correlated to any other four subsections, while most of those four subsections have positive correlations with each other. Further explanation is presented in the chapter 5 (general discussion and conclusion).

4.2 Nonword ABX discrimination

In this task, participants were asked to circle ‘1’ or ‘2’ in order to respond when the third stimulus they hear was identical to the first or the second sound. I shall see the accuracy they got among forty-eight questions by calculating the number of the correct answers.

4.2.1 *Correlation between nonword ABX discrimination and context lexical effects*

The result of correlation between discrimination and log mean shift indicates that a significant correlation between them is not observed (r= .299, p= .244, n= 17).

4.2.2 *Correlation between nonword ABX discrimination and AQ test*

The result of correlation between discrimination and total AQ score suggests that a significant correlation between them is not found (r= -.017, p= .947, n= 17).

4.2.3 *Correlation between nonword ABX discrimination and ‘attention to detail’*

Since it may be possible that high auditory discrimination is due to attention to sounds, which is assumed to be related to the underlying mechanism of ability to pay attention to detail occurred in autism, the correlation between nonword discrimination and ‘attention to detail’ has opted to examine. The result of correlation between discrimination and ‘attention to detail’ points out that a significant correlation between them is not found (r= -.238, p= .357, n= 17).

4.2.4 *Discussion*

The correlations either between the nonword discrimination and log mean shift (lexical effects) or between the nonword discrimination and total AQ score are not found. That is, auditory sensitivity may not influence context lexical effects when listeners perceive sounds. However, since one subsection, ‘attention to detail’, is correlated to lexical context effect in the present study, we should pay attention to the relationship between ‘attention to detail’ and this subsection of AQ (‘attention to detail’). The result indicates that there is no significant relationship between them (r= -.238, p= .357, n= 17). It may be argued that the underlying mechanism of high phonetic discrimination is related to the ability of paying attention to details, and then the correlation between them should be seen. One explanation for this discrepancy would be that individuals with more autistic traits may not hold high auditory discrimination, but high autistic people tend to pay more attention to details, whether in visual or auditory aspects. In other words, the tendency of paying attention to detail may not be relevant to the excellent ability of auditory discrimination. Therefore, it can be seen that the result indicated that there is no significant correlation between nonword discrimination and attention to details. It suggests the degree of paying attention to details is significantly affected by different autistic traits, while the degree of auditory discrimination is not.

4.3 Auditory lexical decision

In this task, participants were asked to press ‘1’ for words or ‘2’ for nonwords on the stimulus response box (SRBOX) in order to examine their accuracy and reaction time. I shall view the correlation between the accuracy of those questions and log mean shift/ total AQ score, as well as the correlation between the reaction time for answering those questions and log mean shift/ total AQ score. The questionnaire is also examined to see if participants' dialects influence their decision of nonword.

4.3.1 *Correlation between auditory lexical decision and lexical effects*

Two aspects, accuracy and reaction time are tested to see if they are correlated to lexical effects. The result of correlation between accuracy and 'attention to detail' suggests that a significant correlation between them is not found (r= -.252, p= .329, n= 17). In addition, the reaction time is not correlated to log mean shift (r= -.102, p= .697, n= 17)

4.3.2 *Correlation between auditory lexical decision and AQ test*

Similarly, the correlation between accuracy/ reaction time and total AQ score were examined. The result indicates that no significant correlation between accuracy and total AQ score was found (r= -.289, p= .260, n= 17); furthermore, the phenomenon is the same in the reaction time and total AQ score (r= .269, p= .296, n= 17). Finally, the relationship between accuracy/ reaction time and one aspect of AQ, 'attention to detail', do not indicate the significant relationship between them.

4.3.3 *Possible influences on decision of nonwords in the lexical decision task from participants' own dialects*

Their accuracy in nonword should be considered first before examining the potential influences from dialects. The result indicates that their nonword accuracy is quite high (5 errors at most among those 24 nonwords) and although they did not get the correct response to some nonword (for example, 'tie2') in lexical decision task, they chose the correct answer for those nonword in the questionnaire. Since any intended nonwords were identified as real words in the offline task (the questionnaire), it is assumed that the dialects may not affect their judgment in the online task (the lexical decision task).

4.3.4 *Discussion*

Lexical knowledge is another factor that may cause the reduced lexical effects in autism. Therefore, this possibility is examined by the auditory lexical decision task in which accuracy and reaction time are considered. In this auditory lexical decision task, the results point out that participants' performance on accuracy are almost over 90 % and both accuracy and reaction time are not correlated to their log mean shift or total AQ score. That is, participants' lexical knowledge may not differ from each other on the basis of different autistic traits. Moreover, due to the phenomenon that participants considered many nonwords in lexical decision task were legal words in their dialects, another possibility that may also affect lexical decision and attenuate the expected lexical effects in the previous word-to-nonword identification task is regarded. Those 48 tokens of words and nonwords are displayed in the questionnaire in which participants are asked to choose whether each token belong to real word, or nonword in Chinese Mandarin. As for those nonwords in the lexical decision task, participants regarded some nonwords were real words in lexical decision task, while they indicated those errors themselves made were nonwords in questionnaire. That is to say, the errors they made were likely to be due to mistakes, not the influences from their dialects. Furthermore, those two stimuli, 'tie2' (the nonword in die2-tie2 continuum), 'diao2' (nonword in diao2-tiao2 continuum) were also examined to see whether participants' dialects may affect their decision to make those nonwords to be real words. Taken together those results of 17 participants, they all responded that 'tie2' and 'diao2' were nonwords both in lexical decision task and questionnaire.

5. General discussion and conclusion

5.1 Discussion

Taken together, the three experiments (identification task, auditory sensitivity task and lexical decision task) presented above suggest that other extraneous factors do not affect participants' lexical context effects and that the relationship between lexical context effects and 'attention to detail' has a significant result.

According to the results from auditory sensitivity (by nonword ABX discrimination) and lexical knowledge (by auditory lexical decision), the possible factors that may reduce lexical effects in autism can be ruled out. It is due to the fact that firstly nonword ABX discrimination is neither correlated to AQ score nor log mean shift; namely, the score of nonword ABX discrimination does not increase or decrease because of different AQ score or lexical effects. Therefore, high AQ individuals may not exhibit high auditory sensitivity which potentially attenuates lexical effects in speech perception. Similarly, there is also no correlation whether between auditory lexical decision and AQ or between auditory lexical decision and lexical effects. It may suggest that listeners' lexical knowledge here is less likely to affect lexical status. As the result, since those factors can be ruled out, we can put our focus on the results from lexical effects on speech perception in autism.

This present study suggests that one characteristic in autism, 'attention to detail' of AQ is associated with context lexical effects in phonetic perception. A negative correlation is found between them, meaning that individuals who tend to focus more on the smaller part of an object would be less affected by lexical knowledge when receiving sounds that are ambiguous to them. This result is consistent with the weak central coherence (Frith, 1989b). The data from the present experiment therefore suggests that individuals with fewer tendencies on details are more likely to adopt more top-down strategy, lexical effects (Ganong, 1980), whereas people with higher tendencies on details are less influenced by this Ganong effect. Therefore one thing that is clear from the correlation between 'attention to detail' and lexical effects is that this tendency on a bottom-up strategy is a consequence of weak central coherence.

However, except 'attentions to details', the other four aspects of characteristics in AQ (social skills, communication, imagination and attention switching) are not correlated to lexical effects. It is therefore worth considering what this discrepancy implies. A potentially useful way of thinking about this discrepancy is to focus on the fact that different domains of AQ, including 'social skill', 'communication', 'imagination', 'attention to detail' and 'attention switching' stand for what kind of areas of behavior in autism. It may be the case that these five subsections of AQ demonstrate divergent aspects of the autism syndrome so that any relationship between 'attention to detail' and the other four can not be found. In other words, it can be assumed that this partial correlation (a negative correlation between 'attention to detail' and lexical effects) presented here means that the extent to which individuals with autistic traits adopt top-down strategy (Ganong effect) is just associated to one aspect of autistic traits, 'attention to detail'. As mentioned above, this tendency of focusing on details is a result of a central coherence bias in autism. One can therefore view this partial correlation as a test of the relationship between weak central coherence and lexical effects in speech perception; that is, 'attention to details' can be seen as a representation of WCC in people with autistic traits.

Another concern has been raised about whether the other four domains belong to WCC or not. If they do belong to WCC, how come the correlations between lexical effects and those four can not be observed as it does in 'attention to details'? However, if those four do not belong to WCC, what kind of accounts in autism can explain those domains? Firstly, we can see what kind of questions AQ is made of. AQ is composed of five domains in which those items are selected from the ‘triad’ of autistic symptoms: socialization, communication and imagination (APA, 1994; Rutter, 1978; Wing and Gould, 1979) and from cognitive abnormality in autism: attention to details and attention switching (Baron-Cohen, Wheelwright, Skinner, Martin and Clubley, 2001). Of those five domains, ‘attention to detail’ has been suggested above to be a demonstration of WCC (e.g. ‘I usually concentrate more on the whole picture, rather than the small details’, ‘I don’t usually notice small changes in a situation, or a person’s appearance’ or ‘ I usually notice car number plates or similar strings of information’).

As for ‘attention switching’, the impairment of executive function has been reported to be able to account for the cognitive abnormality in this area of autism (Turner, 1997). It is due to the fact that autistic individuals fail to regulate or control volitional acts so that they sometimes produce repetitive or embarrassed behaviors. In other words, autistic people are less able to trigger ‘start’ and ‘stop’ in ongoing actions at will (impairment of inhibitory actions) and therefore they have more problems in cognitive flexibility (Ozonoff, Pennington and Rogers, 1991) This lack of cognitive flexibility, shifting from previous attention to anything else, is therefore likely to be the account of poor attention-switching in autism. Specifically, a study into autism has also confirmed that autistic individuals are more likely to produce errors in set-shifting task (Hughes, Russel, and Robbins, 1994). This task requires participants to discriminate two pink geometrical shapes in which only shapes are different. Those participants are asked to learn a rule in order to respond to the target stimulus; after participants achieve six successive correct responses, they are introduced a reverse learnt rule and requested to respond to the previously incorrect stimulus. In the following stages, although participants must little by little learn new contingency with an additional dimension (while lines), they are still asked to focus on the questions in the same dimension, shape. In the final extradimnesional shift stage (EDS), the new contingency this time, by contrast, is derived from the line dimension. Therefore, participants have to neglect the shape stimuli and instead focus on which of the white stimuli are the new target ones at this stage. This stage is also the one that examines whether the subject is able to make an extradimensional shift of attentional set from shapes to lines. The results, suggesting that autistic subjects are less likely to successfully switch the focus of their attention from one dimension (i.e. shapes) to another (i.e. lines) and make more errors than the chronological and mental age matched control ones, are consistent with a failure of inhibition (one of the executive functions) in autism.

The rest of the subsections of AQ, ‘social skill’, ‘communication’ and ‘imagination’ are triad of autistic symptoms in which theory of mind (ToM) is proposed to account for many of those behavioral symptoms (Jarrold, Bulter, Cottington and Jimenez, 2000). It is due to the fact that autistic individuals lack the understanding that another person’s mental state can be different from his / her own. It is therefore argued that this theory-of-mind deficit in autism results in social withdrawal/ poor social skills (Baron-Cohen, 1992, 1995; Frith, 1989b). Additionally, impairments in social interaction like this would lead to lower motivation for communication (Frith 1989a; Happé, 1993). Finally, deficits in imagination (at least pretend play) would also result from a theory-of-mind deficit since Leslie (1987) has proposed that pretend play requires the representation of another people’s mental state.

Since these five subsections of AQ can be regarded to derive from these three psychological explanations, theory of mind (for ‘social skill’, ‘communication’ and ‘imagination’), executive dysfunction (for ‘attention switching’) and weak central coherence (for ‘attention to detail’), an important question is whether these three accounts of autism are related. It has been proposed by Happé (1999) that the deficit accounts, including theory of mind and executive dysfunction can not explain the excellent behaviors in autism, but weak central bias does. This suggests that there might be no close relationship between weak central coherence and those deficit accounts. In other words, these accounts of assets and deficits in autism have been viewed as being complementary in explaining the different syndromes of autism. Moreover, according to the statistical result presented in the previous chapter, it indicates that the deficit accounts, theory of mind and executive dysfunction (in 'social skill', 'communication' vs. 'attention switching') are almost positively correlated (see Table 8). On the other hand, Table 8 also shows that 'attention to detail' which can be seen as one kind of weak central coherence, does not have any close relationship with other four subsections ('social skill', 'communication', 'imagination' and 'attention switching'), which can be seen as the representation of those deficit accounts (theory of mind and executive dysfunction). Those statistical results from Table 8 are consistent with the dissociation claimed by Happé, (1999) that 'theory of mind' and 'executive dysfunction' are psychological explanations that can account for the impairments of autism, whereas 'weak central coherence' is able to explain the assets that result from peculiar perceptual-cognitive processing in autism.

Table 8. Correlations between the demonstration of ‘theory of mind’, ‘executive dysfunction’ and ‘weak central coherence’

	Attention switching	Attention to detail
Social skill	.542* P= .025 N= 17	-.094 P= .720 N= 17
Communication	.488* P= .047 N= 17	-.216 P= .406 N= 17
Imagination	.150 P= .567 N= 17	.106 P= .686 N= 17
Attention switching		.341 P= .180 N= 17

Particularly, two domains— central coherence bias (the asset account) and theory of mind (the deficit account)—have been typically considered to be separate (Frith and Happé, 1994; Baron-Cohen, 1995; Leslie, 1987; Leslie and Roth 1993; Leslie and Thaiss, 1992). This claim proposed by those authors is due to two theoretical reasons. First, Baron-Cohen (1995) and Leslie (1987; Leslie and Roth 1993; Leslie and Thaiss, 1992) claimed that theory of mind is one kind of ‘modular’ ability; that is, an ability underlying the functioning of a fixed neural system (Fodor, 1983). It is said that modular systems are domain specific and the working of a modular system is automatic and not supposed to be influenced by top-down processing from any other system. As a result, from this theoretical viewpoint, the functioning of theory-of-mind should not be connected to other domains; in other words, theory-of-mind is an independent working system that should be separate from weak central processing in autism. Second, Frith and Happé (1994) also showed their agreement with the above claim in that these two accounts seem to explain divergent aspects of autism: theory of mind is for the triad features of autism, while weak central coherence is about the nontriad top-down processing. Moreover, this claim has received a number of empirical reasons for regarding that theory of mind and weak central coherence are distinct areas of autism. It was found that some autistic individuals pass the task that requires more complex second-order theory of mind (which is about appreciation of beliefs), but still present weak central bias (Happé, 1994b, 1997). Taking those arguments outlined above together, it can be concluded that the asset account (weak central coherence) may not be linked to the deficit ones (theory of mind and executive dysfunction). Therefore, it is not surprising that lexical effects of this present study as one kind of central coherence does not correlate with ‘social skill’, ‘communication’, ‘imagination’ (the representation of impaired mind reading) and ‘attention switching’ (the demonstration of executive dysfunction) that are all belonging to deficit accounts of autism.

Although this suggests that the asset account and deficit account of autism are distinct (which is accord to the result of the present study), it should be noted that some researchers proposed the possible link between impairment of global information processing and the social deficits in autism (Jarrold, Bulter, Cottington and Jimenez, 2000). In order to figure out this dissimilarity from the result of the present experiment, we should focus our attention on their methodology. In Jarrold et al. (2000), these authors tried to examine the potential link between theory of mind and central coherence bias in which they chose an eye-reading task (Baron-Cohen, Jolliffe, et al., 1997) and Embedded Figures Test (Witkin et al., 1971)/ block design test as the index of theory of mind and central coherence bias respectively. Three experiments were conducted to see the extend to which normal adults, normally developing children and autistic children may show the correlated results between the eye-reading task (for theory of mind) and Embedded Figures Test (weak central coherence). In experiment 1, sixty normal adults presented that the individuals who did better performance on an eye-reading tests took longer time on locating a target figure in a series of complex drawings. Additionally, in experiment 2, twenty-four normally developing children demonstrated the same performance in which they were assessed with a series of theory-of-mind tasks, such as inferred belief, not-won belief, explicit false belief (Wellman and Bartsch, 1988), own false belief (Perner et al., 1987), other's false belief and second-order false belief (Perner and Wimmer, 1985), and with two tests of child version, the Embeded Figures Test (Coates, 1972) and block design test as the index of weak central coherence. Similarly, results from seventeen autistic children in experiment 3 represented the negative relationship between theory of mind and block design score, as well as the positive correlation between theory of mind and Embedded Figures Test time when the verbal mental age was accounted for. Taken together, these consequences from three kinds of participants (normally developing adults, children and autistic children) indicated that an inverse relationship between performance on the tasks of theory of mind and on tests of central coherence bias was observed.

Nevertheless, although a link between theory-of-mind impairments and central coherence bias has been evidenced in Jarrold, et al., (2000), a concern is raised: 'does this necessarily mean that individuals with weak central coherence have poorer theory-of-mind deficits?' Does that mean a casual relationship exists between the asset (central coherence bias) and deficit (theory of mind) account? If so, the question we should pay attention to is why there can not be found the same results in the present experiment. Consequentially, two equally important questions are worth considering about whether these two kinds of tests, Embedded Figures test and block design test in Jarrold, et al., (2000) can really stand for the whole underlying mechanism of top-down processing (weak central coherence) in autism and whether there is any limitation of the methodology in the present experiment. The former question is discussed in the following part and the latter problem of limitation will be presented in the next section.

Embedded Figures test and block design test have been taken as accepted measures of weak central coherence, in that these tasks require participants to use a local visual processing approach. Besides, according to the results in Jarrold, et al. (2000), the performance on Embedded Figures test was highly correlated to the performance on block design test and these two tasks were both negatively correlated to theory of mind as well. It may therefore imply that Embedded Figures test and block design test tap the same underlying processing. However, although the performance on these two visual tasks show the same detail-focusing strategy in autism, can it predict that other central coherence bias at different domains, such as auditory or verbal-semantic ones, is also related to theory of mind? Would it be possible that although these visuospatial-constructional coherence, Embedded Figures test and block design test (Happé, 1999) are indeed correlated with visual eye-reading or other theory-of-mind tasks, other levels of weak central coherence (such as perceptual and verbal-semantic coherence) in autism are not found to be related to the visually theory-of-mind tasks?

Consequentially, one can argue that poorer theory-of-mind performance does not necessarily predict the weak central coherence, which is consistent with the result of current experiment. Although Jarrold, et al. (2000) provide evidence for a link between theory of mind and weak central coherence, these authors only use the cues from visual stimuli where the issue that visual performance can necessarily predict other domains remains unclear. In other words, they do not clearly offer the explanation on the nature of the association between theory of mind and weak central coherence.

Moreover, in the current experiment, this top-down auditory speech processing can be seen as one type of demonstration of weak central coherence at both the domains of the verbal-semantic and perceptual. As a result, this also raises the concern about whether the performance of central coherence bias on these domains in the current experiment is necessarily correlated to visual theory-of-mind tasks in Jarrold et al. Therefore, one thing that is more clear from Jarrrold, et al. and also from the present experiment, is that it seems more likely that there may be a link between the performance on Embedded Figures test and block design test and on eye-reading task, but it may be too early to make the conclusion that there is indeed a link between weak central coherence (an asset account) and theory of mind (a deficit account). In order to confirm the nature of the association between theory of mind and weak central coherence, additional experiments at different domains (i.e. perceptual and verbal-semantic ones) in the future should be done.

5.2 Limitation of the present experiment and future work

The relationship between top-down Ganong effect in the present study is observed to be negatively correlated to ‘attention to detail’ as a consequence of weak central coherence, suggesting that people who tend to adopt local processing are less likely to shift their phonetic categorization from nonword to words when listening to ambiguous stimuli. However, it should be noted that this evidence of partially correlated result in the current experiment seems not yet to imply that there will be a casual relationship between Ganong effect and autism. One thing that is clear from this present result is that the top-down lexical processing (Ganong effect) can only show the individuals' local-detailed preference, which is just part of the feature in autism. Accordingly, further work is clearly needed in order to explore their relationship in more detail.

Of the present methodology, two aspects are worth considering making some adjustment in the future work: one is the possible limitation of AQ test and the other is the type of population. Indeed, the AQ can distinguish people with autism from normal population (Baron-Cohen, Wheelwright, Skinner, Martin and Clubley, 2001) and the inverse relationship between 'attention to detail' and context lexical effect is also observed in the current experiment. However, in order to validate more about the inverse relationship between this Ganong effect and the central coherence bias in autism, we can adopt more typical measures (such as Embedded Figure Test (Witkin et al., 1971), the block design task (Shah and Frith, 1993), the pronunciation of homographs (Frith and Snowling, 1983) or dot counting (Jarrold and Russell, 1997)…etc.) as the index of the degree of central coherence bias and see if the close relationship indeed exhibits between weak central coherence and this top-down Ganing effect. If correct, then the claim that an individual who tends to adopt the more local processing is less likely to be influenced by lexical effects would be more evidenced. Moreover, this study suggests the local processing strategy in neurotypicals, but we still can not generalize this current finding. So, further investigations including the population of clinically autistic people are needed in the future.

5.3 Conclusion

In this present study, one kind of top-down auditory perception, Ganong effect, is employed to examine its relationship with autistic traits. This effect suggests that people are likely to choose the real words (i.e. the influence of lexical status on phonetic categorization) when they are listening to the ambiguous stimuli that sound either words or nonwords (such as ‘kiss’ or ‘giss’). Additionally, the previous study in autism has been suggested that people with autism are more likely to focus on the detail so that they may show the relatively poorer central coherence (such as Embedded Figure Test or the block design task). The findings from the present study are consistent with the previous research of weak central coherence in that individuals with higher score on ‘attention to detail’ tend not to shift their auditory categorization from nonwords to words. Therefore, it supports the theory of central coherence bias that people with autism are more likely to adopt the detail-focused strategy.

However, the results of the current experiment only show the partial correlation between context lexical effects and ‘attention to detail’ indicating the discrepancy between those five subsections of AQ (‘social skill’, ‘communication’, ‘imagination’, ‘attention switching’ and ‘attention to detail’). What we consider is whether those five subsections are related to each other. If not, one may not be surprised by the result that top-down local processing is not related to the rest of the subsections. As described in the general discussion, three psychological explanations of autism can account for those five subsections. The social triad, ‘social skill’, ‘communication’ and ‘imagination’ can be seen as the demonstration of theory of mind, while ‘attention switching’ can be considered to stem from executive functioning. Finally, ‘attention to detail’ is regarded to be from weak central coherence.

Those three accounts of autism have been seen as describing different aspects of the autism syndrome. Specifically, Happé (1999) proposed that weak central coherence can account for the peculiar perceptual-cognitive style of autism, while the other two, theory of mind and executive dysfunction point out the deficits of social cognition and executive function in autism. In other words, those three accounts can be seen as being complementary in explaining the nature of autism; those accounts (between deficit and assets) may not show close relationship with each other. Therefore, it can be concluded that the results from the current experiment are consistent with this partial association. Specifically, the originally expected inverse relationship between context lexical effects and those four subsections ('social skill', 'communication', 'imagination' and 'attention switching') of AQ is not observed. In addition, since each of those four subsections are all highly correlated to total AQ score, it is not surprising that we can not observe significant correlation between total AQ score and context lexical effects of the current experiment, whereas the result from the present experiment is only correlated to 'attention to detail', which can be seen as the consequence of weak central coherence.

Nevertheless, there remains further work to be done in this area to confirm whether a close inverse relationship between context lexical effects and weak central conference indeed exists. Adjustments to the method need to be made in the aspects of the index of the degree of weak central coherence and the population of clinically autistic people in order to carry out the research where the relationship between this context lexical effect of the present experiment and central coherence bias of autism is more confirmed and where the validity of this present experiment is more evidenced.

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7. Appendices

7.1 AQ

1.	I prefer to do things with others rather than on my own.	definitely agree	slightly agree	slightly disagree	definitely disagree
2.	I prefer to do things the same way over and over again.	definitely agree	slightly agree	slightly disagree	definitely disagree
3.	If I try to imagine something, I find it very easy to create a picture in my mind.	definitely agree	slightly agree	slightly disagree	definitely disagree
4.	I frequently get so strongly absorbed in one thing that I lose sight of other things.	definitely agree	slightly agree	slightly disagree	definitely disagree
5.	I often notice small sounds when others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
6.	I usually notice car number plates or similar strings of information.	definitely agree	slightly agree	slightly disagree	definitely disagree
7.	Other people frequently tell me that what I've said is impolite, even though I think it is polite.	definitely agree	slightly agree	slightly disagree	definitely disagree
8.	When I'm reading a story, I can easily imagine what the characters might look like.	definitely agree	slightly agree	slightly disagree	definitely disagree
9.	I am fascinated by dates.	definitely agree	slightly agree	slightly disagree	definitely disagree
10.	In a social group, I can easily keep track of several different people's conversations.	definitely agree	slightly agree	slightly disagree	definitely disagree
11.	I find social situations easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
12.	I tend to notice details that others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
13.	I would rather go to a library than a party.	definitely agree	slightly agree	slightly disagree	definitely disagree
14.	I find making up stories easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
15.	I find myself drawn more strongly to people than to things.	definitely agree	slightly agree	slightly disagree	definitely disagree

16. I tend to have very strong interests, which I get upset about if I can’t pursue.	definitely agree	slightly agree	slightly disagree	definitely disagree

17. I enjoy social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree
18. When I talk, it isn’t always easy for others to get a word in edgeways.	definitely agree	slightly agree	slightly disagree	definitely disagree
19. I am fascinated by numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
20. When I’m reading a story, I find it difficult to work out the characters’ intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
21. I don’t particularly enjoy reading fiction.	definitely agree	slightly agree	slightly disagree	definitely disagree
22. I find it hard to make new friends.	definitely agree	slightly agree	slightly disagree	definitely disagree
23. I notice patterns in things all the time.	definitely agree	slightly agree	slightly disagree	definitely disagree
24. I would rather go to the theatre than a museum.	definitely agree	slightly agree	slightly disagree	definitely disagree
25. It does not upset me if my daily routine is disturbed.	definitely agree	slightly agree	slightly disagree	definitely disagree
26. I frequently find that I don’t know how to keep a conversation going.	definitely agree	slightly agree	slightly disagree	definitely disagree
27. I find it easy to “read between the lines” when someone is talking to me.	definitely agree	slightly agree	slightly disagree	definitely disagree
28. I usually concentrate more on the whole picture, rather than the small details.	definitely agree	slightly agree	slightly disagree	definitely disagree
29. I am not very good at remembering phone numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
30. I don’t usually notice small changes in a situation, or a person’s appearance.	definitely agree	slightly agree	slightly disagree	definitely disagree
31. I know how to tell if someone listening to me is getting bored.	definitely agree	slightly agree	slightly disagree	definitely disagree

32. I find it easy to do more than one thing at once.	definitely agree / slightly agree / slightly disagree / definitely disagree
33. When I talk on the phone, I'm not sure when it's my turn to speak.	definitely agree / slightly agree / slightly disagree / definitely disagree

34. I enjoy doing things spontaneously.	definitely agree / slightly agree / slightly disagree / definitely disagree
35. I am often the last to understand the point of a joke.	definitely agree / slightly agree / slightly disagree / definitely disagree
36. I find it easy to work out what someone is thinking or feeling just by looking at their face.	definitely agree / slightly agree / slightly disagree / definitely disagree
37. If there is an interruption, I can switch back to what I was doing very quickly.	definitely agree / slightly agree / slightly disagree / definitely disagree
38. I am good at social chit-chat.	definitely agree / slightly agree / slightly disagree / definitely disagree
39. People often tell me that I keep going on and on about the same thing.	definitely agree / slightly agree / slightly disagree / definitely disagree
40. When I was young, I used to enjoy playing games involving pretending with other children.	definitely agree / slightly agree / slightly disagree / definitely disagree
41. I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).	definitely agree / slightly agree / slightly disagree / definitely disagree
42. I find it difficult to imagine what it would be like to be someone else.	definitely agree / slightly agree / slightly disagree / definitely disagree
43. I like to plan any activities I participate in carefully.	definitely agree / slightly agree / slightly disagree / definitely disagree
44. I enjoy social occasions.	definitely agree / slightly agree / slightly disagree / definitely disagree
45. I find it difficult to work out people's intentions.	definitely agree / slightly agree / slightly disagree / definitely disagree

46. New situations make me anxious.	definitely agree	slightly agree	slightly disagree	definitely disagree
47. I enjoy meeting new people.	definitely agree	slightly agree	slightly disagree	definitely disagree
48. I am a good diplomat.	definitely agree	slightly agree	slightly disagree	definitely disagree
49. I am not very good at remembering people's date of birth.	definitely agree	slightly agree	slightly disagree	definitely disagree
50. I find it very easy to play games with children that involve pretending.	definitely agree	slightly agree	slightly disagree	definitely disagree

7.2 AQ (a version of Chinese Mandarin)

The Adult Autism Spectrum Quotient

AQ test 成人版 (16 歲以上適用)

說明：

以下有 4 題例題以及 50 題的正式題，您不需要回答例題，但請務必回答正式題中的每一題。請您細心地閱讀每一題的陳述後，圈選出每一題您同意或不同意的程度，圈選的方式如例題所示。

例題：

1. 我樂於冒風險。	完全同意 (circled)	稍微同意	稍微不同意	完全不同意
2. 我喜歡玩棋盤遊戲(如：西洋棋、象棋、或大富翁等)。	完全同意	稍微同意	稍微不同意	完全不同意 (circled)
3. 學習彈奏樂器對我而言很容易。	完全同意	稍微同意 (circled)	稍微不同意	完全不同意
4. 我對外國或其他的文化著迷。	完全同意	稍微同意	稍微不同意 (circled)	完全不同意

正式題：

1. 與其獨立完成事情，我比較喜歡跟別人一起合作。	完全同意	稍微同意	稍微不同意	完全不同意
2. 我比較喜歡一直沿用同樣的方法來做事情。	完全同意	稍微同意	稍微不同意	完全不同意
3. 當我試著想像某事時，我腦海中很容易就出現畫面。	完全同意	稍微同意	稍微不同意	完全不同意
4. 我經常太強烈地投入於一件事，而忽略了其他的事情。	完全同意	稍微同意	稍微不同意	完全不同意
5. 我經常注意到別人沒察覺到的微小聲音。	完全同意	稍微同意	稍微不同意	完全不同意
6. 我常注意車子的車牌或類似的一連串的訊息。	完全同意	稍微同意	稍微不同意	完全不同意
7. 雖然我認為我說的話是有禮貌的，但是別人還是經常告訴我我說了不禮貌的話。	完全同意	稍微同意	稍微不同意	完全不同意

S. Baron-Cohen, S. Wheelwright, R. Skinner, J. Martin and E. Clubley, (2001), The Adult Autism Spectrum Quotient (AQ), Autism Research Center, University of Cambridge, UK; (Journal of Autism and Developmental Disorders 31: 5-17); Mandarin Version: M. J. Liu (2006), Department of Special Education, National Kaohsiung Normal University, Taiwan, Mail: mj@nknucc.nknu.edu.tw

8. 當我閱讀故事時，我可以輕易地想像故事人物的樣子。	完全同意	稍微同意	稍微不同意	完全不同意
9. 我對日期著迷。	完全同意	稍微同意	稍微不同意	完全不同意
10. 在社交聚會中，我可以輕易地保持對不同的人的談話內容的注意力。	完全同意	稍微同意	稍微不同意	完全不同意
11. 參與社交場合對我而言很容易。	完全同意	稍微同意	稍微不同意	完全不同意
12. 我傾向注意別人沒察覺到的細節。	完全同意	稍微同意	稍微不同意	完全不同意
13. 與其去參加派對，我還比較喜歡去圖書館。	完全同意	稍微同意	稍微不同意	完全不同意
14. 瞎編故事對我而言很容易。	完全同意	稍微同意	稍微不同意	完全不同意
15. 我發現自己對於人的興趣遠超過對於事情的興趣。	完全同意	稍微同意	稍微不同意	完全不同意
16. 我傾向有強烈的興趣，而當我不能去做我感興趣的事情時，我會生氣。	完全同意	稍微同意	稍微不同意	完全不同意
17. 我喜愛社交閒談。	完全同意	稍微同意	稍微不同意	完全不同意
18. 當我說話時，別人不是很容易能插得上話。	完全同意	稍微同意	稍微不同意	完全不同意
19. 我對數字著迷。	完全同意	稍微同意	稍微不同意	完全不同意
20. 當我閱讀故事時，去猜測故事中人物的意圖對我而言很困難。	完全同意	稍微同意	稍微不同意	完全不同意
21. 我並不特別喜愛閱讀小說。	完全同意	稍微同意	稍微不同意	完全不同意
22. 交新朋友對我而言很困難。	完全同意	稍微同意	稍微不同意	完全不同意
23. 我總是會注意各種事物的模式。	完全同意	稍微同意	稍微不同意	完全不同意
24. 與其去博物館，我還比較喜歡去戲院。	完全同意	稍微同意	稍微不同意	完全不同意
25. 如果我每天的生活作息被打亂了，我也不會生氣。	完全同意	稍微同意	稍微不同意	完全不同意

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26. 我經常發現我不知如何使對話持續下去。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
27. 當有人跟我說話時，我能很輕易地察覺言外之意。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
28. 我通常比較專注於大局，而非小細節。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
29. 我不擅長記住電話號碼。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
30. 我通常不會注意到環境中或是人的外表的細微改變。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
31. 我知道如何辨別別人是否已厭倦聽我說話。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
32. 同時做兩樣以上的事情對我來說是容易的。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
33. 當我講電話時，我不太確定什麼時候該我接話。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
34. 我喜愛隨興地做事情。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
35. 我常常是最後一個理解笑話中笑點的人。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
36. 我可以看別人的表情就輕易地猜出他們的想法或感覺。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
37. 當被打擾後，我可以很快地轉換回被打擾前在做的事。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
38. 我擅長社交閒談。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
39. 別人常告訴我我總是重複地說同樣的事。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
40. 兒童時期我喜愛與玩伴玩假裝性質的遊戲。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
41. 我喜歡蒐集事物類別的相關資訊(例如：有關車子類、鳥類、火車類或植物類的資訊) 。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
42. 我很難去想像成為另外一個人是什麼樣子。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
43. 我喜歡仔細地計劃我參與的任何一項活動。	完全 同意	稍微 同意	稍微 不同意	完全 不同意

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44. 我喜愛社交場合。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
45. 猜測別人的意圖對我而言很困難。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
46. 新的局勢會讓我焦慮。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
47. 我喜愛認識新朋友。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
48. 我是個善於交際的人。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
49. 我不擅長記住別人的生日。	完全 同意	稍微 同意	稍微 不同意	完全 不同意
50. 跟兒童玩假裝性質的遊戲對我而言很容易。	完全 同意	稍微 同意	稍微 不同意	完全 不同意

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7.3 Questionnaire

用任一顏色把你答案的框框補滿即可,再麻煩填好寄回給我囉，謝謝☺

	國語裡有這個字 (word)	無此字 (nonword)
ㄊㄧㄥˊ	☐	☐
ㄐㄧㄢˋ	☐	☐
ㄉㄧㄡˊ	☐	☐
ㄉㄨㄤˇ	☐	☐
ㄅㄧㄚˊ	☐	☐
ㄆㄧㄝˊ	☐	☐
ㄅㄚˇ	☐	☐
ㄆㄚˇ	☐	☐
ㄆㄧㄚˊ	☐	☐
ㄉㄧㄠˊ	☐	☐
ㄊㄨㄟˇ	☐	☐
ㄉㄨㄟˇ	☐	☐
ㄒㄧㄤˇ	☐	☐
ㄍㄧˊ	☐	☐
ㄉㄧㄡˊ	☐	☐
ㄊㄧㄡˊ	☐	☐
ㄎㄚˇ	☐	☐
ㄍㄚˇ	☐	☐
ㄍㄨㄟˊ	☐	☐
ㄎㄨㄞˋ	☐	☐

ㄎㄞ	□	□
ㄊㄨㄤˇ	□	□
ㄍㄥˋ	□	□
ㄎㄨㄟˊ	□	□
ㄍㄨㄛˊ	□	□
ㄎㄨㄛˊ	□	□
ㄉㄧㄝˊ	□	□
ㄉㄨㄟˋ	□	□
ㄍㄨㄟˋ	□	□
ㄓㄚˋ	□	□
ㄋㄧㄢˊ	□	□
ㄈㄟ	□	□
ㄍㄧㄢˋ	□	□
ㄎㄧㄢˋ	□	□
ㄅㄧㄡˊ	□	□
ㄍㄥˋ	□	□
ㄐㄧˊ	□	□
ㄊㄨㄥˋ	□	□
ㄊㄧㄡˊ	□	□
ㄆㄧㄡˊ	□	□
ㄅㄧㄝˊ	□	□
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ㄅㄧㄢˊ	□	□
ㄆㄧㄥˊ	□	□
ㄅㄧㄥˊ	□	□