THE RELATION BETWEEN VERB FACTIVITY AND THEORY OF MIND UNDERSTANDING IN MANDARIN-SPEAKING CHILDREN WITH AND WITHOUT AUTISM SPECTRUM DISORDER

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CERTIFICATE OF ORIGINALITY

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Abstract

This dissertation investigated the relation between verb factivity and first-order and second-order false belief (FB) reasoning in Mandarin-speaking children with and without autism spectrum disorders (ASD). Four studies were conducted. The first two included a corpus study on the production of six factivity verbs and an experimental study on the comprehension of these verbs in Mandarin-speaking adults and typically developing (TD) children. The results indicated that Mandarin-speaking TD children were able to understand verb factivity at 4;0, however, their knowledge of it did not reach an adult-like level even at 7;0. In the third study, three factivity verbs, a factive verb *zhīdào* 'know', a non-factive verb *juédé* 'think' and a counter-factive verb *jiǎzhuāng* 'pretend' were employed to examine the relation between verb factivity and first-order and second-order FB understanding in Mandarin-speaking TD children. The results showed that the TD children's understanding of verb factivity conveyed by the factive verb *zhīdào* 'know' significantly predicted first-order and second-order FB reasoning when controlling for verbal mental ability, inhibitory control, working memory and complementation. Besides, complementation and working memory were significant predictors of first-order and second-order FB reasoning as well in TD children, respectively. Although verb factivity was not a unique significant predictor of first-order or second-order FB reasoning, it was the unique predictor that significantly contributed to both first-order and second-order FB reasoning, which suggested a specific role it played in the development of FB reasoning in TD children. The fourth study explored the relation between verb factivity and first-order and second-order FB reasoning in a small group of Mandarin-speaking children with ASD. A group of ten autistic children and a group of ten TD children who were both

chronological age- and verbal mental age-matched (CA-VMA) with the autistic children were involved. The autistic children performed significantly poorer than the CA-VMA-matched TD children on the factive verb *zhīdào* ‘know’ and the counter-factive verb *jiǎzhuāng* ‘pretend’, and on first-order and second-order FB reasoning, but not on the non-factive verb *juédé* ‘think’, inhibitory control, working memory or complementation tasks. This suggested a possible link between verb factivity and first-order and second-order FB reasoning in Mandarin-speaking children with ASD.

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List of Abbreviations

Abbreviations	Items
1PS	First person subject
2PS	Second person subject
3PS	Third person subject
AS	Asperger's Syndrom
ASD	Autism spectrum disorders
BPVT	British Picture Vocabulary Test
CA	Chronological age
CA-VMA	Chronological age- and verbal mental age-matched
CCDI	Chinese Communicative Development Invertory
CCMD-3	the Chinese Classification of Mental Disorders Version 3
CHILDES	Child Language Data Exchange System
CLAN	Computerized Language Analysis
DCCS	Dimensional Change Card Sorting task
DNS	Day-Nigh Stroop task
DS	Dropped subject
DST	Digit Span Test
EF	Executive functioning
EXP	Experiential aspect marker
FB	False belief
GTNI	Gong's Nonverbal Intelligence Test
HFA	High functioning autism
IPSyn	Index of Productive Syntax
MA	Mental age
MCDI	The MacArthur Communicative Development Inventory
MLU	Mean length of utterance
MSV	Mental state verb
PERF	Perfective aspect marker
PPVT-R	Peabody Picture Vocabulary Test- Revised
PRT	Particle
RDLS	The Reynell Developmental Language Scales

Abbreviations	Items
SFP	Sentence final particle
TD	Typically developing
TELD	The Test of Early Language Development
ToM	Theory of mind
TVJ	Truth value judgment task
VMA	Verbal mental age
WISC	Wechsler Intelligence Scale for Children
WS	Wh-word subject

Chapter 1

1.1 Introduction

In Chinese, there is an idiom named 掩耳盗铃 *Yǎn ěr dào líng*[1]'Plugging one's ears while stealing a bell' that comes from a fable in "Lü's Spring and Autumn Annuals · know yourself". This fable tells a story about a man who tried to steal a big bronze bell. He covered his ears when striking the bell with a big iron hammer because he thought that nobody could hear the sound of the bell, as he himself could not hear it. It seems that the man in this fable dose not appreciate that others could have beliefs and intentions that are different from his own. He could not hear the sound, thus he falsely thinks that others could not hear it either. The man's behavior implies that he probably has difficulty with theory of mind (ToM), the ability to attribute mental states (e.g., desires, beliefs, intentions, emotions, feelings and pretending, *etc*.) to oneself and others, to understand that others have beliefs, desires and intentions which are different from reality and one's own and to predict others' behaviors according to their mental states (Premack & Woodruff, 1978). ToM has been regarded as one of the core components of social cognition and is crucial to successful interpersonal communication and social activities.

ToM, an umbrella term, consists of multiple aspects like joint attention, appreciation of intentionality and false belief (FB) (Astington, 1998; Miller, 2006). Among various components of ToM, FB, the understanding that a person has a belief that is different from one's own or reality and will behave according to that belief, has been regarded

[1] The Mandarin transcriptions in this thesis are Hànyǔ pīnyīn, the official romanization system for Standard Chinese in mainland China.

as the core component of ToM, and the mastery of it has been considered as the indicator of successful acquisition of ToM (Wellman, Cross, & Watson, 2001; Wimmer & Perner, 1983).

Successful interpersonal social communication requires sophisticated ToM ability as well as well-developed language and executive functioning (EF) abilities. Typically developing (TD) children experience rapid developments in these abilities in their first few years, whereas children with autism spectrum disorders (ASD) have deficits or delays in these abilities (e.g., Baron-Cohen, 1989; Baron-Cohen, Leslie, & Frith, 1985; Ozonoff, Pennington, & Rogers, 1991; Park, Yelland, Taffe, & Gray, 2012). The findings from substantial studies have revealed that ToM relates to various aspects of language such as pragmatics, syntax and semantics (e.g., Astington & Jenkins, 1999; de Villiers, 2007; Harris, de Rosnay, & Pons, 2005), as well as to several components of EF such as inhibition and working memory (Carlson, Moses, & Breton, 2002; Davis & Pratt, 1995). However, no consensus has been reached on which aspect of language contributes to ToM development particularly, and it remains unclear whether language contributes uniquely to ToM independent of EF. This thesis investigated the relation between verb factivity (a feature of predicates that ascribe factuality, non-factuality or counter-factuality to their complement clauses (Leech, 1981; Li, 2014)) and first-order and second-order FB understanding in Mandarin-speaking children with and without ASD, and to examine whether verb factivity is a unique predictor of FB reasoning when controlling for the effects of other related factors such as verbal mental ability, EF, and complementation.

This chapter consists of seven sections. The first section introduces ToM. The second section presents tasks that are widely used tasks to assess FB and FB development in children with and without ASD. The third second reviews the literature in the relation

between language and first-order and second-order FB reasoning in both TD children and children with ASD. The fourth section presents hypotheses on the relation between language and ToM. The fifth section discusses remained issues on the relation between language and ToM, which is followed by the objectives of this thesis in the sixth section. This chapter ends with the outline of this thesis in the seventh section.

1.2 FB

Sophisticated interpersonal communication requires not only first-order beliefs, that is people's beliefs about an object or an event or another person's belief but also higher order beliefs such as people's beliefs about another person's beliefs about a third person's beliefs (second-order beliefs).

1.2.1 FB tasks

The most widely used tasks for assessing first-order FB reasoning are the change-of-location task (Wimmer & Perner, 1983) and the unexpected content, also called Smarties task (Gopnik & Astington, 1988; Perner, Leekam, & Wimmer, 1987). In the scenario of the standard version of change-of-location task, participants are presented two protagonists A and B. Protagonist A puts an object into a location x and then left the scene. In the absence of protagonist A, protagonist B transfers the object from location x to another location y and then left the scene as well. After protagonist B leaves, protagonist A comes back to the scene. Participants are asked a test question "*Where will protagonist A look for the object when he/she returns?*" and two control questions, one reality question "*Where is the object really?*" and one memory question "*Where did protagonist A put the object in the beginning?*" following the test question

immediately. Correct response to the test question requires one to understand and remember the story and to explicitly represent protagonist A's FB ('the object is in location x') in relation to his/her own knowledge of the location of the object ('location y') (Wimmer & Perner, 1983).

Compared to the change of location task, the unexpected content task has been found easier for children to pass, as participants have direct experience of how themselves could be misled when confronted with the same situation as another person (Perner *et al.*, 1987). In the scenario of the unexpected content task, participants are shown a closed box (e.g., a candy box) which is familiar to them and asked what they think is in the box. After their response (e.g., candies) to the question, they are shown that they were wrong and the actual contents of the box (e.g., pencils), and then they are asked to help to put these pencils back into the box and close it. A control question "*Can you remember what is inside the box?*" and a test question about participants' own previous belief about the content of the box "*What did you think was in the box?*" are asked here. A protagonist A is then introduced to participants, and they are told that protagonist A comes to the scene, and he/she would be shown the closed box and asked what is in the box. Another test question about protagonist A's belief about the content of the box "*What will the protagonist A think is in the box?*" is asked at the end of the story (Perner *et al*., 1987). Correct responses to the test questions in the unexpected content task require one to represent his/her own previous FB and another person's FB and to distinguish them from reality.

For second-order FB reasoning, Perner and Wimmer (1985) established a story-understanding paradigm to assess children's representation of one person's FB about another person's FB by an ice-cream van story. The story consists of four episodes. In the first episode, two protagonists (John and Mary) are informed that an ice-cream van

will stay all afternoon in a park, and Mary leaves the park to go home to get some money to buy ice-creams. In the second episode, only John knows the sudden change of the van's transition from the park to a church in the afternoon. In episode 3, the ice-cream man tells Mary that the van will move to the church for the rest of the day when he passes by Mary's house, and John does not know that the ice-cream man talked to Mary. In episode 4, John comes to Mary's house, and Mary's mom tells John that Mary has gone to buy an ice-cream, thus John will go to look for Mary. A test question is asked here "*Where does John think Mary will go for ice cream?*", being followed by three control questions: (1) "*Does Mary know that the ice-cream van is at the church?*", (2) "*Does John know that the ice-cream man has talked to Mary?*" and (3) "*Where did Mary go for her ice cream?*". To answer the test question correctly, one is required to represent John's second-order FB correctly: John falsely thinks that Mary falsely thinks that the van is still at the park.

1.2.2 FB reasoning in TD children

An increasing number of studies have been conducted to investigate FB development. Most of previous studies on children's first-order FB reasoning employed the change-of-location and unexpected content tasks, with minor revisions according to specific purposes in each investigation. A considerable body of research in Western countries as well as in China has accumulated. Wellman *et al*. (2001) conducted a meta-analysis of ToM development in TD children based on 178 separate studies that were reported from 1983 to January 1998 in different countries. The authors found that younger children at 3;0 performed below chance on first-order FB tasks, but children at 4;0 performed above chance on those tasks. Their results indicated that the country of origin influenced children's FB performance, suggesting that children from different

countries perform differently on FB tasks. However, most of the samples involved in Wellman *et al*.'s (2001) meta-analysis were from English-speaking countries, only a small number of samples from non-English-speaking countries were reported.

Liu *et al*. (2008) conducted a meta-analysis based on studies on Chinese-speaking TD children's first-order FB performance. A total of 196 conditions conducted in mainland China and Hong Kong from 1994 to April 2004 were reported and were compared to 155 conditions conducted from 1988 to 1998 on English-speaking children in the United States and Canada. With regard to the developmental timing of ToM, Mandarin-speaking children from mainland China performed similarly with English-speaking children from United States who started performing above chance at around 4;0, while Cantonese-speaking children from Hong Kong took more than two years than children from Cannada to perform above chance (5;4 vs. 3;2).

The onset of TD children's second-order FB reasoning is at around 5;0 or 6;0, one to two years later than that of their first-order FB reasoning. Perner and Wimmer (1985) assessed five- to eleven-year-old English-speaking children's second-order belief understanding of ice-cream story with various versions and stated that their standard version of ice-cream story was a valid test of children's ability to represent second-order FB. The authors found that the 5;0 begun, many 6;0 and most 7;0 were able to represent and understand the more advanced second-order FB reasoning.

1.2.3 FB reasoning in children with ASD

Apart from studies on TD children's understanding of FB reasoning, a large body of work has been conducted to examine the understanding of FB in children with autism spectrum disorders (ASD). One characteristic of ASD is persistent deficits in social

interaction, verbal and non-verbal communication (American Psychiatric Association, 2013), regardless of IQ. One hypothesis on the deficits in social communication in individuals with ASD is that they are due to deficits or specific developmental delays in ToM (Baron-Cohen, 1989; Baron-Cohen *et al*., 1985). The findings from dozens of research have evidenced that children with ASD have delays or impairments in both first-order and second-order FB reasoning (e.g., Baron-Cohen, 1989; Baron-Cohen *et al*., 1985; Colle, Baron-Cohen, & Hill, 2007; Happé, 1995; Leung & Li, 2019; Ozonoff *et al*., 1991; Zhang, Shao, & Zhang, 2016; Zhou & Fang, 2011).

Baron-Cohen *et al*. (1985) were the first researchers who adapted Wimmer and Perner's (1983) change-of-location paradigm to test autistic children's first-order FB reasoning. Twenty-seven TD children (mean age = 4;5) and 14 children with Down's Syndrome (mean age = 10;11; mean non-verbal mental age (MA) = 5;11; mean verbal mental age (VMA) = 2;11) were involved as controls for 20 children with ASD (mean age = 11;11; mean non-verbal MA = 9;3; mean MA = 5;5). The participants' non-verbal MA was measured by Leiter International Performance Scale, and MA was measured by the British Picture Vocabulary Test (BPVT). Although the autistic children had a higher MA than the controls, 80% of them failed first-order FB tasks. The authors concluded that autistic children as a group failed to represent mental states and to appreciate differences between their own and other's beliefs.

As there were 20% of autistic children that passed first-order FB tasks in Baron-Cohen *et al*. (1985), it is likely that autistic children had a developmental delay rather than had deficits in FB reasoning. As five- to six-year-old TD children were able to represent second-order FB, Baron-Cohen (1989) proposed that if autistic children, who were older than 6;0 and passed first-order FB tasks and failed second-order FB tasks, it would suggest that they had a delay in FB development. To test this hypothesis,

Baron-Cohen (1989) used an adapted version of Perner and Wimmer's (1985) procedure to test second-order FB reasoning in ten autistic children (mean age = 15;4; mean VMA = 7;10; mean non-verbal MA = 10;8) who passed first-order FB tasks. Ten TD children (mean age = 7;6) and ten children with Down's Syndrome (mean age = 14;4; mean VMA = 4;8; mean non-verbal MA = 6;10) were involved as controls. The participants' non-verbal MA was measured by Leiter International Performance Scale, and MA was measured by the BPVT. The autistic children had a higher MA than the controls. The results showed that 90% and 60% of the TD children and the children with Down's syndrome, respectively, passed second-order FB task, whereas none of the autistic children passed the task. Therefore, Baron-Cohen (1989) concluded that autistic children were chronologically delayed in FB development.

The findings from some subsequent studies lent support to Baron-Cohen's (1989) hypothesis that autistic children are delayed in FB development. Happé (1995) tested 70 autistic children's, 34 mentally handicapped children's and 70 TD children's first-order FB reasoning with change-of-location and unexpected content tasks. The autistic children (mean age = 12;10; mean VMA = 6;3) were matched with the mentally handicapped children in both chronological age (CA) (mean = 12;3) and VMA (mean = 6;2). The participants' VMA was measured by BPVT. The author found that the proportion of the autistic children who passed FB tasks was significantly smaller than those of the mentally handicapped children and TD children (mean age = 4;0; mean VMA = 4;3) (20% vs 58% and 56%, respectively). The results showed that autistic children had a delay in first-order FB reasoning. For TD children with a VMA of 4;0, they had a 50% chance to pass first-order FB tasks, whereas it took twice as long for autistic children who had a VMA of 9;2 to have a 50% probability to pass first-order

FB tasks. Therefore, it suggested that autistic children required a higher VMA to pass first-order FB tasks.

Apart from studies in English-speaking children, several studies on Chinese-speaking children have also found that autistic children have difficulties in passing FB tasks (Yang & Zhou, 2007; Zhang *et al*., 2016; Zhou & Fang, 2011). Yang and Zhou (2007) examined 18 Chinese-speaking autistic children's (mean age = 7;7; mean IQ = 99) and 30 TD children's (mean age = 8;0; mean IQ = 117) understanding of first-order FB tasks by appearance-reality task, change-of-location task and unexpected content task. The participants' IQ was assessed by Gong's Nonverbal Intelligence Test (GTNI, Gong, 1997). Over 90% of TD children passed all three first-order FB tasks, whereas the proportions of the autistic children who passed each task were quite low, 22%, 19%, 62%, and 39% of autistic children passed the appearance-reality task, change-of-location task, unexpected content (self-false-belief question), and unexpected content (other-false-belief question) task, respectively. Similar to Yang and Zhou (2007), Zhang *et al.* (2016) also examined able Chinese-speaking autistic children's first-order FB reasoning by an unexpected content FB task. Thirty-four children with high functioning autism (HFA, people with autism with IQ above 70) (mean age = 6;2,; mean VMA = 4;8) were matched with 76 TD children (mean age = 5;1; mean VMA, mean = 5;1) in VMA. The participants' VMA was measured by the Chinese version of the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Sang & Miao, 1990). The authors found that 24% of the autistic children and 49% of the TD children passed first-order FB task. Similar results have been obtained even when less linguistic demanding non-verbal first-order FB tasks were used. Zhou and Fang (2011) employed a non-verbal first-order FB task to test a group of low functioning Chinese-speaking autistic children's first-order FB reasoning. Twenty-six autistic children

(mean age = 10;10; mean IQ = 38; mean MA = 1;0) were matched with 28 mentally retarded children (mean age = 10;4; mean IQ = 39; mean MA = 1;3) in age, IQ and MA (measured by the Chinese Communicative Development Invertory, CCDI, Tardif, Zhang and Liang (2008)). The results showed that the mentally retarded children performed significantly better than the autistic children, with 54% and 14% of the two groups of children, respectively, passing first-order FB tasks.

Although a number of studies have found that children with ASD have deficits or specific delays in first-order and second-order FB reasoning, the findings from several other studies argued that a quite high proportion of autistic children were able to pass first-order and second-order FB tasks (e.g., Bauminger & Kasari, 1999; Dahlgren & Trillingsgaard, 1996; Tager-Flusberg & Sullivan, 1994). Dahlgren and Trillingsgaard (1996) tested 20 able autistic children's (mean age = 10;7; mean MA = 10;6; mean VMA = 10;2; mean IQ = 99) understanding of first-order change-of-location FB task and second-order ice-cream van FB task and compared their performances with those of 20 children with Asperger's Syndrom (AS) (mean age = 10;2; mean MA = 10;2; mean VMA = 11;0; mean IQ = 100) and 20 TD children (mean age = 9;0; mean MA = 10;6; mean VMA = 10;8; mean IQ = 117). The participants' IQ was assessed by Wechsler Intelligence Scale for Children (WISC) (Wechsler, 1949). The results showed that 90% and 60% of the children with ASD, 85% and 60% of the children with AS and 100% and 90% of TD children passed first-order and second-order FB tasks, respectively. All three groups of children did not perform significantly different on first-order FB tasks. For second-order FB task, the TD children performed significantly better than the children with ASD ($p < .03$) and the children with AS ($p < .03$). Another study conducted by Bauminger and Kasari (1999) as well documented that a quite high proportion of autistic children were able to pass second-order FB

tasks. Bauminger and Kasari (1999) tested second-order FB understanding in 22 children with HFA (mean age = 10;9; mean IQ = 108). Nineteen TD children were recruited as controls. The autistic children and TD children (mean age = 10;11; mean IQ = 116) were carefully matched in age and IQ. The IQ was based on the WISC-R. The authors found that as high as 68% of the autistic children and 89.5% of the TD children passed second-order FB task.

With regard to previous studies that have found autistic children's deficits or delays in second-order FB tasks, Tager-Flusberg and Sullivan (1994) argued that the source of the delays was not clearly specified, and proposed that it was the added information-processing load of second-order tasks that posed difficulties for autistic children in understanding second-order FB tasks. The authors tested 12 autistic children's (mean age = 17;1; mean VMA = 9;8; mean IQ = 76) and 12 mentally retarded children's (mean age = 14;3; mean VMA = 8;6; mean IQ = 73) second-order FB reasoning by a new version of the standard second-order FB story which was shorter in length and less complexed, therefore reduced information processing demands. The participants' VMA was measured by PPVT. All of the autistic children and mentally retarded children passed the standard first-order FB task, and around 58% and 67% of the two groups of children, respectively, passed the new version second-order FB task.

In sum, mixed results have been obtained about whether autistic children have deficits or delays on FB reasoning, and about the proportions of autistic children who are able to pass FB tasks. Baron-Cohen *et al*. (1985) and Happé (1995) found that autistic children have deficits and delays in first-order FB tasks, only around 20% of their autistic children passed first-order FB tasks, whereas as high as 90% of autistic children passed first-order FB tasks in Dahlgren and Trillingsgaard (1996). For second-order FB tasks, some studies documented that none of autistic children passed

them (Baron-Cohen, 1989), whereas others reported that around 60% or even higher proportion of autistic children were able to pass them (Bauminger & Kasari, 1999; Dahlgren & Trillingsgaard, 1996; Tager-Flusberg & Sullivan, 1994). The VMAs of autistic children in Dahlgren and Trillingsgaard (1996) (10;2) and Tager-Flusberg and Sullivan (1994) (9;8) were older than those in Baron *et al*. (1985) (5;5), Baron-Cohen (1989) (7;10), Happé (1995) (6;3) and Zhang *et al*. (2016) (4;8). This suggests that autistic children may need higher VMA to pass FB tasks, which implies a role of language in autistic children's FB reasoning.

1.3 Language and FB reasoning

In children's first few years, both language and ToM develop rapidly. A great many studies have found that language and ToM are closely related in both TD children and children with ASD. In this section, previous studies on the relation between various aspects of language and first-order and second-order FB reasoning in children with and without ASD are reviewed.

1.3.1 Language and first-order FB reasoning in TD children

In the past four decades, an increasing number of studies have been conducted to examine the relation between various aspects of language and first-order FB reasoning in TD children. Some researchers have found that general language relates to first-order FB reasoning (Cheung, 2006; Cheung *et al*., 2004), some claim that general syntax (Astington & Jenkins, 1999) and specific syntactic sentential complement structure relate to first-order FB reasoning (de Villiers, 2000, 2005; de Villiers & de Villiers, 2000, 2003; Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003; Mo

et al., 2014; Schick *et al*., 2007), while others argue that lexical-semantics or some semantic feature such as mental state verbs (MSVs) and verb factivity relate to first-order FB reasoning (Cheung, Chen, & Yeung, 2009; Ornaghi, Brockmeier, & Gavazzi, 2011; Ruffman, Slade, & Crowe, 2002).

1.3.1.1 General language

A number of studies have found that general language assessed by various measurements relates to children's first-order FB reasoning in different languages. Jenkins and Astington (1996) found that general language (syntax and semantics) ability assessed by the Test of Early Language Development (TELD) (Hresko, Reid, & Hammill, 1981) was a significant predictor of 3;0 to 5;0 English-speaking children's performance on first-order FB tasks. Farrar and Maag (2002) examined the relation between English-speaking children's early general language at 2;0 and their later first-order FB performance at 4;0 longitudinally. The children's language ability at 2;0 was assessed by the MacArthur Communicative Development Inventory (MCDI) (including vocabulary and grammatical complexity) and mean length of utterance (MLU). The authors found that the children's early general language ability uniquely predicted their ToM performance at 4;0 when controlling for their general language ability assessed by Peabody Picture Vocabulary Test (PPVT) at 4;0. Several studies confirmed the importance of general language in first-order FB reasoning as well when controlling for other specific aspects of language. Cheung *et al*. (2004) and Cheung (2006) examined relative roles of general language and sentential complement structures in first-order FB reasoning in four-year-olds. Cheung *et al*. (2004) found that English-speaking children's general language measured by TELD-3 (Hresko, Reid, & Hammill, 1999) was a unique predictor of their first-order FB performance when controlling for complementation. Both Cheung *et al*. (2004) and Cheung (2006)

found that Cantonese-speaking children's general language assessed by the Reynell Developmental Language Scales (RDLS) (Reynell & Huntley, 1985) uniquely predicted their first-order FB reasoning when controlling for complementation. Therefore, the authors claimed that general language comprehension was a more important contributor to the 4;0's performance on FB tasks, compared to sentential complement structure.

1.3.1.2 Syntax

Although several studies did not find a significant role of general syntax or specific sentential complement structure in children's first-order FB performance, there were a fair number of studies that did find the importance of general syntax and sentential complementation in first-order FB reasoning (e.g., Astington & Jenkins, 1999; de Villiers & de Villiers, 2000, 2003; de Villiers & Pyers, 2002; Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003; Mo *et al*., 2014). Astington and Jenkins (1999) investigated the relation between first-order FB reasoning and language, including both syntax and semantics in 59 three-year-olds longitudinally three times over a period of seven months. The children's language ability was assessed by the TELD. The authors found that the children's earlier general syntactic but not semantic ability significantly predicted their later FB performance. Therefore, the authors claimed that first-order FB development depends on general syntax.

To examin which particular aspect of syntax relates to FB reasoning in more detail, de Villiers and de Villiers (2000) proposed that sentential complement structure provided a representational format for children's FB reasoning. Sentences with complement clauses, for example, "*John thinks that Mary is at the office*.", being different from other complex syntactic structures such as relative clauses, make it possible that the

whole sentence is true, while the proposition is false (de Villiers & de Villiers, 2000). In de Villiers and de Villiers's (2000) words,

"Complementation provides a means of representing someone's mental world, and that mental world could be distinct from our mental world. On this account it is not just that language provides the discourse within which children reach an understanding of mind, it is critical that it also provides structures of the right semantic complexity and power for the representation of false beliefs."

De Villiers and de Villiers (2000) and de Villiers and Pyers (2002) measured three-year-olds' language ability and first-order FB understanding at four times within one year. The children's general language ability was measured by MLU and Index of Productive Syntax (IPSyn) (Scarborough, 1990) without complements. The results indicated that the mastery of sentential complement structure, but not general language predicted the children's later performance on first-order FB tasks, but not vice versa. Therefore, the authors claimed that the acquisition of sentential complement structure was necessary for FB reasoning.

More evidence from training studies lent support to the important role of complementation in first-order FB reasoning (Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003; Mo *et al.*, 2014). Hale and Tager-Flusberg (2003) conducted training on complementation, FB and relative clauses to English-speaking preschoolers who failed FB tasks at pretests, age 3;0 to 4;10. The children were divided into three groups, with one group receiving training on complementation, FB and relative clauses, respectively. The posttest was administered after two sessions of training. The group who received complementation training showed improvement in both complementation and FB tasks, while the group who received FB and relative clause training only showed improvement in corresponding tasks related to the training

they received. Lohmann and Tomasello (2003) conducted training on sentential complement structure and perspective-shifting discourse about deceptive objects to German-speaking three-year-olds. The children were divided into four groups and received training on (1) perspective-shifting discourse about deceptive objects with mental or communicative verbs, on (2) perspective-shifting discourse about deceptive objects without mental or communicative verbs, on (3) sentential complement structures, and on (4) deceptive objects without language, respectively. The authors found that the groups of children who received training on perspective shifting discourse objects with sentential complement structures and on sentential complements significantly outperformed those who did not receive training on sentential complements, suggesting that sentential complement was sufficient by itself to facilitate children's first-order FB reasoning. Mo *et al*. (2014) investigated the role of sentential complements in three- to four-year-old Mandarin-speaking children's first-order FB reasoning. Three groups of children received training on (1) sentential complement structures with communication verbs and (2) with MSVs and (3) on the understanding of false representations, respectively, were compared to a control group of children. The authors found that the children who received training on sentential complement structures with communication verbs and false representations performed significantly better on first-order FB tasks than the control group. The results from this study suggested that sentential complement structure played an important role in facilitating Chinese-speaking children's first-order FB reasoning as well.

1.3.1.3 Semantics

Apart from general language and syntax, a few studies have found that lexical-semantics is closely related to children's first-order FB reasoning as well. It has been proposed that the use of MSVs that express inner cognitive, emotive or perceptive

events and function as labels for people's belief may help children to promote their awareness of mental experiences and to form mental state concepts. In addition, the use of them as well provides children with a linguistic environment which may help them to focus on their mental states (Brown, Donelan-McCall, & Dunn, 1996; Montgomery, 2002). A few studies found that the input of early MSVs causally related to children's later first-order FB reasoning. Ruffman *et al*. (2002) and Howard (2008) investigated the relation between mothers' use of MSVs and children's first-order FB performance. In Ruffman *et al*. (2002), mothers' use of mental state language in picture description and children's first-order FB performances at three-time slots within 14 months were obtained. The results revealed that mothers' use of MSVs at children's early age was causally related to the children's later first-order FB performance when controlling for the children's age, language ability, and early first-order FB performance. Howard (2008) examined the influence of mothers' conversational use of MSVs to three- and four-year-olds' understanding of MSVs and ToM in a more detailed way. Mothers' use of utterances with *think*, *know*, *remember*, *guess* and *forget* were analyzed. The author found that mothers' use of these verbs in questions positively predicted the children's MSVs and first-order FB performances.

Besides early MSVs input, training on MSVs as well plays an important role in children's first-order FB understanding. Howard (2012) conducted a training study to examine the role of MSVs in children's first-order FB reasoning. Seventy-two preschoolers received two sessions of training in MSVs *think, know* and *remember* over two weeks. MSVs were presented in the form of different sentence types (statement or question), referents (first person or other person), and interaction styles (overheard (directed to someone other than the child) or interactive (directed to the

child)). The author found that MSVs in the style of overheard in both statement and question and about others promoted children's first-order FB performance.

Although results from a number of studies revealed the important role of MSVs in FB reasoning, different MSVs differ in the degree of facilitating FB reasoning. Lee, Olson, and Torrance (1999) and Tardif, Wellman and Cheung (2004) examined the role of the explicit use of MSVs in FB probe questions in Chinese-speaking 3;0 to 5;0 preschoolers' FB performance. Three Mandarin MSVs *xiǎng* 'think', *yǐwéi* 'falsely think' and *dāng* 'regard as', and two Cantonese MSVs *nam2* 'think' and *ji5wai4* 'falsely think' were used in FB probe questions in Lee *et al*. (1999) and Tardif *et al*. (2004), respectively. Among these verbs, *xiǎng/nam2* 'think' are more neutral than the other three in describing mental states. *Yǐwéi/Ji5wai4* 'falsely think' and *dāng* 'regard as' are commonly used for describing situations related to FB. The results showed that children performed significantly better in *yǐwéi/ji5wai4* 'falsely think' and *dāng* 'regard as' conditions than in *xiǎng/nam2* 'think' condition, which suggested that MSVs expressing FB were more likely to facilitate children's FB reasoning.

MSVs are used in complex sentences with sentential complements to express one's belief. For example, 小明以为蛋糕在盒子里。(*Xiǎomíng yǐwéi dàngāo zài hézi li.* Xiǎomíng falsely think cake at box inside. 'Xiǎomíng falsely thinks that the cake is in the box'). With regard to the role of MSVs used in sentential complement structure in FB reasoning that has been attested in a number of previous studies, there are several possibilities. The first is that it is the syntactic sentential complementation structure that plays a role in FB reasoning. The second is that it is the semantic features of MSVs that contribute to FB reasoning. The use of different MSVs in Lee *et al*. (1999) and Tardif *et al*. (2004) suggests that it is likely that the semantic features of MSVs, rather than sentential complementation structure alone contribute to their participants' FB

reasoning. As MSVs *xiǎng* ‘think’, *yǐwéi* ‘falsely think’ and *dāng* ‘regard as’ were all used in the same syntactic structure in Lee *et al*. (1999) and Tardif *et al*. (2004), whereas the children’s performances in *yǐwéi* ‘falsely think’ and *dāng* ‘regard as’ were significantly different from that in *xiǎng* ‘think’. One distinguishing semantic feature among the three verbs is verb factivity, the feature that a verb presupposes speakers’ beliefs about the truth or falsity of propositions of complement clauses (Kiparsky & Kiparsky, 1971; Leech, 1981). From the perspective of verb factivity, *xiǎng* ‘think’ is a non-factive verb which does not presuppose speakers’ beliefs about the truth or falsity of the propositions of its complement clauses, while *yǐwéi* ‘falsely think’ and *dāng* ‘regard as’ could be used as counter-factive verbs which presuppose speakers’ beliefs about the falsity of the propositions of their complement clauses (Leech, 1981). Therefore, it was likely that it was the feature of verb factivity of MSVs *yǐwéi* ‘falsely think’ and *dāng* ‘regard as’ that played a role in children’s FB reasoning in Lee *et al*. (1999) and Tardif *et al*. (2004).

1.3.1.4 Verb factivity

Verb factivity is a feature of predicates that presupposes speakers’ beliefs about the truth or falsity of the propositions of complement clauses (Leech, 1981). The use of verb factivity requires monitoring other’s mental states. It has been hypothesized that verb factivity and FB are naturally related as the understanding of both complement falsity and FB reasoning involves decoupling a false mental representation of reality (Chen *et al*., 2012; Cheung *et al*., 2012). The results from a behavioral study (Cheung *et al*., 2009) and two neuroimaging studies (Chen *et al*., 2012; Cheung *et al*., 2012) have evidenced that verb factivity is closely related to first-order FB reasoning.

As verb factivity is conveyed in sentential complement structure, to examine whether verb factivity contributes uniquely to children's first-order FB reasoning when controlling for the effect of sentential complement structure, Cheung *et al*. (2009) assessed four-year-old Cantonese-speaking children's understanding of sentential complement structure and verb factivity separately with independent tasks. Two factives *zi1dou3* 'know' and *faat3jin6* 'discover' and two counter-factives *ji5wai4* 'falsely think' and *gong2daai6waa6* 'lie' were employed to examine the children's understanding of verb factivity. The four verbs could be further divided into MSVs (*zi1dou3* 'know' and *ji5wai4* 'falsely think') and behavioral verbs (*faat3jin6* 'discover' and *gong2daai6waa6* 'lie'). The choice of these verbs made it possible to compare the role of children's understanding of factives and counter-factives in their first-order FB reasoning, as well as the role of their understanding of MSVs and behavioral verbs in their FB performance. With respect to the children's understanding of sentential complementation, the neutral communication verb *waa6* 'say' was used in the complement task which followed de Villiers and Pyers (2002). In the factivity task, test sentences with factivity verbs were presented in the form of an isolated truth value judgment (TVJ) task (e.g., "*May ji5wai4 Mary zau2 zo2*."), in which children were required to make judgments about the truth values of complement clauses solely depending on the semantics of factivity verbs. In order to control the influence of factivity-biased verbs, the verb *nam2* 'think' which did not presuppose the truth or falsity of complement clauses was used in FB probe test questions. The authors found that the children's understanding of counter-factivity conveyed by the mental state counter-factive *ji5wai4* 'falsely think' predicted their first-order FB performance the most strongly even when controlling for complementation.

Chen *et al*. (2012) and Cheung *et al*. (2012) conducted neuroimaging studies to investigate whether Mandarin-speaking adults' FB reasoning related to their understanding in the counter-factive verb *yǐwéi* 'falsely think' by using ERP and fMRI, respectively. They proposed that counter-factives and FB may share similar activities and common region in the brain as they both involve decoupling a false mental representation from reality. The participants received non-verbal pictorial material expressing true and false beliefs and sentences with the counter-factive *yǐwéi* 'falsely think' which negated its complement clauses. The results from the two neuroimaging studies have shown that the counter-factive *yǐwéi* 'falsely think' and non-verbal FB understanding share some common neural basis, but they are not neurologically equivalent and had unique neural representations.

1.3.2 Language and second-order FB reasoning in TD children

Although first-order FB reasoning is crucial for social interpersonal communication, situations in real life are much more complexed than story scenes described in first-order FB tasks. More advanced belief reasoning such as second-order FB reasoning is necessary and important for people, for example, to understand idioms and ironies appropriately (Caillies & Le Sourn–Bissaoui, 2013), to make moral judgments correctly (Fu *et al*., 2014) and the like. However, compared to first-order FB reasoning, second-order FB reasoning is far less investigated and relatively little is known about it (Miller, 2012). It remains unclear how second-order FB reasoning is shifted from first-order FB reasoning, how it is related to language, and which aspects of language contribute uniquely to its development.

A few studies have recently been conducted to examine the relation between language and second-order FB reasoning. Hollebrandse *et al*. (2014) examined whether language supported the development of the higher-order FB reasoning by comparing 6;0 to 9;0 Dutch-speaking children's performance on a verbal and a low-verbal version of a second-order FB task. In the verbal task, eight stories with each being accompanied by four pictures were presented. In the low-verbal task, the children were shown four short movies about first-order and second-order FB reasoning, respectively. The results showed that the children performed significantly better on the verbal version than on the low-verbal version of second-order FB task, which led the authors to conclude that language might facilitate children's explicit second-order FB reasoning. However, Hollebrandse *et al*. (2014) did not assess children's language ability separately, therefore the role of language in second-order FB reasoning remains inconclusive.

Different from Hollebrandse *et al*. (2014), the results from Lockl and Schneider (2007) demonstrated an important role of language in children's second-order FB reasoning. Lockl and Schneider (2007) investigated the relations among language, first-order and second-order FB reasoning, and metamemory in a longitudinal study on 170 3;0 to 5;0 German-speaking children. The children's language ability was estimated by a battery of language measurements including syntactic, semantic, morphological and phonological aspects. The authors found that at 5;0, the children's general language ability, a combined score of sentence comprehension, sentence memory, morphological rule ability, and phonological memory was strongly correlated with their second-order FB reasoning, and the children's early language ability (sentence comprehension and sentence memory) significantly contributed to their later second-order FB performance.

Arslan, Hohenberger and Verbrugge (2017) examined the relation between the more specific aspect of language, syntactic recursion and the development of second-order FB reasoning. The authors investigated the role of second-order syntactic recursion and working memory in the development of second-order FB reasoning in 4;0 to 8;0 Turkish-speaking children who were divided into two groups: the younger groups, aged 4;0 to 6;0, and the older group, aged 6;0 to 8;0. In an attempt to examine the role of syntactic feature of embedded representation, the authors tested the children's understanding of second-order relative clauses rather than sentential complement clauses. The children received simple as well as complex working memory span tests, and their second-order FB performance was divided into judgment and justification. The results indicated that syntactic recursion significantly correlated with younger children's performance on second-order FB judgment and justification when controlling for age and simple working memory, whereas the significant relationship disappeared when controlling for complex working memory. The complex working memory was a significant predictor of younger children's performance on second-order FB judgment and justification and of older children's performance on second-order FB justification when controlling for age, syntactic recursion and simple working memory.

1.3.3 Language and FB reasoning in ASD children

Apart from ToM, results from a body of research have shown that children with ASD have difficulties in various linguistic forms such as MSVs (Tager-Flusberg, 1992), reflexive pronouns (Perovic, Modyanova, & Wexler, 2013), serial verb construction (Leung & Li, 2015, 2019) and verb factivity (Cheung *et al.*, 2017; Yi *et al.*, 2013). Substantial studies have as well investigated the relation between language and ToM

in autistic children and found that various aspects of language such as verbal ability, syntactic ability, and sentential complements play important roles in autistic children's FB reasoning (e.g., Durrleman *et al*., 2016; Farrar, Seung, & Lee, 2017; Fisher, Happé, & Dunn, 2005; Happé, 1995; Lind & Bowler, 2009; Paynter & Peterson, 2010; Sparrevohn & Howie, 1995; Tager-Flusberg, 2000; Tager-Flusberg & Joseph, 2005; Ziatas, Durkin, & Pratt, 1998). However, it is still an open question that which particular aspects of language are important or are more important to autistic children's success in FB tasks. The findings from several studies have suggested that verbal ability is important to autistic children's FB performances (Happé, 1995; Sparrevohn & Howie, 1995; Ziatas *et al*., 1998). Happé (1995) found that autistic children took more than twice as long to reach 50% of possibility of passing first-order FB tasks at a VMA of 9;2, compared to TD children who had a 50% possibility of passing first-order FB task at a VMA of 4;0, which suggested that autistic children needed a higher level of verbal ability to pass FB tasks successfully, compared to TD children. Sparrevohn and Howie (1995) as well found that a group of autistic children with high VMA (mean = 9;3) performed significantly better than another group of autistic children with low VMA (mean = 5;8) on first-order FB and second-order FB tasks. Although verbal ability plays an important role in autistic children's FB reasoning, studies that examined the role of both lexical and syntactic skills in autistic children's ToM performances have found that syntactic ability is a stronger predictor than verbal ability of autistic children's FB reasoning (Fisher *et al*., 2005; Paynter & Peterson, 2010). More specifically, other researchers investigated the specific role of complementation on FB performance in autistic children and found that autistic children were especially dependent on the knowledge of complementation to bootstrap their meta-representation capacity, thus concluded that the acquisition of sentential complements was the key to autistic children's FB reasoning (Farrar *et al*., 2017; Lind

& Bowler, 2009; Tager-Flusberg, 2000; Tager-Flusberg & Joseph, 2005). Furthermore, Durrleman and colleagues found that sentential complements with verbs of communication and cognition played a role in autistic children's FB performances (Durrleman *et al*., 2016; Durrleman & Franck, 2015).

In sum, most of previous studies have focused on the relation between language and first-order FB reasoning, relatively few studies have been conducted to examine how language is related to second-order FB reasoning, especially in children with ASD. Although there were a few studies on language and second-order FB reasoning in TD children (Arslan *et al*., 2017; Hollebrandse *et al*., 2014; Lockl & Schneider, 2007), no conclusive knowledge of the relation between language and second-order FB reasoning can be drawn from a limited number of studies. To date, no consensus has been reached on which aspects of language contribute uniquely to first-order and second-order FB reasoning and on how they are related in children with and without ASD.

1.4 Hypotheses

Since Premack and Woodruff (1978) first coined the term ToM in their study on chimpanzees, substantial research has been conducted to investigate the relationship between ToM and language in order to have a better understanding of their developments. Dozens of studies have found that language relates to ToM, whereas it remains unclear how they are related. With regard to the relation between them, several hypotheses have been proposed, as shown in this section below.

1.4.1 Cognitive determinism

Researchers from the perspective of cognitive determinism hold that the understanding of one's own and others' mental states is the prerequisite for mastering linguistic forms that are served to express one's own and others' minds (Cromer, 1991). From the point of view of cognitive determinism, the conceptual understanding of ToM is first acquired, and then language emerges to reflect the development of ToM. Therefore, children's comprehension and production of linguistic forms such as mental state verbs (MSVs) like *think* and *know* are considered as an indicator of the development of their corresponding mental states (Bartsch & Wellman, 1995; Shatz, Wellman, & Silber, 1983).

1.4.2 Strong version of linguistic determinism

On the contrary, researchers from the perspective of the strong version of linguistic determinism hold that ToM development and language are fundamentally related, language is the prerequisite for ToM development. Various aspects of language have been proposed to provide an avenue for children's ToM development. Some researchers have claimed that conversation is critical to children's ToM development because in conversation, children are provided an environment to keep track of others' belief, to discover and know that different people have different minds toward the same object and event and to foster the development of their understanding others' minds (Dunn, 1988; Dunn *et al*., 1991; Harris *et al*., 2005). A few researchers have proposed that the use of MSVs plays a pivotal role in ToM development because MSVs such as *think, know* and *remember* encode concepts of one's own and others' minds semantically, and the use of them enables children to pay attention to their own and

others' mental states (Howard, 2012; Ruffman *et al*., 2002). Besides, others have proposed that it is general syntax or specific syntactic structures rather than semantics that play a specific role in ToM development (Astington & Jenkins, 1999; de Villiers, 2005; de Villiers & de Villiers, 2000; de Villiers & Pyers, 2002; Schick *et al*., 2007). De Villiers and de Villiers (2000) have proposed that the particular linguistic form complementation plays a causal role in children's successful performance on FB tasks because the syntactic process of complementation allows a false proposition to be embedded under another proposition, and the whole sentence remains true, thus this process perhaps provids a means of representing someone's mental world which could be distinct from the reality and our own's. Therefore, on this account, the specific linguistic form sentential complement structure makes it possible for the representation of propositional attitudes such as FB.

Empirical data from both TD children and language-delayed deaf children support the strong version of linguistic determinism. De Villiers and de Villiers (2000) reported a longitudinal study which tested three- to four-year-old TD children's understanding of first-order FB tasks and complementation at three times within one year. Children's spontaneous speech was assessed by IPSyn, and MLU was calculated as well. The authors found that the children's earlier knowledge of sentential complements significantly predicted their later FB performance, but not vice versa. More evidence comes from empirical data from language-delayed deaf children in a few studies. De Villiers and de Villiers (2000) assessed language-delayed deaf children's first-order FB understanding by modified first-order FB tasks. The authors found that sentential complement structure was the strongest predictor of children's performance on first-order FB tasks. Schick *et al*. (2007) examined first-order FB reasoning in 176 deaf children with hearing or deaf parents by both verbal and low verbal FB tasks. Their

results showed that deaf children with deaf parents performed significantly better on FB tasks than those with hearing parents who were significantly delayed in language, and both vocabulary and complementation significantly predicted deaf children's performance on verbal FB tasks, whereas only complementation was a significant predictor of deaf children's performance on low verbal FB tasks.

1.4.3 Language plays a facilitating role in ToM development

Apart from cognitive determinism and linguistic determinism, which hold that language and ToM development are in a causal relationship, some researchers hold that the two are not in a causal relationship, rather language plays a facilitating role in ToM development. Evidence from several training studies from different languages supports this point of view (Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003; Mo *et al*., 2014; Ornaghi *et al*., 2011). Hale and Tager-Flusberg (2003) found that training on sentential complement played a facilitating role in English-speaking children's performance on first-order FB tasks. Lohmann and Tomasello (2003) found that training on perspective-shifting discourse about deceptive objects and sentential complement improved German-speaking children's first-order FB performance. Mo *et al*. (2014) found that training on sentential complement improved Chinese-speaking children's performance on first-order FB tasks. Ornaghi *et al*. (2011) found that training on MSVs in three-year-old Italian-speaking children significantly improved their performance on first-order FB tasks at 4;0.

1.5 Motivations

To date, a number of issues on the relation between ToM and language remain unsolved. For instance, no consensus has been reached on which aspects of language are related to ToM development specifically. It remains unclear which linguistic forms in particular contribute the strongest to FB reasoning, whether the effect of language extends to higher-order FB reasoning or not, if yes, whether different aspects of language or linguistic forms contribute differently to different levels of FB reasoning. Most of previous studies investigated the relation between language and first-order FB reasoning, while the relation between language and second-order FB reasoning is less known.

Studies on the relation between various specific aspects of language and different levels of FB reasoning may shed light on children's ToM development and on the relation between language and cognition. Among the linguistic forms investigated in previous studies such as MSVs, sentential complement, relative clause and verb factivity, the understanding of verb factivity may serve as a good window to examine belief as it involves making judgments of the truth or falsity of the propositions of complement clauses according to speakers' belief, of which the process is quite similar to FB understanding. However, sparse well-documented studies, especially in Chinese have been conducted to investigate the relation between verb factivity and children's FB reasoning. A few issues remain unclear. For example, how verb factivity relates to different levels of children's FB reasoning, whether or not different types of factivity verbs relate to and play facilitating roles in children's FB reasoning differently, and whether or not verb factivity contributes uniquely to children's FB understanding

when controlling for other related factors such as general language ability, sentential complement and EF.

Most of previous studies on the relation between language and FB reasoning are conducted on English-speaking children, research on this topic on Chinese-speaking children are relatively fewer. Different languages differ in various aspects such as syntactic structures. For instance, English sentences taking complement clauses (e.g., Mary thinks that John is not at the office.) require a 'that' complementizer, however, Chinese sentences taking complement clauses do not require such a complementizer (e.g., 玛丽觉得约翰不在办公室。*Mǎlì juédé Yuēhàn bú zài bàngōngshì.* Mary think John not at office. 'Mary thinks that John is not at the office.'). Moreover, children from different countries performed differently in the onset of mastering FB reasoning and the sequence of ToM development (Liu *et al*., 2008; Wellman *et al*., 2001; Zhang *et al*., 2016). Investigations on the relation between verb factivity and FB reasoning in Chinese are important for testing the universality of the hypotheses on the relation between language and ToM.

1.6 Objectives

The main purpose of this dissertation was to investigate the relation between verb factivity and first-order and second-order FB understanding in Mandarin-speaking TD children and in children with ASD. Before exploring the main objective, it is necessary to examine how do Mandarin-speaking children use and understand the selected verbs in this dissertation in terms of verb factivity, because it remains unknown about the classification of those verbs according to verb factivity based on empirical data. Therefore, the second aim of this dissertation is to examine Mandarin-speaking TD

children's developing knowledge of verb factivity in a corpus study and an experimental study.

1.7 Overview of the dissertation

This dissertation consists of five chapters. Chapter 1 introduces the topic examined, presents literature reviews on the relation between various aspects of language and first-order and second-order FB reasoning in both TD and autistic children, summarizes hypotheses proposed to explain the relation between language and ToM, and generates research gaps existing at present and objectives that this dissertation investigated. Chapter 2 reports two studies which examined Mandarin-speaking TD children's developing knowledge of verb factivity. The first was a corpus study, in which Mandarin-speaking adults' and children's production of six verbs were examined on the basis of the data from Child Language Data Exchange System (CHILDES) database (MacWhinney, 2000). The second was an experimental study, in which Mandarin-speaking adults' and children's understanding of verb factivity conveyed by the six verbs in a TVJ task was investigated. Chapter 3 and Chapter 4 examines the relation between verb factivity and first-order and second-order FB reasoning in Mandarin-speaking TD children and in Mandarin-speaking children with ASD, respectively. The role of verb factivity in FB reasoning was examined when controlling for verbal mental ability, inhibition, working memory, and sentential complement. The last chapter concludes main finddings in this dissertation, empirical and theoretical significances of these findings, issues remained and suggestions for future studies.

Chapter 2

2.1 Introduction

Predicates (or more precisely, a feature of predicates) could be classified into factives, non-factives and counter-factives according to whether they ascribe factuality, non-factuality, or counter-factuality to their complement clauses (Leech, 1981). Factives such as *know* presuppose speakers' beliefs about the truth of the propositions of their following complement clauses. Contrary to factives, counter-factives such as *pretend* presuppose speakers' beliefs about the falsity of the propositions of their following complement clauses. Both factives and counter-factives carry presupposition, of which one main property is that it stays constant in the negation of an expression. For example, the factive verb *know* in both (1) and (2) presupposes the speaker Paul's belief about the truth of the complement clause. The counter-factive verb *pretend* in both (3) and (4) presupposes Paul's belief about the falsity of the complement clause. In contrast, non-factives do not carry such presupposition. The non-factive verb *think* in both (5) and (6) does not presuppose Paul's belief about the truth or falsity of the complement clause, instead, it only denotes a positive or a negative reaction to the possibility of an event's occurrence (Hopmann & Maratsos, 1978; Scoville & Gordon, 1980).

(1). Paul: "Mary knew that there were candies in the box."

(2). Paul: "Mary did not know that there were candies in the box."

(3). Paul: "Mary pretended that there were candies in the box."

(4). Paul: "Mary did not pretend that there were candies in the box."

(5). Paul: "Mary thought that there were candies in the box."

(6). Paul: "Mary did not think that there were candies in the box."

2.2 Previous studies

This section introduces the most widely used task in assessing children's understanding of factivity first, and then reviews previous studies on the understanding of factivity in both English-speaking children and Chinese-speaking children.

One characteristic of factivity conveyed by factives and counter-factives is that the truth value of propositions of their complement clauses remains constant when they are negated. Therefore, tasks employed in the literature on children's understanding of factivity have been designed according to this feature of factivity. The most widely used task in previous studies is TVJ task (e.g., Abbeduto & Rosenberg, 1985; Cheung *et al*., 2009; Falmagne, Gonsalves, & Bennett-Lau, 1994; Harris, 1975; Hopmann & Maratsos, 1978; Macnamara, Baker, & Olson, 1976; Schulz, 2003; Scoville & Gordon, 1980), in which test sentences are constructed in different conditions according to the polarity of predicates of main and complement clauses: (1) affirmative main clause predicate and affirmative complement clause predicate ("+ +" condition, hereafter) (e.g., Mary knew that there were candies in the box.), (2) negative main clause predicate and affirmative complement clause predicate ("– +" condition, hereafter) (e.g., Mary did not know that there were canides in the box.), (3) affirmative main clause predicate and negative complement clause predicate ("+ –" condition, hereafter) (e.g., Mary knew that there were no candies in the box.), and (4) negative main and complement clause predicates ("– –" condition, hereafter) (e.g., Mary did not know that there were no candies in the box.). In TVJ task, participants are presented test sentences, and then are required to make truth value judgments of the propositions of complement clauses by using "yes", "no" or "do not know/maybe/can't tell". The forms and procedures of TVJ task vary in different studies. For example, some studies

presented test sentences in isolation (e.g., Cheung *et al*., 2009; Falmagne *et al*., 1994; Harris, 1975; Hopmann & Maratsos, 1978), while some presented test sentences in short story context (e.g., Abbeduto & Rosenberg, 1985; Aravind & Hackl, 2017; Macnamara *et al*., 1976; Schulz, 2003; Scoville & Gordon, 1980). Some studies required participants to repeat short stories or test sentences (e.g., Hopmann & Maratsos, 1978; Macnamara *et al*., 1976; Scoville & Gordon, 1980), whereas some did not (e.g., Abbeduto & Rosenberg, 1985; Cheung *et al*., 2009; Falmagne *et al*., 1994; Harris, 1975).

Harris (1975) is one of the earliest studies on children's understanding of factivity. He investigated four-to-twelve-year-olds' understanding of two factives *know* and *happy*, two non-factives *say* and *whisper*, and two counter-factives *pretend* and *wish*. Four tasks were employed, namely Imperatives task in which participants were required to carry out commands containing counter-factives (*pretend* and *make believe*) and non-factives (*say* and *whisper*) in the "+ +" condition, Short-term memory task in which participants were required to repeat sentences uttered by the experimenter, Truth questioning task (TVJ task) in which participants were required to judge truth values of complement clauses by using "yes", "no" or "can't tell", and Anomaly task in which participants were required to judge whether test sentences made sense or not. Test sentences in the last three tasks were constructed with third person subject (3PS hereafter) as sentence subjects in the "+ +", "– +", "+ –" and "– –" conditions. The results indicated that over 60% of the nursery schoolers' responses were based on the interpretation of complement clauses but not of the whole complex sentences in the Imperatives task, suggesting that they employed a complement only strategy. In the short-term memory task, the children had difficulty in repeating sentences in the "– –" condition. In the TVJ task, the children's responses indicated that they performed well

on the factives in the four conditions and on the counter-factives in the "+ +" and "+ –" conditions but not in the "– +" and "– –" conditions, their responses to the non-factives suggested that they probably treated them as factives. In the Anomaly task, the children tended to make judgments according to world knowledge rather than linguistic information. The overall results suggested that factives and counter-factives were easier than non-factives, and test sentences in the "+ +" condition were the easiest and those in the "– –" condition were the most difficult for the children. Harris (1975) stated that children's understanding of factivity was a difficult and gradual process, which might begin in preschool years but did not reach an adult-like level until sometime after sixth grade. Although Harris (1975) conducted a variety of tasks, not all of those tasks assessed the knowledge of factivity appropriately. The Imperatives, Short-term memory and Anomaly tasks were more likely to measure the understanding of the lexical meaning of target verbs rather than the understanding of the speaker's (the experimenter's) beliefs about complement clauses. Although the TVJ task was expected to measure the understanding of factivity, the data were not reported according to age groups. Therefore, when children were able to understand factivity verbs and how did they understand them developmentally were not reported clearly in this study.

Hopmann and Maratsos (1978) also reported child's developing understanding of factivity. They tested 60 4;0's, 5;0's and 7;0's understanding of five factives (*know*, *be surprising*, *be happy*, *be nice* and *be sad*) and five non-factives (*think*, *be possible*, *desire*, *be true* and *want*). A forced-choice design was used, in which isolated test sentences were composed in the "+ +" and "– +" conditions. The participants were required to repeat test sentences uttered by the experimenter (e.g., "*It isn't surprising that the fish pushed the tree"*) and then were forced to choose the agent of the

complement clause from two toys (e.g., a fish and a bunny). The authors found that the more emotionally neutral predicates (*know* and *be surprising*) were easier than predicates expressing an emotionally evaluative reaction (*be sad*, *be nice* and *be happy*) for children to understand. The results indicated that the 5;0 were able to understand factivity conveyed by *know* and *be surprising* and the 7;0 were able to understand factivity conveyed by the investigated verbs fairly well. The authors claimed that the 4;0 and 5;0 showed an overextended negation tendency (a negated predicate in the superordinate clause of a complex sentence always negates the proposition in the subordinate clause) in understanding factives because their denying responses to factives in the "– +" condition were significantly more than those in the "+ +" condition. However, it may be questionable to draw such a conclusion in this way. Making more denying responses does not necessarily mean having an overextended negation tendency, it should be the number of denying responses themselves that determines whether children have an overextended negation tendency or not. The data in Table 1 in the article showed that the means of the 4;0's and the 5;0's denying responses were 2.65 and 1.75, respectively, which were not much high, compared to the maximum score 10. Therefore, it was unclear about the 4;0's understanding of factives in this study. Apart from this, the children's understanding of non-factives was unclear as well due to the forced-choice design, in which the children were forced to make a choice from two options. The problem arises here is that the use of non-factives does not presuppose the truth or falsity of the propositions of complement clauses, in this case, no choice can be made. Therefore, the forced-choice design task did not measure children's understanding of non-factives appropriately.

In order to find whether it was true that young children had an overextended affirmation tendency as shown in Hopmann and Maratsos (1978), Scoville and Gordon

(1980) did not only construct test sentences in the "+ +" and "– +" conditions, but also in the "+ –" condition in which participants' responses would make it possible to distinguish correct responses to factives from an overextended affirmation tendency. The 5;0's, 8;0's, 11;0's, and 14;0's understanding of five factives (*know*, *forget*, *be sorry*, *be happy* and *be surprised*) and five non-factives (*be sure*, *think*, *figure*, *say* and *believe*) was examined. A TVJ task was used in a context of a television quiz show, in which test sentences were carefully controlled in the form of 'Doctor Fact + (not) factives/non-factives + that the ball is (not) red/green/blue/yellow'. In the show, Doctor Fact was a mind reader who tried to guess while blindfolded the color of a ping-pong ball chosen at random from a puzzle box by Miss Fancy who knew the color of the ball. In each test trial, Doctor Fact whisperd to Miss Fancy to tell her what he thought the color the ball was, and then Miss Fancy uttered test sentences. The children were required to repeat test sentences and then to make judgments of the color of the ball by pushing one of three buttons standing for 'yes', 'no' and 'I.D.K.' ('I don't know'), respectively. If 'yes' or 'no' button was pushed, the experimenter asked 'Are you sure?', and the children responded to this question by pushing the 'sure' or 'not sure' button. The authors found that the younger children the 5;0, 8;0 and 11;0 had an overextended negation tendency in their responses to factives, and they seldom used indeterminate responses to non-factives. The results indicated that the children began to distinguish factives from non-factives after 11;0. After reviewing several previous studies, the authors concluded that the acquisition of factivity seemed to proceed on a verb-by-verb basis. However, the children's performances on each verb investigated in this study were not clearly reported; instead, only response patterns for the group of the five factives and of the five non-factives were reported. Therefore, the children's developing knowledge of those verbs was unclear in this study, what is more, the paradigm used in the TVJ task seemed not appropriate to measure the understanding

of non-factives. For non-factives, the speaker is supposed to be uncertain about the truth of complement clauses, whereas Miss Fancy, the speaker in the TVJ task, knew the color of the ball. This may explain why the children seldom made indeterminate 'I.D.N.' responses which are correct to non-factives.

The findings from Falmagne *et al*. (1994) provided support to Scoville and Gordon's (1980) suggestion that the acquisition of factivity proceeded on a verb-by-verb basis. In Falmagne *et al*. (1994), the third (8;6 to 9;5) and sixth (11;4 to 12;5) graders' understanding of twelve verbs (*knew*, *was aware*, *made clear*, *recognized*, *noticed*, *pointed out*, *emphasized*, *was sure*, *said*, *thought*, *assumed* and *reasoned*) being constructed in the "+ +" and "– +" conditions was assessed in a TVJ task and a But-not task. In the TVJ task, participants were required to pretend to say test sentences which were constructed with 3PS as sentence subjects, being followed with complement clauses, and then they were required to make truth value judgments of complement clauses by "yes" (Y), or "no" (N) or "maybe or maybe not" (M). In the But-not task, complement clauses were negated in "but-not" clauses, therefore test sentences were self-contradictory on factives but semantically acceptable on non-factives. Participants were required to judge whether sentences "made sense" or "did not make sense". The results showed that the children's response patterns of those verbs in the "+ +" and "– +" conditions in the TVJ task predominantly included YY, YM and MM. The most frequent response pattern of *knew* and *noticed* was YY, of *assume* and *thought* was MM, and of *recognized*, *made clear*, *pointed out*, and *emphasized* was YM. The pattern of YM indicated that the children treated those verbs as factives in affirmative condition but not always when they were negated. This phenomenon suggested that the children had a representation of factivity for those verbs, but the representation was insufficiently stable and robust to sustain in negative

contexts. With regard to the children's responses in the But-not task, they were consistent with those in the TVJ task. On the whole, the results indicated that some factive verbs (*knew* and *noticed*) were acquired earlier than others (*was aware* and *recognized*), whereas for some verbs such as *was sure*, even the sixth graders (11;0 to 12;0) did not master it as non-factives as adults. The authors concluded that the development of factivity was an extended and multifaceted process that continued after grade six.

Although a body of research found that children's understanding of factivity developed over a long period of time, even school-age children at 12;0 or adolescences at around 14;0 did not develop an adult-like understanding of it (e.g., Falmagne *et al*., 1994; Harris, 1975; Hopmann & Maratsos, 1978; Scoville & Gordon, 1980), the findings from a number of studies suggested that children were able to understand factivity at quite an early age at around 4;0 (e.g., Abbeduto & Rosenberg, 1985; Aravind & Hackl, 2017; Cheung *et al*., 2009; Macnamara *et al*., 1976; Schulz, 2003; Yi *et al*., 2013), at which age children begin to pass first-order FB tasks (Liu *et al*., 2008; Wellman *et al*., 2001; Wimmer & Perner, 1983).

Different from previous studies that employed TVJ task in the form of isolated test sentences and found that children at 4;0 did not understand factivity (Harris, 1975; Hopmann & Maratsos, 1978), Macnamara *et al*. (1976) used a TVJ task in the form of short story which ended with test sentences in the "+ +" or "– +" condition to examine two groups of 20 four-year-olds' understanding of *pretend*, *forget* and *know*. One group was tested on *pretend* and *forget* and the other on *know*. The rhildren were required to repeat stories before answering a serial of test questions which were expected to measure their understanding of presupposition and implicative. Test

questions only in the *pretend* stories but not in the *forget* and *know* stories measured the understanding of verb factivity, therefore only children's performances on *pretend* are reported here. The results indicated that the 4;0 were able to understand factivity conveyed by the counter-factive *pretend*, and they performed better in the "+ +" condition than in the "– +" condition.

Similar to Macnamara *et al*. (1976), Abbeduto and Rosenberg (1985) employed a TVJ task in the form of short story as well. Three-, four- and seven-year-olds' developmental understanding of factives (*know*, *forget* and *remember*) and non-factives (*think* and *believe*) was examined by three tasks including a TVJ task, a verb choice task and a definition task. In the TVJ task, two-sentence introductory contexts were presented before test sentences that were constructed with 3PS as sentence subjects in the "+ +" and "– +" conditions. Those contexts did not provide any clues for relevant answers but established referents of test sentences. Children were required to repeat three possible answers "yes", "no" and "don't know" before making truth value judgments. In the verb choice task, participants were presented conclusive or inconclusive stories, in each of which a story character observed an event, and then were required to select from a pair of cognitive verbs (*believe* vs. *think*, *believe* vs. *know* and *think* vs. *know*) to best describe a story character's mental state. In the definition task, children were asked to define cognitive verbs and stated the meanings of sentences containing those verbs. The overall results of the three tasks indicated that the 3;0 did not master factivity conveyed by any of the examined factivity verbs due to their use of complement-only strategy and their "yes" bias responses to those verbs, the 4;0 and 7;0 were able to understand the factives *know*, *forget* and *remember*, and the non-factive *think*. As for the non-factive *believe* which has factive property, even the 7;0 did not masterd it as adults. Before they mastered *believe*, their responses

suggested that they treated it as a factive. The findings of Abbeduto and Rosenberg (1985) provided support to the proposal that the acquisition of factivity proceeds on a verb-by-verb basis (Falmagne *et al*., 1994; Scoville & Gordon, 1980), and were in line with Macnamara *et al*. (1976) in that children as young as 4;0 were able to understand factivity, whereas were inconsistent with Hopmann and Maratsos (1978) and Scoville and Gordon (1980) which found that the 4;0 and 5;0, and the 5;0, 8;0 and 11;0, respectively, had an overextended negation tendency in understanding factives.

More evidence on four-year-olds being able to understand factivity comes from Schulz (2003) who conducted two experimental studies to investigate 55 English-speaking children's (aged 3;3 to 6;11) understanding of factives and non-factives in the "+ +" condition in TVJ tasks. In the first experiment, discourse background was provided through stories which were accompanied with three pictures and described events that took place or failed to take place. Participants were required to answer questions constructed by *forget to/that* and *tell to/that*. Schulz (2003) found that the children had no difficulties in interpreting sentences with *forget to/that* and *tell to/that* in stories where events took place, with *tell to/that* and *forget to* in stories where events failed to take place, whereas had difficulties in understanding presupposition failure, that is in interpreting *forget that* in stories where events failed to took place. In the second experiment, no discourse backgroup was provided. The TVJ task was in the form of three-sentence stories which introduced characters and set up the situation but did not provide any clues for making truth value judgments, which was adapted from Abbeduto and Rosenberg (1985). The stories ended with factives (*forget that* and *find out that*), negative-implicatives (*forget to* and *refuse to*) and non-factives (*think that* and *ask to*). The children performed fairly well on test sentences with all verbs except for *refurse to*. The overall results of the two experiments suggested that children at 4;0

were able to understand presupposition properties of factives and non-factives and to distinguish them according to the truth value of their complement clauses, which supported the findings from Macnamara *et al*. (1976) and Abbeduto and Rosenberg (1985).

Aravind and Hackl (2017) tested four- to six-year-olds' understanding of two factives *forget* and *remember* by TVJ tasks in two contexts as well. The TVJ task was in the form of stories including two characters who had carried out some chores. In the first context, the character in question carried out chores but forgot about having done one of them and fails to report it. In the second context, only one conducted the assigned task, while the other did not. Later, neither recalled whether they conducted the task or not. A puppet was asked to describe what happened in the stories by uttering test sentences involving factives constructed in the "+ +" and "– +" conditions. A comprehension question about the complement was asked in the second context but not in the first context before the puppet uttered test sentences. Different from previous studies, participants in this study were required to make truth value judgment of the whole test sentences rather than of complement clauses. The results showed that the children performed fairly well on the two verbs in the first context but not in the second context. The authors claimed that the children in their sample had an adult-like presuppositional representation of the two verbs. However, as the TVJ task used in this study tested children's ability to make truth value judgments of the whole test sentences according to contextual information but not their ability to infer speakers' beliefs about complement clauses, the results could not conclude whether they understood the two verbs from the perspective of factivity or not.

To examine whether younger children are able to understand verb factivity or not, Dudley *et al*. (2015) designed a hidden object task (Moore & Davidge, 1989) which they claimed to be less demanding and more directly targeted factivity than TVJ task to examine 40 three-year-olds' understanding of the factive *know* and the non-factive *think*. In the hidden object task, participants are told that the experimenter would hide a toy into one of two boxes (e.g., a red box and a blue box). A puppet (Lambchop) would try to find the toy, but he is too shy to speak but to whisper to the experimenter to tell him/her the location of the toy. The experimenter delivered clues by uttering test sentences in the form of 'Lambchop knows/thinks that …' in the "+ +", "– +" and "+ –" conditions, and then participants were required to point out the location of the toy according to experimenter's utterances. The results indicated that the children's response pattern of *think* was similar to the adults', and around half of the children had an adult-like understanding of *know*, while the remainings seemed to treat it as a non-factive verb like *think*. Therefore, the authors claimed that their three-year-olds were able to distinguish the factive *know* from the non-factive *think*. Although the children did perform differently on *know* and *think*, it does not necessarily mean that they had mastered the factivity and non-factivity conveyed by the two verbs, respectively. The paradigm of the hidden object task used in this study may not test the understanding of the non-factive *think* appropriately, like the paradigm used in the TVJ task in Scoville and Gordon (1980). As the use of *think* denotes that speakers should be uncertain about the truth value of the complement clauses, whereas the speaker in the hidden object task was the the one who hid the object and who, of course, knew the location of the toy. Moreover, the paradigm of the hidden object task allows only two responses *yes* or *no*, but not *maybe*/*can't tell/don't know* that is the correct response to the non-factive *think*. Therefore, the three-year-olds' adult-like performance on *think* may not indicate their mastery of non-factivity expressed by *think*.

Most of previous studies on child's understanding of verb factivity have been conducted on English-speaking children, studies on Chinese-speaking children are relatively few (Cheung *et al*., 2009; Yi *et al*., 2013). Cheung *et al*. (2009) investigated Cantonese-speaking four-year-olds' understanding of two factives (*zi1dou3* 'know' and *faat3jin6* 'discover') and two counter-factives (*ji5wai4* 'falsely think' and *gong2daai6waa6* 'lie')[2] by an isolated TVJ task. Test sentences were constructed with 3PS as sentence subjects in the "+ +" condition. Unexpected results were obtained as the authors reported. The children performed above chance on counter-factives, whereas at chance on factives. However, it was possible that the children's above chance performance on the counter-factives might due to their bias "no" responses. As test sentences were constructed only in the "+ +" condition, it remains unclear whether the four-year-olds understood counter-factives or not. Simialr to Cheung *et al*. (2009), Yi *et al*. (2013) examined Chinese-speaking children's understanding of two types of factivity verbs as well, one factive verb *zhīdào* 'know' and one counter-factive verb *yǐwéi* 'falsely think'. The children were native Mandarin-speaking, aged 3;2 to 4;8 and 5;2 to 8;10. Test sentences constructed with first person subject (1PS hereafter) as sentence subjects in the "+ +" condition were uttered by a puppet in a hidden object task. The results showed that both younger and older groups of children performed significantly above chance on *zhīdào* 'know' and below chance on *yǐwéi* 'falsely think'. Contrary to Cheung *et al*.'s (2009) finding, the authors found that Mandarin-speaking children performed better on the factive verb *zhīdào* 'know' than on the

[2] The two verbs were named strong non-factives in Cheung *et al*. (2009). As the target verbs investigated in this thesis are classified into factives, non-factives and counter-factives according to the classification of Leech (1981). To label verbs consistently in this thesis, verbs are labelled according to Leech's (1981) terminologies. *Ji5wai4* could be a non-factive verb as well as a counter-factive verb, while it was used as a counter-factive verb in Cheung *et al*. (2009) as the authors reported.

counter-factive verb *yǐwéi* ‘falsely think’. Although the authors claimed that they assessed the knowledge of verb factivity, it was possible that test sentences used with 1PS as sentence subjects assessed the knowledge of certainty rather than verb factivity (Moore, Bryant, & Furrow, 1989; Moore & Davidge, 1989).

Although a number of studies have been conducted to examine child’s developing understanding of factivity in the past four decades since factivity was introduced (Kiparsky & Kiparsky, 1971), consensuses have not been reached on when do children begin to understand and how do they treat and represent different types of factivity verbs. Among previous studies reviewed above, Harris (1975) and Hopmann and Maratsos (1978) did not find that children at 4;0 were able to understand factivity, whereas several researchers claimed that the 4;0, even the 3;0 were able to understand factivity (e.g., Abbeduto & Rosenberg, 1985; Aravind & Hackl, 2017; Cheung *et al*., 2009; Dudley *et al*., 2015; Macnamara *et al*., 1976; Schulz, 2003; Yi *et al*., 2013). Harris (1975) and Abbeduto and Rosenberg (1985) found that children tended to treat non-factives as factives before they mastered non-factivity, while Dudley *et al*. (2015) claimed that their three-year-olds treated the factive *know* as the non-factive *think*. Moreover, the designs of the tasks used in some of previous studies did not assess the knowledge of factivity appropriately. For example, the forced-choice design task (Hopmann & Maratsos, 1978) and the hidden object task (Dudley *et al*., 2015) that allow only ‘yes’ and ‘no’ responses but not indeterminate responses, and the TVJ task (Scoville & Gordon, 1980) and the hidden object task (Dudley *et al*., 2015) in which speakers know the truth value of complement clauses are not appropriate to assess the understanding of non-factives. The use of 1PS as sentence subjects (Yi *et al*., 2013) may not assess the knowledge of factivity. The tasks in several studies (Abbeduto & Rosenberg, 1985; Cheung *et al*., 2009; Harris, 1975; Hopmann & Maratsos, 1978;

Schulz, 2003) that were designed with no explicit speakers but with experimenters as speakers did not make speakers' evidence for presupposing the truth value of complement clauses explicitly in test situation (Scoville & Gordon, 1980). In sum, our knowledge about children's, especially Chinese-speaking children's understanding of factivity remains inconclusive.

2.3 The current studies

To date, it remains unclear at what time children begin to understand verb factivity or how they perform on the three types of factivity verbs. Previous studies have focused on factives and non-factives, sparse studies have examined counter-factives or all three types of factivity verbs systematically. Most of previous studies on child's understanding of verb factivity were conducted on English-speaking children in western countries, relatively few well-documented studies have been conducted to investigate Chinese-speaking children's understanding of verb factivity, our knowledge about Chinese-speaking children's understanding of verb factivity is quite sparse at present. In the existing well-documented studies on Chinese-speaking children's understanding of verb factivity, test sentences were constructed only in the "+ +" condition (Cheung *et al*., 2009; Yi *et al*., 2013), sparse studies have examined Chinese-speaking children's understanding of all three types of factivity verbs in different conditions systematically.

Compared to English, Chinese has specific linguistic features such as Chinese verbs do not inflect for tense and sentences taking complement clauses in Chinese do not take *that*-complementizer as those in English. It has been proposed that the overt complementitzer *that* in English is obligatory with factives (Kiparsky & Kiparsky,

1971). Therefore, the developing knowledge of verb factivity in Chinese-speaking children may be different from that in English-speaking children. Studies on Chinese-speaking children's production and comprehension of verb factivity could contribute to the literature on the acquisition of verb factivity and offer insights to our knowledge about the universality of the acquisition of verb factivity.

The purpose of the studies in this chapter was to examine the developing knowledge of verb factivity in Mandarin-speaking children. To obtain comprehensive knowledge of verb factivity, both the child's production and comprehension of all three types of factivity verbs were examined. According to the issues about child's knowledge of verb factivtity under debate, four questions were asked: (1) How do Mandarin-speaking children use the verbs examined in this chapter in their spontaneous speech in terms of verb factivity? (2) Whether they are able to understand verb factivity conveyed by the investigated verbs or not at the 4;0? (3) If not, when do they begin to understand verb factivity conveyed these verbs? (4) And how do they perform on these verbs developmentally?

To address the first question, a corpus study was conducted, in which distributions of factivity verbs in child-directed speech and child speech were examined in the data from the CHILDES database (MacWhinney, 2000). To address the last three questions, an experimental study was conducted. The two studies are reported in the following sections.

2.4 Corpus study of verb factivity

2.4.1 Method

2.4.1.1 Database

The use of factivity verbs in both Mandarin-speaking children and adults was examined in speech samples in four Mandarin corpora from the CHILDES database (MacWhinney, 2000): (1) Tong Corpus, (2) Zhou1 Corpus, (3) Zhou2 Corpus and (4) Chinese-Tardif Corpus. Utterances produced by target children and their caregivers were transcribed and checked by Mandarin native speakers following the CHAT format, the standard transcription system for CHILDES. Table 2.1 shows the information of the age range of target children, the number of transcripts and target children in each corpus.

The four corpora were selected for two reasons: (1) Most of children start to produce sentences with complements usually after their third birthday (Diessel & Tomasello, 2001), as verb factivity investigated in this chapter is conveyed in sentential complement structures, thereby, corpora including children above 3;0 were selected; (2) The data from the four corpora were obtained in various forms, including free speech (Tong corpus), semi-structured speech (Zhou1 and Zhou2 corpora) and storytelling (Chinese-Tardif corpus) in both cross-sectional (Chinese-Tardif, Zhou1 and Zhou2 corpora) and longitudinal (Zhou1 and Tong corpora) methods. Therefore, the data from the four corpora make it possible to investigate child's use of factivity verbs comprehensively.

Table 2. 1 Information of corpora

	Age range	No. of transcripts	No. of children
Tong	1;7-3;4	22	1
Zhou1	1;2-4;0	50	46[3]
Zhou2	3;0-6;0	139	139
Chinese-Tardif	2;8-5;0	603	594[4]
Total	1;2-6;0	814	780

The children from the four corpora were divided into four groups according to chronological age. The number of transcripts and children, and the age range of each age group are presented in Table 2.2.

Table 2. 2 Number of transcripts and children at each age group

Groups	Transcripts	Children
Group 1 (1;2-2;11)	89	70
Group 2 (3;0-3;11)	330	324
Group 3 (4;0-4;11)	325	318
Group 4 (5;0-6;0)	70	70
Total	814	780[5]

Six verbs were examined: 知道 *zhīdào* 'know', 发现 *fāxiàn* 'discover/be aware', 觉得 *juédé* 'feel/think', 听说 *tīngshuō* 'hear', 以为 *yǐwéi* 'think/falsely think' and 假装 *jiǎzhuāng* 'pretend'. Among the six verbs, *fāxiàn* 'discover/be aware', *juédé*

[3] There are five speech transcripts that were obtained from one child longitudinally in the Zhou1 corpus, therefore, there are 46 transcripts in the Zhou1 corpus.

[4] In the Chinese-Tardif corpus, there are nine children that two speech transcripts were obtained from them, therefore, there are 594 transcripts in the Chinese-Tardif corpus.

[5] The Tong corpus was a longitudinal study, the child was counted twice in the first and second age groups. In the Zhou1 corpus, there was a child that was also longitudinally studied, and he was also counted twice in the first and third age groups. Therefore, there are 780 different children.

‘feel/think’ and *yǐwéi* ‘think/falsely think’ have two meanings. According to Modern Chinese Dictionary (Chinese Academy of Social Sciences, 2016), the first meaning of *fāxiàn* is ‘discover’, referring to discover something that has not been found previously, the second meaning refers to be aware, feel or notice. If it is used in the meaning of ‘discover’, it expresses factivity. If it is used in the meaning of ‘be aware’, it expresses non-factivity. For *juédé*, the first meaning is ‘feel’ and the second is ‘think’ (Lv, 1999, p235). When it is used as ‘feel’, sentences usually do not take complement clauses. If it is used as ‘think’, sentences usually take complement clauses. As verb factivity investigated in this chapter is conveyed through sentences with complement clauses, only *juédé* used as ‘think’ is examined in this study. The first meaning of *yǐwéi* is ‘think’, which is a synonym of *juédé*/*rènwéi* ‘think’, referring to judgments of persons and events. The second meaning of it is ‘falsely think’, referring to judgments of persons and events that are inconsistent with reality (Lv, 1999; Zhang, 1999). When *yǐwéi* is used as ‘falsely think’, it is usually used with adverbs like 原 *yuán* ‘original/at first’ or 本 *běn* ‘original/at first’ which emphasize that speakers’ judgments are inconsistent with the reality, like sentence (7), or it may be followed by another clause which is usually used with conjunctions such as “但是 *dànshì* ‘but’, 其实 *qíshí* ‘in fact’ and 原来 *yuánlái* ‘turn out to be’ to clarify the reality, like sentence (8). If the reality can be inferred from the context, the clause can be omitted, but in this case, a sentence final particle such as 呢 *ne* or 哩 *li* is usually added at the end of the sentence, like sentence (9) (Xu, 2014; Zhang, 1999). In sentences with complement clauses, *yǐwéi* is used as ‘think’ as well as ‘falsely think’, however, it was treated as ‘falsely think’ in almost all previous studies on Chinese-speaking children (Cheung *et al*., 2009; Lee *et al*., 1999; Tardif *et al*., 2004; Yi *et al*., 2013).

(7). 小芬 原 以为 他 在 办公室 呢。
Xiǎofēn yuán yǐwéi tā zài bàngōngshì ne.
Xiaofen original falsely think he at office SFP.
'Xiaofen falsely thought that he was at the office.'

(8). 我 以为 有 人 敲 门， 其实 不 是。
Wǒ yǐwéi yǒu rén qiāo mén, qíshí bú shì.
I falsely think have person knock door, actually no is.
'I falsely thought that someone was knocking the door, but actually it was

(9). 他 以为 这 不 是 你 的 呢。
Tā yǐwéi zhè bú shì nǐ de ne.
He falsely think this not is you DE SFP.
'He falsely thought it was not yours.'
(according to the context, 这 *zhè* 'this' is yours.)

2.4.1.2 Coding

The target verbs were searched as keywords in the CLAN program (Computerized Language Analysis) with the command "kwal +s'target verb*' *.cha", and then utterances with target verbs were extracted from these corpora. The speaker of each utterance and to whom it was spoken to were examined. Non-target-child-directed speech and utterances that were unintelligible, incomplete, stereotype and repetitive were excluded from subsequent analysis. Only target-child-directed utterances and utterances produced by the target child were further analyzed. Utterances were categorized into simple sentences and sentences with complement clauses, and only the latter were further analyzed as verb factivity is conveyed through them. Each utterance was checked in the context to examine how target verbs were used in terms of factivity.

Verbs used in sentences with complement clauses may differ in conveying verb factivity in different sentence types, conditions of negation status and sentence subject types. Therefore, utterances were coded along three dimensions. The first was sentence type, including statement and question. The second was negation status, including four types: "+ +", "– +", "+ –" and "– –" conditions. The third was sentence subject types, including 1PS, second person subject (2PS hereafter), 3SP, dropped subject (DS hereafter), and wh-word subject (WS).

2.4.2 Results

The four corpora included 148717 utterances. The number of complete and intelligible utterances involving the target verbs is presented in Table 2.3. It demonstrates that these target verbs were infrequently used by both adults and children. The proportion of the most frequently used verb *zhīdào* 'know' by children was 1.5% (699/47988) and by adults was 0.6% (555/100729). Among complete and intelligent utterances, 83% (1032/1240) of them were simple sentences and 17% (208/1240) of them were sentences taking complement clauses. Table 2.4 shows the number of utterances with the six verbs taking complement clauses and the proportions they take up in the total number of complete and intelligible utterances of the corresponding verb. In the following sections, the use of each verb in child's speech and child-direct speech is elaborated, and then the first emergence of each verb is examined.

Table 2. 3 Number of complete and intelligible utterances

Verbs	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
***Zhīdào* 'Know'**	100	134	295	192	211	142	93	87	699	555
***Fāxiàn* 'Discover'**	3	19	44	148	45	13	1	2	93	182
***Juédé* 'Think/Feel'**	2	22	8	17	12	49	6	29	28	117
***Tīngshuō* 'Hear'**	0	1	0	2	0	0	0	0	0	3
***Yǐwéi* 'Think/Falsely think'**	0	3	2	1	9	4	5	4	16	12
***Jiǎzhuāng* 'Pretend'**	0	5	1	2	2	6	0	1	3	14

Table 2. 4 Number and proportion of sentences taking complement clauses

Verbs	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
***Zhīdào* 'Know'**	8 (8%)	46 (34%)	6 (2%)	48 (25%)	28 (13%)	44 (31%)	14 (15%)	14 (19%)	56 (8%)	152 (28%)
***Fāxiàn* 'Discover'**	0	3 (16%)	12 (27%)	11 (7%)	22 (49%)	2 (15%)	1 (100%)	1 (50%)	35 (38%)	17 (9%)
***Juédé* 'Think'**	2 (100%)	16 (73%)	6 (75%)	17 (100%)	10 (83%)	39 (80%)	6 (100%)	24 (83%)	24 (75%)	97 (86%)
***Tīngshuō* 'Hear'**	0	1 (100%)	0	1 (50%)	0	0	0	0	0	2 (67%)
***Yǐwéi* 'Think/Falsely think'**	0	3 (100%)	2 (100%)	1 (100%)	9 (100%)	4 (100%)	5 (100%)	4 (100%)	16 (100%)	12 (100%)
***Jiǎzhuāng* 'Pretend'**	0	5 (100%)	1 (100%)	0	0	1 (17%)	0	0	1 (33%)	6 (43%)

2.4.2.1 *Zhīdào* 'Know'

Although *zhīdào* 'know' is classified as a factive verb by Li (2014), not all sentences with it taking complement clauses convey factivity. For example, *zhīdào* 'know' used with first person singular *wǒ* 'I' as main clause subject in negation and a wh-question word such as *shénme* 'what' in complement clauses expresses speakers' doubt on something (Tao, 2003) and cancels presuppositions of complement clauses (Schulz, 2003, p35). Li (2014) stated that *zhīdào* 'know' used in negation with wh-questions and A-not-A questions as its complement clauses conveys non-factivity rather than factivity. For instance, *zhīdào* 'know' in sentence (10) presupposes the speaker's belief

about the truth of the complement “this is Xiǎomíng’s book”, thus conveys factivity; whereas, *zhīdào* ‘know’ in sentence (11) expresses the speaker’s doubt on the complement clause rather than presupposes his or her belief about the truth of the complement clause, thus it conveys non-factivity rather than factivity.

(10). 她 不 知道 这 是 小明 的 书。
Tā bù zhīdào zhè shì Xiǎomíng de shū.
She no know this is Xiǎomíng DE book.
‘She does not know this is Xiaoming’s book.’

(11). 我 都 不 知道 这 是 什么 东西。
Wǒ dōu bù zhīdào zhè shì shénme dōngxi.
I even no know this is what thing.
‘Even I do not know what it is.’

To examine whether *zhīdào* ‘know’ used in sentences taking complement clauses conveys factivity or not, the use of it in each utterance was checked in the context. For example, in sentence (12.3), the child used *zhīdào* ‘know’ in its negation form with 1PS as the main clause subject and with a wh-word in the complement clause. Taking together the context as demonstrated by sentences (12.1) and (12.2), the child asked his/her mother what the white one is, which indicates that his/her use of *zhīdào* ‘know’ in sentence (12.3) expresses his/her doubt on what the white one is, instead of conveying factivity. In sentence (13.5), the child used *zhīdào* ‘know’ with 3PS as the main clause subject. Taking together the context as demonstrated by sentences (13.1) to (13.4), the child’s use of *zhīdào* ‘know’ in sentence (13.5) indicates that his/her belief about the complement clause, that is water is shallow, is true, thus conveys factivity. It has been found that *zhīdào* ‘know’ used in the following six conditions in the corpora conveys non-factivity rather than factivity: (1). (我)不知道 (*Wǒ*) *bù*

zhīdào (I) no know '(I) do not know' + wh-questions/A-not-A questions (e.g., sentence (12.3)). (2). 我怎么知道 *wǒ zěnme zhīdào* I how know 'How do I know' + wh-questions/A-not-A questions (e.g., sentence (14.5))? (3). 谁知道 *shuí zhīdào* who know 'who knows' + wh-questions/A-not-A questions (e.g., sentence (15.5)). (4). (你)不知道 (*Nǐ*) *bù zhīdào* (You) no know '(You) do not know' + wh-questions/A-not-A questions (e.g., sentence (16.4))? (5). 你知道 *Nǐ zhīdào* You know 'You know' + wh-questions/A-not-A questions (e.g., sentence (17.5))? (6). 你知道 *Nǐ zhīdào* You know 'You know' + complement clauses (e.g., sentence (18.2))?

Child: 3;0

(12.1) Child: 这个 白 的 是 什么, 白 的?
Zhègè bái de shì shénme, bái de?
This white DE is what, white DE?
'What is this white one, this white one?'

(12.2) Mother: 这个 是 木头 的。
Zhègè shì mùtóu de.
This is wood DE.
'This is wooden.'

(12.3) Child: 这个 白 的 我 不 知道 像 什么。
(Zhou/cs36fa06.cha: line 116)
Zhègè bái de wǒ bù zhīdào xiàng shénme.
This white DE I no know like what.
'This white one, I do not know what it is like.'

Child: 5;0

(13.1) Child: 小 男 孩儿 , 小 狗儿 掉 到 水里 去 了。
Xiǎonánháir, xiǎogǒur diàodào shuǐli qù le.
Little boy, little dog fall to water go SFP.
'The little boy and the little dog fall into the water.'

(13.2) Child: 小 男 孩儿 就 和 小 狗儿 又 起来 了。
Xiǎonánhái jiù hé xiǎogǒur yòu qǐlái le.
Little boy then and little dog again up SFP.
'And then the little boy and the little dog get out of the water again.'

(13.3) Child: 他 淹 不 死 , 为 什么?
Tā yān bù sǐ, wèishénme?
He drown no die, why?
'Why he did not drown?'

(13.4) Investigator: 你 告诉 我 啊, 为 什么?
Nǐ gàosù wǒ a, wèishénme?
You tell me PRT, why?
'You tell me why.'

(13.5) Child: 他 知道 水 浅。
(Chinese-Tardif/F3-21120108.cha: line 226)
Tā zhīdào shuǐ qiǎn.
He know water shallow.
'He knows that the water is shallow.'

Mother: the child was 2;1

(14.1) Child: 来 看 喜羊羊。
Lái kàn Xǐyángyáng (a cartoon).
Come see Xiyangyang.
'Come and watch Xiyangyang.'

(14.2) Mother: 哪里 有 嘛?
Nǎli yǒu ma?
Where have SFP?
'Where is it?'

(14.3) Mother: 你 告诉 妈妈 哪里 有 妈妈 再 带 你 去。
Nǐ gàosù māma nǎli yǒu māma zài dài nǐ qù.
You tell mammy where have mammy again take you go.

‘You tell mammy where it is, and then mammy will take you there.’

(14.4) Child: 哪里 有 啊 ？

Nǎli yǒu a?

Where have SFP?

‘Where is it?’

(14.5) Mother 我 怎么 知道 哪里 有 啊 ？

(Tong/130802.cha": line 2118)

Wǒ zěnme zhīdào nǎli yǒu a?

I how know where have SFP?

‘How do I know where it is?’

Mother: the child was 3;4

(15.1) Mother: 你 说 清楚 一点。

Nǐ shuō qīngchǔ yìdiǎn.

You say clear a little.

‘Speak clearer.’

……

(15.2) Mother: 那 你 说 车 前面 朝 墙 ， 车 屁股 朝 你。

Nà nǐ shuō chē qiánmiàn cháo qiáng, chē pìgǔ cháo nǐ.

Then you say car front toward wall, car rear toward you.

‘Then you say the front of the car is toward the wall, the rear of the car is toward you.’

(15.3) Mother: 这 不 就 清楚 了 吗？

Zhè bù jiù qīngchǔ le ma?

This no then clear PRT SFP?

‘Is this then clear?’

(15.4) Mother: 你 自己 话 也 没 说 好。

Nǐ zìjǐ huà yě méi shuō hǎo.

You self word also no say good.

‘You yourself did not speak clear.’

(15.5) Mother: 谁 知道 你 说 什么。

(Tong/141025.cha": line 2443)

Shuí zhīdào nǐ shuō shénme.

Who know you say what.

‘Who knows what you are saying.’

Mother: the child was 2;4

(16.1) Mother: 我们 来 玩 拼图。

Wǒmen lái wán pīntú.

We come play jigsaw.

‘Let’s play the jigsaw.’

……

(16.2) Mother: 同同， 这里 为什么 缺 一 块 呀？

Tóngtong, zhèli wèishénme quē yí kuài ya?

Tongtong, here why lack one piece SFP?

‘Tongtong, why one piece of the jigsaw is missing?’

(16.3) Child: 不 知道 到 哪里 去了。

Bù zhīdào dào nǎli qù le.

No know to where go SFP.

‘I do not know where it is.’

(16.4) Mother: 不 知道 到 哪里 去 了？

(Tong/131103.cha: line 112)

Bù zhīdào dào nǎli qù le?

No know to where go SFP?

‘You do not know where it is?’

(16.5) Mother: 是 不 是 你 弄 丢 的 呀？

Shì bú shì nǐ nòng diū de ya?

Is no is you make lose DE SFP?

‘Did you lose it?’

Mother: the child was 4;6

(17.1) Mother 耶 什么 呀？

Ye shénme ya?

Prt what SFP?

'What is it?'

(17.2) Child 机器人。

Jīqìrén.

Robot.

'A robot.'

(17.3) Child 你 看。

Nǐ kàn.

You see.

'Look.'

(17.4) Mother 这个 我 没 看 过。

Zhège wǒ méi kàn guò.

This I no see EXP.

'I did not see this one.'

(17.5) Mother 你 知道 是 干 什么 的?

(Zhou/cs54fb20.cha: line 184)

Nǐ zhīdào shì gàn shénme de?

You know is do what DE?

'You know what it is used for?'

Mother: the child was 5;6

(18.1) Child: 我 知道 是 这样子 搞 的。

Wǒ zhīdào shì zhéyàngzi gǎo de.

I know is this do DE.

'I know it is done like this.'

(18.2) Mother: 你 知道 是 这样子 搞 的 啊?

(Zhou/cs66mb13.cha: line 327)

Nǐ zhīdào shì zhèyàngzi gǎo de a?

You know is this do DE SFP?

'You know it is done like this?'

(18.3) Mother: 妈妈 也 不 知道。

Māma yě bù zhīdào.

Mammy also no know.
'Mammy also does not know.'

Table 2.5 presents the number of sentences with *zhīdào* 'know' conveying factivity and non-factivity. As the numbers of sentences at each age group were different, to compare the children's and adults' use of *zhīdào* 'know' across the four age groups, the proportions of sentences with *zhīdào* 'know' were calculated by the number of sentences with *zhīdào* 'know' over the number of sentences at each age group. It shows that the children did not begin to use *zhīdào* 'know' as a factive verb until they reached 3;0. Their use of it as a factive verb became more and more frequently, and this was the same with adults. Adults always used *zhīdào* 'know' to convey factivity more frequently than non-factivity. Children younger than 5;0 did not use it to convey factivity more frequently than non-factivity.

Table 2. 5 Number (proportion) of sentences with *zhīdào* 'know' conveying factivity and non-factivity

	Group1 (1;2-2;11)		**Group2 (3;0-3;11)**		**Group3 (4;0-4;11)**		**Group4 (5;0-6;0)**		**Total**	
	CHI	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**
Factive	0	26 (57%)	2 (33%)	32 (67%)	11 (39%)	37 (84%)	12 (86%)	12 (86%)	25 (45%)	107 (70%)
Non-factive	8 (100%)	20 (43%)	4 (67%)	16 (33%)	17 (61%)	7 (16%)	2 (14%)	2 (14%)	31 (55%)	45 (30%)

Sentences with *zhīdào* 'know' conveying factivity and non-factivity were further analyzed according to sentence types, negation status, and sentence subject types. When using *zhīdào* 'know' to convey factivity, children tended to use it in statement, while adults tended to use it in question. When using *zhīdào* 'know' to convey non-factivity, both children and adults tended to use it in statement (see Table 2.6).

With regard to the negation status of sentences with *zhīdào* 'know' being used as a factive verb, children mainly used it in the "+ +" and "– +" conditions, adults used it in the "+ +" condition the most frequently, and both children and adults seldom used it in the "+ –" condition. For the negation status of sentences with *zhīdào* 'know' being used to convey non-factivity, both children and adults used it in the "– +" condition the most frequently, and they were not found using it in the "+ –" condition (see Table 2.7).

Table 2. 6 Sentence types of sentences with *zhīdào* 'know'

	Group1 (1;2-2;11)		**Group2 (3;0-3;11)**		**Group3 (4;0-4;11)**		**Group4 (5;0-6;0)**		**Total**	
	CHI	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**
Factive										
Statement	0	11 (42%)	2 (100%)	19 (59%)	10 (91%)	19 (51%)	11 (92%)	6 (50%)	23 (92%)	55 (51%)
Question	0	15 58%	0 0%	13 (41%)	1 (9%)	18 (49%)	1 (8%)	6 (50%)	2 (8%)	52 (49%)
Non-factive										
Statement	8 (100%)	16 (80%)	4 (100%)	14 (88%)	13 (76%)	5 (71%)	2 (100%)	1 (50%)	27 (87%)	36 (80%)
Question	0	4 (20%)	0	2 (12%)	4 (24%)	2 (29%)		1 (50%)	4 (13%)	9 (20%)

Table 2. 7 Negation types of sentences with *zhīdào* 'know'

	Group1 (1;2-2;11)		**Group2 (3;0-3;11)**		**Group3 (4;0-4;11)**		**Group4 (5;0-6;0)**		**Total**	
	CHI	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**
Factive										
"+ +"	0	23 (88%)	1 (50%)	25 (78%)	3 (27%)	32 (87%)	11 (92%)	9 (75%)	15 (60%)	89 (83%)
"+ –"	0	0	0	2 (6%)	0	1 (3%)	1 (8%)	1 (8%)	1 (4%)	4 (4%)
"– +"	0	3 (12%)	1 (50%)	5 (16%)	8 (73%)	4 (11%)	0	2 (17%)	9 (36%)	14 (13%)
Non-factive										
"+ +"	0	3 (15%)	0	3 (19%)	5 (29%)	1 (14%)	0	2 (100%)	5 (16%)	9 (20%)
"– +"	8 (100%)	17 (85%)	4 (100%)	13 (81%)	12 (71%)	6 (86%)	2 (100%)	0	26 (84%)	36 (80%)

Table 2.8 presents the number of sentences with *zhīdào* ‘know’ grouped according to sentence subject types. As the subjects of some sentences were dropped, the subject types of these sentences were determined according to the context. For example, in sentence (19.3), the subject of the main clause is dropped, but according to the context as demonstrated by sentences (19.1) and (19.2), the subject should be 2PS. When *zhīdào* ‘know’ was used as a factive verb, it shows that all sentences produced by children younger than 5;0 were used with 3PS, while 75% of sentences produced by the 5;0 were used with 1PS. On the whole, children used *zhīdào* ‘know’ as a factive verb with 3PS the most frequently, while adults used it with 2PS the most frequently. For sentences with *zhīdào* ‘know’ conveying non-factivity, both children and adults used 1PS as sentence subjects the most frequently.

Mother: the child was 2;1

(19.1) Mother: 屋顶 在 哪里 啊，同同 ？
Wūdǐng zài nàli ya, Tóngtong?
Roof is where PRT, Tongtong?
‘Where is the roof, Tongtong?’

(19.2) Child: 屋顶 在 哪里 啊 ？
Wūdǐng zài nàli ya?
Roof is where SFP?
‘Where is the roof?’

(19.3) Mother: 知道 什么 是 屋顶 吗 ？
(Tong/130802.cha: line 1998)
Zhīdào shénme shì wūdǐng ma?
Know what is roof SFP?
‘Do you know what is roof?’

Table 2. 8 Sentence subject types of sentences with *zhīdào* 'know'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
***zhīdào* 'know'_Factive**										
1PS	0	4 (15%)	0	8 (25%)	0	18 (49%)	9 (75%)	4 (33%)	9 (36%)	34 (32%)
2PS	0	22 (85%)	0	17 (53%)	0	17 (46%)	2 (17%)	6 (50%)	2 (8%)	62 (58%)
3PS	0	0	2 (100%)	7 (22%)	11 (100%)	2 (5%)	1 (8%)	2 (17%)	14 (56%)	11 (10%)
***zhīdào* 'know'_ Non-factive**										
1PS	8 (100%)	17 (85%)	4 (100%)	12 (75%)	16 (94%)	6 (86%)	2 (100%)	1 (50%)	30 (97%)	36 (80%)
2PS	0	3 (15%)	0	1 (6%)	0	1 (14%)	0	1 (50%)	0	6 (13%)
3PS	0	0	0	2 (13%)	0	0	0	0	0	2 (4%)
Wh-word	0	0	0	1 (6%)	0	0	0	0	0	1 (2%)
DS	0	0	0	0	1 (6%)	0	0	0	1 (3%)	0

2.4.2.2 *Fāxiàn* 'Discover/be aware'

A total of 306 utterances with *fāxiàn* 'discover/be aware' were extracted from the four corpora, 90% (275/306) of them were simple sentences and 17% (52/306) of them were sentences with complement clauses. Among the 52 sentences taking complement clauses, only two of them conveyed non-factivity according to the context. As the number of sentences with *fāxiàn* 'be aware' conveying non-factivity was very small, only sentences with *fāxiàn* 'discover' conveying factivity were further analyzed.

Table 2.9 shows that majority of sentences with *fāxiàn* 'discover' taking complement clauses were statements (84%: 42/50), all sentences produced by children were statements. No children younger than 3;0 were found producing sentences with *fāxiàn* 'discover' taking complement clauses.

Table 2. 9 Sentence types of sentences with *fāxiàn* 'discover'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
Statement	0	3 (100%)	12 (100%)	4 (40%)	21 (100%)	1 (50%)	1 (100%)	0	34 (100%)	8 (50%)
Question	0	0	0	6 (60%)	0	1 (50%)	0	1 (100%)	0	8 (50%)

Table 2.10 shows that 68% (34/50) and 32% (16/50) of sentences with *fāxiàn* 'discover' were used in the "+ +" and "+ –" conditions, respectively. Neither children nor adults used sentences with *fāxiàn* 'discover' in the "– +" condition.

Table 2. 10 Negation status types of sentences with *fāxiàn* 'discover'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
"+ +"	0	2 (67%)	8 (67%)	9 (90%)	10 (48%)	1 (50%)	1 (100%)	1 (100%)	19 (56%)	13 (81%)
"+ –"	0	1 (33%)	4 (33%)	1 (10%)	11 (52%)	1 (50%)	0	0	15 (44%)	3 (19%)

Table 2.11 shows the distributions of sentence subject types of sentences with *fāxiàn* 'discover'. It demonstrates that 94% and 75% of children's and adults' sentences with *fāxiàn* 'discover' were used with 3PS, respectively.

Table 2. 11 Sentence subject types of sentences with *fāxiàn* 'discover'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
1PS	0	2 (67%)	1 (8%)	0	0	0	1 (100%)	0	2 (6%)	2 (13%)
2PS	0	0	0	0	0	1 (50%)	0	1 (100%)	0	2 (13%)
3PS	0	1 (33%)	11 (92%)	10 (100%)	21 (100%)	1 (50%)	0	0	32 (94%)	12 (75%)

2.4.2.3 *Juédé* ‘Think’

A total of 140 complete and intelligent utterances with *juédé* ‘think/feel’ were extracted from the four corpora. Simple sentences and sentencens with complement clauses took up 14% (20/140) and 86% (120/140), respectively. Table 2.12 shows that children tended to use *juédé* ‘think’ in statement, 88% of their utterances were statements and only 13% were questions, while for adults, 58% and 42% of their utterances with *juédé* ‘think’ were used in statement and question, respectively. Only one child (the child from the Tong corpus) produced sentences with *juédé* ‘think’ with complement clauses before 3;0.

Table 2. 12 Sentence types of sentences with *juédé* ‘think’

	Group1 (1;2-2;11)		**Group2 (3;0-3;11)**		**Group3 (4;0-4;11)**		**Group4 (5;0-6;0)**		**Total**	
	CHI	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**
Statement	1 (50%)	8 (50%)	5 (83%)	10 (59%)	10 (100%)	24 (62%)	5 (83%)	14 (58%)	21 (88%)	56 (58%)
Question	1 (50%)	8 (50%)	1 (17%)	7 (41%)	0	15 (38%)	1 (17%)	10 (42%)	3 (13%)	40 (42%)

Table 2.13 shows the negation status of sentences with *juédé* ‘think’. It demonstrates that over 80% of children’s and adults’ utterances were used in the “+ +” condition. No sentences produced by children were used in the “– +” condition.

Table 2. 13 Negation status types of sentences with *juédé* ‘think’

	Group1 (1;2-2;11)		**Group2 (3;0-3;11)**		**Group3 (4;0-4;11)**		**Group4 (5;0-6;0)**		**Total**	
	CHI	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**
“+ +”	1 (50%)	12 (75%)	5 (83%)	14 (82%)	9 (90%)	35 (90%)	6 (100%)	22 (92%)	21 (88%)	83 (86%)
“+ –”	1 (50%)	3 (19%)	1 (17%)	3 (18%)	1 (10%)	3 (8%)	0	2 (8%)	3 (13%)	11 (11%)
“– +”	0	1 (6%)	0	0	0	1 (3%)	0	0	0	2 (2%)

Table 2.14 presents sentence subject types of sentences with *juédé* 'think'. It demonstrates that children younger than 3;0 only used *juédé* 'think' with 1PS, the 3;0 began to use it with 2PS and the 4;0 began to use it with 3PS. Children tended to use *juédé* 'think' with 1PS, and adults tended to use it with both 1PS and 2PS.

Table 2. 14 Sentence subject types of sentences with *juédé* 'think'

	Group1 (1;2-2;11)		**Group2 (3;0-3;11)**		**Group3 (4;0-4;11)**		**Group4 (5;0-6;0)**		**Total**	
	CHI	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**	**CHI**	**ADT**
1PS	2 (100%)	13 (81%)	5 (83%)	11 (65%)	8 (80%)	8 (21%)	4 (67%)	10 (42%)	19 (79%)	42 (44%)
2PS	0	3 (19%)	1 (17%)	6 (35%)	0	31 (79%)	2 (33%)	8 (33%)	3 (13%)	48 (50%)
3PS	0	0	0	0	2 (20%)	0	0	6 (25%)	2 (8%)	6 (6%)

2.4.2.4 *Tīngshuō* 'Hear'

Only two complete and intelligible utterances with *tīngshuō* 'hear' produced by adults were detected in the four corpora. Both sentences were statements and were used in the "+ +" condition with 1PS as sentence subjects. The results suggest that *tīngshuō* 'hear' may be used very infrequently in child-directed speech and in child's speech or the contexts of the four corpora were not suitable to elicit this verb.

2.4.2.5 *Yǐwéi* 'Think/Falsely think'

A total of 28 complete and intelligible utterances with *yǐwéi* 'think/falsey think' were extracted from the four corpora. All took complement clauses. Each sentence was analyzed in the context to determine whether it was used as 'think' or as 'falsely think'. The results show that *yǐwéi* was used as a counter-factive verb in all sentences

produced by both adults and children. Sentence (20.1) below is an example of *yǐwéi* ‘falsely think’ being used as a counter-factive verb according to the context.

Child: 5;0

(20.1) Child: 狗 看见 一 个蜜蜂 窝，以为 是 小 青蛙 在 动 呢。
(Chinese-Tardif/F3-21119201.cha: line 75)
Gǒu kànjiàn yí gè mìfēng wō, yǐwéi shì xiǎo qīngwā zài dòng ne.
Dog see one CL bee nest, falsely think is little frog is move SFP.
‘The dog saw a honeycomb, falsely thought that the frog was moving.’

(20.2) Child: 他 就 上去 一 看，原来 是 蜜蜂 飞 出来 了。
Tā jiù shàngqù yí kàn, yuànlái shì mìfēng fēi chūlái le.
He just up one see, turn out to be is bee fly out SFP.
‘He came to have a look, it turned out to be some bees that flew out.’

Table 2.15 demonstrates that over 90% of children’s and adults’ utterances with *yǐwéi* ‘falsely think’ were statements and were used in the “+ +” condition (see Table 2.16). Very few of their utterances were used in question or in the “+ –” condition. No utterances were found being used in the “– +” condition. As for sentence subject types, both children and adults used *yǐwéi* ‘falsely think’ with 3PS the most frequently, 69% and 58% of children’s and adults’ utterances were used with 3PS, respectively (see Table 2.17).

Table 2. 15 Sentence types of sentences with *yǐwéi* 'falsely think'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
Statement	0	2 (67%)	1 (50%)	1 (100%)	9 (100%)	4 (100%)	5 (100%)	4 (100%)	15 (94%)	11 (92%)
Question	0	1 (33%)	1 (50%)	0	0	0	0	0	1 (6%)	1 (8%)

Table 2. 16 Negation status types of sentences with *yǐwéi* 'falsely think'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
"+ +"	0	2 (67%)	2 (100%)	1 (100%)	8 (89%)	4 (100%)	5 (100%)	4 (100%)	15 (94%)	11 (92%)
"+ –"	0	1 (33%)	0	0	1 (11%)	0	0	0	1 (6%)	1 (8%)

Table 2. 17 Sentence subject types of sentences with *yǐwéi* 'falsely think'

	Group1 (1;2-2;11)		Group2 (3;0-3;11)		Group3 (4;0-4;11)		Group4 (5;0-6;0)		Total	
	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT	CHI	ADT
1PS	0	0	1 (50%)	0	2 (22%)	2 (50%)	1 (20%)	1 (25%)	4 (25%)	3 (25%)
2PS	0	2 (67%)	1 (50%)	0	0	0	0	0	1 (6%)	2 (17%)
3PS	0	1 (33%)	0	1 100%	7 (78%)	2 (50%)	4 (80%)	3 (75%)	11 (69%)	7 (58%)

2.4.2.6 *Jiǎzhuāng* 'Pretend'

A total of 16 complete and intelligible utterances with *jiǎzhuāng* 'pretend' were extracted from the four corpora. Sentences taking complement clauses and sentences taking verb phrases as their objects took up 44% (7/16) and 56% (9/16), respectively. All seven sentences with *jiǎzhuāng* 'pretend' taking complements were used in the "+ +" condition. Among the seven sentences, only one with 1PS was produced by the

target child from the Tong corpus at his 3;4. The other six sentences were produced by adults, of which two were used with 1PS and the other four were used with 2PS.

2.4.2.7 First emergence of target verbs

To investigate the exact time that children produced sentences with the target verbs, the first emergences of these verbs in different conditions by the children in the corpora are examined.

Table 2.18 shows the first emergence of sentences with *zhīdào* 'know' used in different conditions. The first emergence of *zhīdào* 'know'_non-factive was detected in the Tong corpus at 2;1, it was used in the "+ +" condition with 1PS in statement. The first emergences of *zhīdào* 'know'_factive in the "– +" and "+ +" conditions were found in the Chinese-Tardif corpus at 3;0 and 3;5, respectively, both were used with 3PS. The first emergences of *zhīdào* 'know'_factive in the "+ +" condition with 1PS and 2PS were found much later than that with 3PS at 5;0 and 5;6, respectively. Among all three conditions, the first emergence of sentences with *zhīdào* 'know'_factive in the "+ –" condition was found at a late age at 6;0, which was much later than the other two conditions.

Table 2.19 shows that the first emergence of *fāxiàn* 'discover' occurred in the Chinese-Tardif corpus at 3;0, being used in the "+ –" condition with 3PS. The first emergences of *fāxiàn* 'discover' in the "+ +" condition with 3PS and 1PS were found in the Chinese-Tardif and Tong corpora at 3;1 and 3;4, respectively.

Table 2.20 shows that the first emergence of *juédé* 'think' was found in the Tong corpus at 2;4, being used in the "+ +" and "+ –" conditions with 1PS in question and statement, respectively. This was much earlier than the first emergence of *juédé* 'think'

in the "+ +" condition with 2PS in the Tong corpus at 3;3 and 3PS in the Chinese-Tardif corpus at 4;5.

Table 2. 18 First emergence of sentences with *zhīdào* 'know'

Conditions	Corpus	Age
Non-factive		
Statement - "– +" - 1PS	Tong	2;1
Factive		
Statement - "+ +" - 1PS	Zhou	5;0
Statement - "+ +" - 2PS	Zhou	5;6
Statement - "+ +" - 3PS	Chinese-Tardif	3;5
Statement - "+ –" - 1PS	Zhou	6;0
Statement - "– +" - 3PS	Chinese-Tardif	3;0

Table 2. 19 First emergence of sentences with *fāxiàn* 'discover'

Conditions	Corpus	Age
Statement - "+ +" - 1PS	Tong	3;4
Statement - "+ +" - 3SP	Chinese	3;1
Statement - "+ –" - 3PS	Chinese	3;0

Table 2. 20 First emergence of sentences with *juédé* 'think'

Conditions	Corpus	Age
Question - "+ +" - 1PS	Tong	2;4
Question - "+ +" - 2PS	Tong	3;3
Statement - "+ +" - 3PS	Chinese	4;5
Statement - "+ –" - 1PS	Tong	2;4

Table 2.21 shows that the first emergence of *yǐwéi* 'falsely think' in the "+ +" condition with 1PS and 2PS in statement was found in the Tong corpus at 3;3. The first emergence of *yǐwéi* 'falsely think' in the "+ +" condition with 3PS and in the "+ –"

condition with 1PS was found in the Chinese-Tardif corpus at 4;4 and 4;2, respectively, which was much later than that of *yǐwéi* 'falsely think' in the "+ +" with 1PS and 2PS.

Table 2. 21 First emergence of sentences with *yǐwéi* 'falsely think'

Conditions	Corpus	Age
Statement - "+ +" - 1PS	Tong	3;3
Statement - "+ +" - 2PS	Tong	3;3
Statement - "+ +" - 3PS	Chinese	4;4
Statement - "+ –" - 1PS	Chinese	4;2

No sentences with *jiǎzhuāng* 'pretend' taking complement clauses were found being produced by children from the Zhou and Chinese-Tardif corpora. There was only one sentence with *jiǎzhuāng* 'pretend' taking complement clause that was produced by the child from the Tong corpus at his 3;4. This sentence was used in the "+ +" condition with 1PS.

2.4.3 Summary

This corpus study made it possible to examine whether children used these target verbs or not, the first emergences of these verbs, and how they used these verbs in their spontaneous speech. Some verbs were found being used by children at quite an early age, for example, *zhīdào* 'know'_non-factive (at 2;1) and *juédé* 'think' (at 2;4), whereas some verbs such *zhīdào* 'know' in the "+ –" condition emerged at quite a late age at 6;0 in the corpora.

The results showed that Mandarin-speaking children were able to use *zhīdào* 'know' and *fāxiàn* 'discover' as factives at 3;0. However, they used *zhīdào* 'know' more

frequently as a non-factive verb than as a factive verb before 5;0. It is unexpected that *fāxiàn* ‘discover’ was used by both children and adults only in the “+ +” and “+ –” conditions but not in the “– +” condition. The first emergence of *juédé* in the “+ +” and “+ –” conditions with 1PS was quite early at 2;4 before 3;0, and the use of it the in the “+ +” condition with 2PS and 3PS emerged at 3;3 and 4;5 after 3;0, respectively. The results showed that children used *juédé* ‘think’ predominantly in the “+ +” condition with 1PS. *Yǐwéi* was only used as ‘falsey think’ by both adults and children in the corpora, and over 90% of sentences with it were used in the “+ +” condition. The first emergence of *yǐwéi* ‘falsey think’ in the “+ +” condition with 1PS and 2PS was at 3;3, with 3PS was at 4;4 and in the “+ –” condition with 1PS was at 4;2. For *jiǎzhuāng* ‘pretend’, the first and the only emergence of it occurred at 3;4, being used in the “+ +” condition with 1PS.

Sentences with 3PS conveying factivity emerged earlier than those with 1PS and 2PS. The first emergence of *zhīdào* ‘know’_factive in the “+ +” and “– +” conditions with 3PS was at 3;5 and 3;0, respectively, which was earlier than those of *zhīdào* ‘know’_factive in the “+ +” with 1PS and 2PS at 5;0 and 5;1, respectively, and in the “+ –” condition with 1PS at 6;0. The first emergence of *fāxiàn* ‘discover’ in the “+ –” and “+ +” conditions with 3PS at 3;0 and 3;1, respectively, was earlier than that of *fāxiàn* ‘discover’ in the “+ +” condition with 1PS at 3;4 as well. Moreover, sentences conveying verb factivity with 3PS were used the more frequently. Sentences with *zhīdào* ‘know’_factive with 3PS took up 56%, which was much higher than those with 1PS (36%) and 2PS (8%). Sentences with *fāxiàn* ‘discover’ with 3PS took up as many as 94%, while those with 1PS took up only 6%. Sentences with *yǐwéi* ‘falsely think’ 3PS took up 69%. The results provided evidence to support that verb factivity is best expressed in third person case (Kiparsky & Kiparsky, 1971).

Some verbs or some verbs in some conditions were absent in the corpora. For example, no sentences with *tīngshuō* 'hear' were found in child's speech, and there were only two in child-direct-speech. Sentences with *fāxiàn* 'discover', *juédé* 'think' and *yǐwéi* 'think/falsey think' were found only in the "+ +" and "+ –" conditions, but not in the "– +" condition. Sentences with *jiǎzhuāng* 'pretend' were found only in the "+ +" condition. The absence of those verbs being used in certain conditions in the corpora may be due to several possibilities. The first is that children were able to use these verbs in these conditions, but discourse contexts might not be appropriate for eliciting their production of those verbs in those conditions (Schulz, 2003). The second is that some verbs are usually not used in certain conditions in Mandarin due to their semantic feature. For instance, *yǐwéi* 'think/falsely think' and *jiǎzhuāng* 'pretend' themselves carry the meaning of negation, thus they are seldom used in the "– +" condition. The results revealed that even adults did not use the two verbs in the "– +" condition in the corpora. The third is that children have not acquired those verbs in those conditions yet (Schulz, 2003).

One limitation of corpus studies is that child's speech was not sampled all the time, thus the data in the corpora might not cover certain verbs in certain conditions that children have acquired. The lack of verbs such as *tīngshuō* 'hear' and *fāxiàn* 'discover' in the "– +" condition in the corpora did not necessarily indicate that children did not acquire them, it may be that contexts were not suitable to elicit those verbs. To obtain a comprehensive knowledge of verb factivity, the comprehension of the six factivity verbs examined in the corpus study was investigated in an experimental study. One advantage of experimental studies is that it makes it possible to examine children's comprehension of factivity verbs in specific syntactic structures, which may be rarely produced in spontaneous speech.

2.5 Experimental study of verb factivity understanding

2.5.1 Method

2.5.1.1 Participants

A total of 208 native Mandarin-speaking children (N = 160) and adults (N = 48) participated in the experimental study. Table 2.22 shows the distribution of the participants in different age groups. The 160 children, aged 4;2 to 7;6, were from a kindergarten and a primary school in Shenzhen, a city in southern China. All children were reported free of language and cognitive deficits at the time the data collection was taken place. The children were randomly selected in the kindergarten and in the primary school. Parent consent forms were obtained before the testing began. Each child received stickers and a pencil bag as a reward for participation. Among the 48 adults, 43 were from Shenzhen University, two were from Shenzhen Polytechnic, the other three were my friends who studied and worked in Hong Kong. Approval for this study has been obtained from the Ethics Committee of the Department of Chinese and Bilingual Studies of the Hong Kong Polytechnic University. The 208 participants were divided into five age groups, 4;0 to 7;0 and the adult groups. The information of the participants is presented in Table 2.22.

Table 2. 22 Distribution of participants (N = 208)

Group	**Age**			**Gender**		**Total**
	Range	**Mean**	**SD**	**M**	**F**	
4;0	4;2 to 4;11	4;7	0;3	15	17	32
5;0	5;0 to 5;11	5;6	0;3	27	28	55
6;0	6;0 to 6;11	6;6	0;3	23	19	42
7;0	7;0 to 7;6	7;2	0;1	17	14	31
Adult	19;9 to 35;5	22;5	2;9	22	26	48
Total				104	104	208

2.5.1.2 Truth Value Judgment task

A TVJ task adapted from Abbeduto and Rosenberg (1985) was employed to assess the participants' understanding of verb factivity. The test was conducted in short story context which did not provide any clues for relevant answers, but only established referents of test sentences for the purpose of reducing the likelihood that participants took into consideration of their own experience when making judgments. In the TVJ task, two hand puppets, one girl named 小花 *xiǎohuā* and one female teacher were introduced first. *Xiǎohuā* and the teacher were placed on the right and left sides of the participant, respectively. Each trial was accompanied by a picture (see Figure 2.1). *Xiǎohuā* told the participant a short story which consisted of two to three sentences like sentence (21) depicting the picture, and a test sentence like sentence (22), and then the teacher asked a test question like sentence (23). The participant was told that three responses 是 *shì* 'yes', 不是 *búshì* 'no' and 可能吧 *kěnéngba* 'maybe' were available to make truth value judgments. Three buttons, on which there were labels of 'yes', 'no' and 'maybe', respectively, were placed in front of the participant for him/her to make choices.

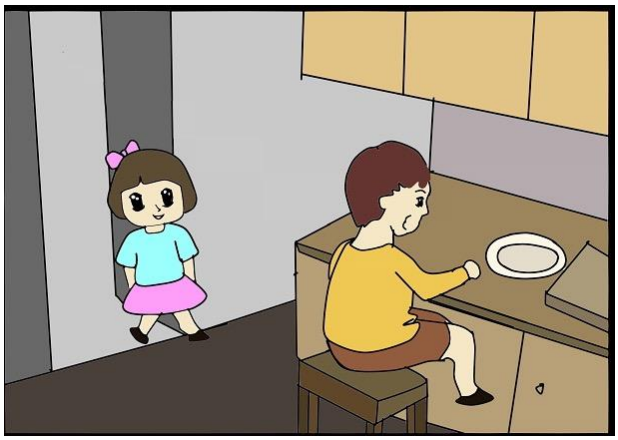

Figure 2. 1 A picture for a test trial in the TVJ task

Short story

(21). 这 是 芬芬， 这 是 大鹏。
Zhè shì Fēn Fēn, zhè shì Dà Péng.
This is Fēn Fēn, this is Dà Péng.
'This is Fēn Fēn, this is Dà Péng.'

Test sentence

(22). 芬芬 知道 大鹏 吃 了 两 块 蛋糕。
Fēn Fēn zhīdào Dà Péng chī le liǎng kuài dàngāo.
Fēn Fēn know Dà Péng eat PERF two CL cake.
'Fēn Fēn knows that Dà Péng ate two pieces of cake.'

Test question

(23). 那么 大鹏 吃 了 两 块 蛋糕 吗?
Nàme Dà Péng chī le liǎng kuài dàngāo ma?
So Dà Péng eat PERF two CL cake SFP?
'So Did Dà Péng eat two pieces of cake?'

Before testing trials, six practice trials were administered for the purpose of familiarizing participants the test and making sure that they knew that the three response alternatives were used to make judgments and they were able to use them.

Among the first six practice trials, two trials could be answered by *shì* 'yes', two by *búshì* 'no' and the other two by *kěnéngba* 'maybe'. In the first three practice trials, feedbacks and explanations were given despite whether participants responded correctly or not. In the last three practice trials, feedbacks and explanations were given only when participants responded incorrectly. The criterion for participants to pass practice trials was that they needed to answer correctly with the three responses at least once. If participants did not reach the criterion in the first six practice trials, they would receive at most two more trials which could be answered with the response they did not choose in the first six practice trials. If participants still did not reach the criterion, the test ends. All participants passed practice trials.

The six verbs investigated in the corpus study were examined in the experimental study: *zhīdào* 'know', *fāxiàn* 'discover/be aware', *juédé* 'think', *tīngshuō* 'hear', *yǐwéi* 'think/falsely think' and *jiǎzhuāng* 'pretend'. According to Li (2014) which examined the commonly used Mandarin factives, non-factives and counter-factives systematically in various syntactic structures, *zhīdào* 'know' is a factive verb, *juédé* 'think' and *tīngshuō* 'hear' are non-factives, *jiǎzhuāng* 'pretend' is a counter-factive verb, *fāxiàn* 'discover/be aware' is a factive verb as well as a non-factive verb, and *yǐwéi* 'think/falsely think' is both a non-factive verb and a counter-factive verb. However, no empirical data are available to support the categorizations of these verbs. The results of this experimental study would provide evidence to verify the categorizations. For *fāxiàn* 'discover/be aware', the present study only employed its meaning of 'discover'. The choice of the six verb covers all three types of factivity verbs according to the categorization of Li (2014): the factives (*zhīdào* 'know' and *fāxiàn* 'discover'), the non-factives (*juédé* 'think', *tīngshuō* 'hear' and *yǐwéi* 'think') and the counter-factives (*jiǎzhuāng* 'pretend' and *yǐwéi* 'falsely think'). In addition,

the six verbs could be further divided into MSVs (*zhīdào* 'know', *juédé* 'think' and *yǐwéi* 'think/falsely think') and behavioral verbs (*fāxiàn* 'discover', *tīngshuō* 'hear' and *jiǎzhuāng* 'pretend'). Some factivity verbs such as *know* carry the features of both mental status and factivity, some factivity verbs such as *pretend* do not carry the feature of mental status but factivity, while some factivity verbs such as *think* do not carry the feature of factivity but mental status. It has been found that MSVs such as *know* and *think* relate to FB reasoning (Howard, 2012; Ruffman *et al*., 2002). Therefore, when examining the relation between factivity verbs and FB reasoning, the classification of factivity verbs into MSVs and behavioral verbs makes it possible to decide whether it is the feature of mental status or factivity of factivity verbs that contributes to FB reasoning.

Test sentences with complement clauses were constructed with the six verbs being used as main clause predicates in three conditions: "+ +", "+ –" and "– +" conditions. Test sentences with *zhīdào* 'know', *fāxiàn* 'discover', *juédé* 'think' and *tīngshuō* 'hear' were constructed in all three conditions, and test sentences with *yǐwéi* 'think/falsely think' and *jiǎzhuāng* 'pretend' were constructed only in the "+ +" and "+ –" conditions because the two verbs carry the meaning of negation themselves. The reasons to construct sentences in all three conditions was twofold. First, the specific feature of verb factivity is that it remains constant under negation, thus participants' correct responses to sentences in both "+ +" and "– +" conditions make it possible to make sure whether they understand these verbs in terms of verb factivity or not. Second, the use of these verbs in the "+ –" condition makes it possible to distinguish participants' correct responses to factives from overaffirmations and their correct responses to counter-factives from overnegations. All test sentences were constructed with third person subjects because it has been proposed that verb factivity is best expressed in

third person case (Kiparsky & Kiparsky, 1971), and this is supported by the findings from the current corpus study. Five test sentences were constructed by each verb in each condition. Therefore, there were 80 test sentences, 40 sentences were with the MSVs (*zhīdào* 'know', *juédé* 'think' and *yǐwéi* 'think/falsely think') and 40 were with the behavioral verbs (*fāxiàn* 'discover', *tīngshuō* 'hear' and *jiǎzhuāng* 'pretend'). Practice trials and test trials were audio-recorded by two native Mandarin-speaking females, one for *Xiǎohuā* and the other for the teacher.

2.5.1.4 Procedure

Each participant received the test individually. After the participant was seated, two puppets, *Xiǎohuā* and a teacher was introduced to him/her, and he/she was told that *Xiǎohuā* would tell him or her stories according to some pictures, and then the teacher would ask him or her a question. The participant was told that he or she could select one of the three responses *shì* 'yes', *búshì* 'no' and *kěnéngba* 'maybe' by pressing corresponding labeled buttons to answer the teacher's question. Pictures and test trials were played by a notebook computer in front of the participant. During the test, the experimenter occasionally reminded the participant of the three responses. The order of the MSV and behavioral verb groups was counterbalanced. The 40 test trials within each group were pseudo-randomized. Test sentences with the same verb in the same condition did not occur more than two consecutive trials.

2.5.2 Results

The number of each type of responses to each verb in each condition was analyzed to examine how participants treated these verbs. As the numbers of participants in the

five age groups were different, the proportions of the number of responses were calculated by dividing the number of each type of responses to each verb in each condition within each age group by the total number of responses to the corresponding verb in the corresponding condition within the corresponding age group, as shown in Table 2.23 to 2.28 below. The data of the adult group was used as a reference point for interpreting the children's performances. If a verb is factive, correct responses to sentences with it in the "+ +", "– +" and "+ –" conditions are "yes", "no" and "yes", respectively. If a verb is counter-factive, correct responses to sentences with it the "+ +" and "+ –" conditions are "no" and "yes", respectively. If a verb is non-factive, correct responses to sentences with it in all three conditions are "maybe". In the following, performances of the adult group are elaborated to examine how they treated these verbs first, and then the children's performances are compared to those of the adult group to examine their developing knowledge of these verbs. One-way ANOVAs were conducted to examine whether there were significant differences among the numbers of the three types of responses to each verb in each condition within each age group or not, and whether the five age groups performed significantly different in each verb in each condition or not. One sample t-tests were conducted to examine whether participants' performances were above chance or not. In the following sections, the performance on each verb is presented first, and then the categorization of each verb in terms of factivity is determined according to adults' understanding of the corresponding verb. Based on the categorizations of these verbs, the children's performances on all three types of factivity verbs are compared.

2.5.2.1 *Zhīdào* 'Know'

Table 2.23 shows that the adults' "yes", "no" and "yes" responses to *zhīdào* 'know' in the "+ +", "+ –" and "– +" conditions took up as high as 100%, 98% and 90%,

respectively. One-way ANOVAs yielded significant response type differences in the "+ +" condition, $F(2, 141) = 28441.5$, $p < .01$, in the "+ –" condition, $F(2, 141) = 5748.14$, $p < .01$, and in the "– +" condition, $F(1, 141) = 421.03$, $p < .01$. Post-hoc (Tukey) analyses revealed that their "yes" responses were significantly more than "no" ($p < .01$) and "maybe" ($p < .01$) responses in the "+ +" condition, their "no" responses were significantly more than "yes" ($p < .01$) and "maybe" ($p < .01$) responses in the "+ –" condition and their "yes" responses were significantly more than "no" ($p < .01$) and "maybe" ($p < .01$) responses in the "– +" condition. One sample t-tests revealed that their "yes", "no" and "yes" responses were significantly above chance in the "+ +" condition, $t(47) = 158.84$, $p < .01$, in the "+ –" condition, $t(47) = 72.4$, $p < .01$, and in the "– +" condition, $t(47) = 18.29$, $p < .01$, respectively. The adults' performance on *zhīdào* 'know' suggest that they treated it as a factive verb. As each participant made one choice for each test trial, therefore, the proportions of each type of responses to each verb stand for the proportions of the number of participants making the corresponding responses as well. Therefore, the results indicate that *zhīdào* 'know' was treated as a factive verb in the "+ +", "+ –" and "– +" conditions by 100%, 98% and 90% of the adults, respectively.

The children's performances on *zhīdào* 'know' were similar to the adults' in that the proportions of their "yes", "no" and "yes" responses in the "+ +", "+ –" and "– +" conditions were significantly higher than those of the other two responses, respectively. One-way ANOVAs yielded significant differences among response types at each age group in the "+ +" condition (4;0: $F(2, 93) = 32.25$, $p < .01$; 5;0: $F(2, 162) = 42.72$, $p < .01$; 6;0: $F(2, 123) = 80.67$, $p < .01$; 7;0: $F(2, 90) = 141.35$, $p < .01$), in the "+ –" condition (4;0: $F(2, 93) = 63.9$, $p < .01$; 5;0: $F(2, 162) = 49.3$, $p < .01$; 6;0: $F(2, 123) = 68.17$, $p < .01$; 7;0: $F(2, 90) = 97.13$, $p < .01$), and in the "– +" condition

(4;0: $F(2, 93) = 10.38$, $p < .01$; 5;0: $F(2, 162) = 30.15$, $p < .01$; 6;0: $F(2, 123) = 28.5$, $p < .01$; 7;0: $F(2, 90) = 86.56$, $p < .01$). Post-hoc (Tukey) analyses revealed that the children's "yes" responses in the "+ +" condition were significantly more than "no" responses (4;0 to 7;0: $p < .01$) and "maybe" responses (4;0 to 7;0: $p < .01$), their "no" responses in the "+ –" condition were significantly more than "yes" responses (4;0 to 7;0: $p < .01$) and "maybe" responses (4;0 to 7;0: $p < .01$), and their "yes" responses in the "– +" condition were significantly more than "no" responses (4;0: $p = .02$; 5;0 to 7;0: $p < .01$) and "maybe" responses (4;0 to 7;0: $p <. 01$). In addition, one sample t-tests revealed that their "yes", "no" and "yes" responses to *zhīdào* 'know' in the "+ +", "+ –" and "– +" conditions, respectively, were significantly above chance ("yes"_"+ +": 4;0: $t(31) = 5.49$, $p < .01$; 5;0: $t(54) = 6.27$, $p < .01$; 6;0: $t(41) = 8.24$, $p < .01$; 7;0: $t(30) = 11.03$, $p < .01$; "no"_"+ –": 4;0: $t(31) = 7.39$, $p < .01$; 5;0: $t(54) = 6.55$, $p < .01$; 6;0: $t(41) = 8.02$, $p < .01$; 7;0: $t(30) = 9.5$, $p < .01$; "yes"_"– +": 4;0: $t(31) = 3.46$, $p < .01$; 5;0: $t(54) = 5.48$; $p < .01$; 6;0: $t(41) = 5.07$, $p < .01$; 7;0: $t(30) = 9.45$, $p < .01$). The results suggest that the children treated *zhīdào* 'know' as a factive verb as well, and they were able to understand verb factivity conveyed by *zhīdào* 'know' at 4;0.

Table 2. 23 Proportions of each type of responses to *zhīdào* 'know' (N = 208)

Groups	*Zhīdào* 'Know'_"+ +"			*Zhīdào* 'Know'_"+ –"			*Zhīdào* 'Know'_"– +"		
	Yes	No	Maybe	Yes	No	Maybe	Yes	No	Maybe
4;0 (N = 32)	62%	23%	16%	18%	73%	9%	51%	31%	18%
5;0 (N = 55)	59%	23%	18%	16%	61%	23%	55%	29%	16%
6;0 (N = 42)	72%	12%	16%	14%	71%	15%	60%	15%	24%
7;0 (N = 31)	81%	8%	10%	9%	80%	11%	72%	10%	17%
Adult (N = 48)	100%	0%	0%	1%	98%	1%	90%	3%	7%

One-way AONVAs were conducted to examine whether there were significant differences among the five age groups' responses to each verb in each condition. The analyses yielded significant age group differences in participants' "yes" responses to

zhīdào ‘know’_“+ +”, $F(4, 203) = 19.45$, $p < .01$, “no” responses to *zhīdào* ‘know’_“+ –”, $F(4, 203) = 13.23$, $p < .01$, and “yes” responses to *zhīdào* ‘know’_“– +”, $F(4, 203) = 14.03$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults’ “yes”, “no” and “yes” responses to *zhīdào* ‘know’ in the “+ +”, “+ –” and “– +” conditions, respectively, were significantly more than those of the children (“yes”_“+ +”: 4;0 to 6;0: $p < .01$; 7;0: $p = .02$; “no”_“+ –”: 4;0 to 6;0: $p < .01$; 7;0: $p = .03$; “yes”_“– +”: 4;0 to 6;0: $p < .01$; 7;0: $p = .05$). The 7;0’s “yes”, “no” and “yes” responses to *zhīdào* ‘know’ in the “+ +”, “+ –” and “– +” conditions, respectively, were significantly more than those of the younger children (“yes”_“+ +”: 4;0: $p = .02$; 5;0: $p < .01$; “no”_“+ –”: 5;0: $p = .02$; “yes”_“– +”: 4;0: $p = .03$; 5;0: $p = .05$). The results suggest that the children’s understanding of *zhīdào* ‘know’ in terms of factivity developed rapid at 7;0, however, they did not reach an adult-like understanding of it even at 7;0.

2.5.2.2 *Fāxiàn* ‘Discover’

Table 2.24 shows that 100% and 99% of the adults’ responses to *fāxiàn* ‘discover’_“+ +” and *fāxiàn* ‘discover’_“+ –” were ‘yes’ and ‘no’, respectively, whereas their responses to *fāxiàn* ‘discover’_“– +” consisted of 39% “yes”, 40% “no”, and 21% “maybe”. One-way ANOVA yielded significant response type differences in adults’ responses to *fāxiàn* ‘discover’ in the “+ –” condition, $F(2, 141) = 9655.37$, $p < .01$, and in the “– +” condition, $F(2, 141) = 6.02$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults’ “no” responses in the “+ –” condition were significantly more than “yes” responses ($p < .01$) and “maybe” responses ($p < .01$), and their “yes” and “no” responses in the “– +” condition were significantly more than “maybe” responses (“yes” and “no”: $p = .01$). The results indicate that *fāxiàn* ‘discover’ used in the “+ +” and “+ –” conditions was treated as a factive verb by adults, while in the “– +” condition, some of them treated it as a factive verb, some of them comprehended it

based on other aspects rather than verb factivity. More will be discussed about their performances on *fāxiàn* 'discover' in the "– +" condition in the discussion section in this chapter later.

Table 2. 24 Proportions of each type of responses to *fāxiàn* 'discover' (N = 208)

Groups	*Fāxiàn* 'Discover'_"+ +"			*Fāxiàn* 'Discover'_ "+ –"			*Fāxiàn* 'Discover'_"– +"		
	Yes	No	Maybe	Yes	No	Maybe	Yes	No	Maybe
4;0 (N = 32)	51%	33%	16%	19%	69%	12%	41%	49%	10%
5;0 (N = 55)	57%	30%	13%	16%	68%	16%	43%	40%	17%
6;0 (N = 42)	71%	17%	12%	12%	72%	16%	40%	42%	18%
7;0 (N = 31)	81%	10%	10%	3%	88%	10%	50%	40%	10%
Adult (N = 48)	100%	0%	0%	0%	99%	1%	39%	40%	21%

For children's performances, one-way ANOVAs yielded significant differences in their response types in the "+ +" condition (4;0: $F(2, 93) = 13.40$, $p < .01$; 5;0: $F(2, 162) = 35.1$, $p < .01$; 6;0: $F(2, 123) = 56.86$, $p < .01$; 7;0: $F(2, 90) = 142.02$, $p < .01$), in the "+ –" condition (4;0: $F(2, 93) = 49.05$, $p < .01$; 5;0: $F(2, 162) = 66.23$, $p < .01$; 6;0: $F(2, 123) = 61.65$, $p < .01$; 7;0: $F(2, 90) = 296.19$, $p < .01$), and in the "– +" condition (4;0: $F(2, 93) = 16.83$, $p < .01$; 5;0: $F(2, 162) = 16.19$, $p < .01$; 6;0: $F(2, 123) = 8.1$, $p < .01$; 7;0: $F(2, 90) = 15.99$, $p < .01$). Post-hoc (Tukey) analyses revealed that the children's "yes" responses in the "+ +" condition were significantly more than "no" responses (4;0: $p = .03$; 5;0 to 7;0: $p < .01$) and "maybe" responses (4;0 to 7;0: $p < .01$), their "no" responses in the "+ +" condition were significantly more than "maybe" responses (4;0: $p = .03$; 5;0: $p = .01$), their "no" responses in the "+ –" condition were significantly more than "yes" responses (4;0 to 7;0: $p < .01$) and "maybe" responses (4;0 to 7;0: $p < .01$), and their "yes" and "no" responses in the "– +" condition were significantly more than "maybe" responses ("yes": 4;0 to 7;0: $p < .01$; "no": 4;0 to 7;0: $p < .01$). One sample t-tests revealed that the proportions of the children's "yes" and "no" responses to *fāxiàn* 'discover' in the "+ +" and "+ –" conditions, respectively,

were significantly above chance ("yes"_"+ +": 4;0: $t(31) = 3.15$, $p < .01$; 5;0: $t(54) = 5.2$, $p < .01$; 6;0: $t(41) = 7.04$, $p < .01$; 7;0: $t(30) = 11$, $p < .01$; "no"_"+ –": 4;0: $t(31) = 6.5$, $p < .01$; 5;0: $t(54) = 7.64$, $p < .01$; 6;0: $t(41) = 7.06$, $p < .01$; 7;0: $t(30) = 15.84$, $p < .01$), the proportion of the 4;0's "no" responses in the "– +" condition was significantly above chance, $t(31) = 2.62$, $p = .01$, and the proportions of the 5;0's and the 7;0's "yes" responses in the "– +" condition were significantly above chance (5;0: $t(54) = 2.66$, $p = .01$; 7;0: $t(30) = 2.78$, $p = .01$). The results suggest that around 50% to 70% of the children were able to understand *fāxiàn* 'discover' used in the "+ +" and "+ –" conditions as a factive verb at 4;0, however, for *fāxiàn* 'discover' in the "– +" condition, like adults, some of children treated it as a factive verb and some of them comprehended based on other aspects rather than verb factivity.

One-way ANOVAs yielded significant differences among the age groups in participants' "yes" responses to *fāxiàn* 'discover' in the "+ +" condition, $F(4, 203) = 41.76$, $p < .01$, and in their "no" responses in the "+ –" condition, $F(4, 203) = 10.55$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults' "yes" and "no" responses in the "+ +" and "+ –" conditions, respectively, were significantly more than the children's ("yes"_"+ +": 4;0 to 6;0: $p < .01$; 7;0: $p = .03$; "no"_"+ –": 4;0 to 6;0: $p < .01$), the 7;0's "yes" responses in the "+ +" condition were significantly more than the 4;0's ($p < .01$) and the 5;0's ($p < .01$), the 6;0's "yes" responses in the "+ +" condition were significantly more than the 4;0's ($p = .02$), and the 7;0's "no" responses in the "+ –" condition were significantly more than the 5;0's ($p = .02$). The results suggest that the 6;0 and 7;0 experienced rapid development in the course of the acquisition of *fāxiàn* 'discover' in the "+ +" and "+ –" conditions, however, they did not reach an adult-like understanding of it in these two conditions even at 7;0.

2.5.2.3 *Juédé* ‘think’

Table 2.25 demonstrates that the adults’ responses to *juédé* ‘think’ in the three conditions were predominantly “maybe”. One-way ANOVAs yielded significantly differences in adults’ response types in the “+ +” condition, $F(2, 141) = 370.89$, $p < .01$, in the “+ –” condition, $F(2, 141) = 368.19$, $p < .01$, and in the “– +” condition, $F(2, 141) = 327.28$, $p < .01$. Post-hoc (Tukey) analyses revealed that their “maybe” responses in all three conditions were significantly more than “yes” and “no” responses, with all p values less than .01. The results indicate that the adults treated *juédé* ‘think’ as a non-factive verb.

Table 2. 25 Proportions of each type of responses to *juédé* ‘think’ (N = 208)

Groups	***Juédé* ‘Think’_“+ +”**			***Juédé* ‘Think’_“+ –”**			***Juédé* ‘Think’_“– +”**		
	Yes	**No**	**Maybe**	**Yes**	**No**	**Maybe**	**Yes**	**No**	**Maybe**
4;0 (N = 32)	40%	33%	27%	25%	53%	22%	39%	38%	23%
5;0 (N = 55)	35%	33%	32%	35%	36%	30%	39%	37%	24%
6;0 (N = 42)	26%	25%	50%	29%	24%	48%	36%	17%	47%
7;0 (N = 31)	22%	16%	62%	16%	26%	57%	25%	21%	54%
Adult (N = 48)	6%	1%	93%	3%	6%	91%	5%	5%	89%

With regard to children’s performances on *juédé* ‘think’, Table 2.25 shows that the distributions of response types were quite different across the four age groups of children. For the 4;0, one-way ANOVAs yielded significant differences in their response types only in the “+ –” condition, $F(2, 93) = 11.85$, $p < .01$, their “no” responses in the “+ –” condition were significantly more than “yes” responses ($p < .01$) and “maybe” responses ($p < .01$), and were significantly above chance, $t(31) = 3.79$, $p < .01$. For the 5;0, one-way ANOVAs yielded significant differences in their response types in the “– +” condition, $F(2, 162) = 4.46$, $p = .01$, that their “yes” responses in the “– +” condition were significantly more than “maybe” responses ($p = .02$), but were

not significantly above chance, $t(54) = 1.45$, $p = .15$. By 6;0, one-way ANOVAs yielded significant differences in their response types in the three conditions ("+ +": $F(2, 123) = 7.55$, $p < .01$; "+ –": $F(2, 123) = 6.6$, $p < .01$; "– +": $F(2, 123) = 9.13$, $p < .01$). Post-hoc (Tukey) analyses revealed that the 6;0's "maybe" responses in "+ +" and "+ –" conditions were significantly more than "yes" responses (" + +": $p < .01$; "+ –": $p = .02$) and "no" responses (" + +" and "+ –": $p < .01$), the 6;0's "yes" and "maybe" responses in the "– +" condition were significantly more than "no" responses ("yes": $p = .02$; "maybe": $p < .01$). One sample t-tests revealed that the 6;0's "maybe" responses in all three conditions were significantly above chance ("+ +": $t(41) = 2.89$, $p = .01$; "+ –": $t(41) = 2.69$, $p = .01$; "– +": $t(41) = 2.4$, $p = .02$). By 7;0, the children began to perform like adults. One-way ANOVAs yielded significant differences in their response types in all three conditions ("+ +": $F(2, 90) = 17.48$, $p < .01$; "+ –": $F(2, 90) = 15.7$, $p < .01$; "– +": $F(2, 90) = 13.82$, $p < .01$). Post-hoc (Tukey) analyses revealed that the 7;0's "maybe" responses in all three conditions were significantly more than "yes" and "no" responses, with all p values less than .01. One sample t-tests revealed that their "maybe" responses in all three conditions were significantly above chance ("+ +": $t(30) = 3.99$, $p < .01$; "+ –": $t(30) = 3.5$, $p < .01$; "– +": $t(30) = 3.58$, $p = .01$). The results indicated that the 4;0 and 5;0 did not understand non-factivity conveyed by *juédé* 'think'. The 4;0's responses suggest that they might have a "no" bias or employed a complement-only strategy to understand *juédé* 'think' in the "+ –" condition. By 6;0, they began to understand *juédé* 'think' as a non-factive verb.

One-way ANOVAs yielded significant age differences in participants' "maybe" responses in the "+ +" condition, $F(4, 203) = 29.91$, $p < .01$, in the "+ –" condition, $F(4, 203) = 33.88$, $p < .01$ and in the "– +" condition, $F(4, 203) = 38.61$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults' "maybe" responses in all three

conditions were significantly more than the 4;0's to 7;0's, with all *p* values less than .01, the 7;0's "maybe" responses in all three conditions were significantly more than the 4;0's and the 5;0's, with all *p* values less than .01, the 6;0's "maybe" responses in the "+ +" and "+ –" conditions were significantly more than the 4;0's ("+ +": $p = .03$; "+ –": $p = .01$), and the 6;0's "maybe" responses in the "– +" condition were significantly more than the 4;0's ($p = .01$) and the 5;0's ($p < .01$). The results suggest that the children experienced rapid development in the course of the acquisition of *juédé* 'think' at 6;0; however, they did not reach an adult-like understanding of its non-factivity even at 7;0.

2.5.2.4 *Tīngshuō* 'Hear'

Table 2.26 shows that the adults' "maybe" responses to *tīngshuō* 'hear' took up 89%, 87%, and 84% in the "+ +", "+ –", and "– +" conditions, respectively. One-way ANOVAs yielded significant differences in adults' response types in the "+ +" condition, $F(2, 141) = 270.95$, $p < .01$, in the "+ –" condition, $F(2, 141) = 228.4$, $p < .01$, and in the "– +" condition, $F(2, 141) = 148.7$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults' "maybe" responses in all three conditions were significantly more than "yes" and "no" responses, with all *p* values less than .01, their "yes" responses in the "+ +" condition were significantly more than "no" responses ($p = .03$), their "no" responses in the "+ –" condition were significantly more than "yes" responses ($p = .01$). One sample t-tests revealed that adults' "maybe" responses were significantly above chance in all three conditions ("+ +": $t(47) = 15.4$, $p < .01$; "+ –": $t(47) = 14.09$, $p < .01$; "– +": $t(47) = 11.76$, $p < .01$). Apart from "maybe" responses, the other responses in the "+ +", "+ –" and "– +" conditions were "yes", "no" and "yes" respectively, the pattern of which was the same with that of a factive verb. Therefore, the adults' performance on *tīngshuō* 'hear' indicate that over 80% of them

treated it as a non-factive verb, while around 10% of them were likely to treat it as a factive verb.

Table 2. 26 Proportions of each type of responses to *tīngshuō* 'hear' (N = 208)

Groups	*Tīngshuō* 'Hear'_"+ +"			*Tīngshuō* 'Hear'_"+ –"			*Tīngshuō* 'Hear'_"– +"		
	Yes	No	Maybe	Yes	No	Maybe	Yes	No	Maybe
4;0 (N = 32)	56%	24%	21%	36%	54%	11%	39%	48%	13%
5;0 (N = 55)	45%	29%	26%	28%	52%	20%	39%	36%	24%
6;0 (N = 42)	50%	16%	33%	25%	48%	27%	44%	26%	30%
7;0 (N = 31)	55%	12%	32%	9%	65%	26%	40%	34%	26%
Adult (N = 48)	11%	0%	89%	0%	13%	87%	12%	4%	84%

The children performed on *tīngshuō* 'hear' differently from the adults. One-way ANOVAs yielded significant differences in children's response types in the "+ +" condition (4;0: $F(2, 93) = 14.74$, $p < .01$; 5;0: $F(2, 162) = 6.38$, $p < .01$; 6;0: $F(2, 123) = 11.29$, $p < .01$; 7;0: $F(2, 90) = 11.57$, $p < .01$), in the "+ –" condition (4;0: $F(2, 93) = 17.42$, $p < .01$; 5;0: $F(2, 162) = 19.8$, $p < .01$; 6;0: $F(2, 123) = 6.13$, $p < .01$; 7;0: $F(2, 90) = 25.62$, $p < .01$), and in the "– +" condition (4;0: $F(2, 93) = 13.97$, $p < .01$; 5;0: $F(2, 162) = 4.94$, $p = .01$; 6;0: $F(2, 123) = 3.76$, $p = .03$). Post-hoc (Tukey) analyses revealed that the children's "yes" responses in the "+ +" condition were significantly more than "no" responses (4;0, 6;0 and 7;0: $p < .01$; 5;0: $p = .01$) and "maybe" responses (4;0 and 5;0: $p < .01$; 6;0: $p = .05$; 7;0: $p = .03$), their "no" responses in the "+ –" condition were significantly more than "yes" responses (4;0: $p = .04$; 5;0 and 7;0: $p < .01$; 6;0: $p = .01$) and "maybe" responses (4;0, 5;0 and 7;0: $p < .01$; 6;0: $p = .01$), their "yes" responses in the "– +" condition were significantly more than "no" responses (6;0: $p = .03$) and "maybe" responses (4;0: $p < .01$; 5;0: $p = .01$), and the 4;0's "yes" and "no" responses in the "+ –" and "– +" conditions, respectively, were significantly more than "maybe" responses ("yes"_"+ –" and "no"_"– +": $p < .01$).

One sample t-tests revealed that the 4;0's to 7;0's "yes" and "no" responses in the "+ +" and "+ –" conditions, respectively, were significantly above chance ("yes"_"+ +": 4;0: $t(31) = 3.93$, $p <. 01$; 5;0: $t(54) = 2.62$, $p = .01$; 6;0: $t(41) = 2.93$, $p = .01$; 7;0: $t(30) = 2.92$, $p = .01$; "no"_"+ –": 4;0: $t(31) = 3.29$, $p < . 01$; 5;0: $t(54) = 4.42$, $p < .01$; 6;0: $t(41) = 2.54$, $p = .02$; 7;0: $t(30) = 4.62$, $p < .01$), and the 4;0's "no" responses in the "– +" condition were significantly above chance, $t(31) = 2.67$, $p = .01$. The results suggest that Mandarin-speaking children aged 4;0 to 7;0 were likely to treat *tīngshuō* 'hear' as a factive verb.

One-way ANOVAs yielded significant differences among age groups in participants' "maybe" responses in the "+ +" condition, $F(4, 203) = 39.71$, $p < .01$, in the "+ –" condition, $F(4, 203) = 52.85$, $p < .01$, and in the "– +" condition, $F(2, 203) = 43.97$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults' "maybe" responses in all three conditions were significantly more than the children's, with all p values less than .01. The results suggest that the children, even by 7;0 did not understand *tīngshuō* 'hear' as a non-factive verb.

2.5.2.5 *Yǐwéi* 'Think/Falsely think'

Table 2.27 demonstrates that the highest proportions of the adults' responses to *yǐwéi* 'think/falsely think' in the "+ +" and "+ –" conditions were "maybe" and "yes", taking up 64% and 53%, respectively. One-way ANOVAs yielded significant differences in their response types in the "+ +" condition, $F(2, 141) = 35.91$, $p < .01$, and in the "+ –" condition, $F(2, 141) = 22.46$, $p < .01$. Post-hoc (Tukey) analyses revealed that adults' "no" responses in the "+ +" condition were significantly more than "yes" responses ($p < .01$), their "maybe" responses in the "+ +" condition were significantly more than "yes" responses ($p < .01$) and "no" responses ($p < .01$), and their "yes" and

"maybe" responses in the "+ –" condition were significantly more than "no" responses ("yes" and "maybe": $p < .01$). One sample t-tests revealed that the adults' "maybe" and "yes" responses in the "+ +" and "+ –" conditions were significantly above chance ("maybe"_"+ +": $t(47) = 5.16$, $p < .01$; "yes"_"+ –": $t(47) = 3.21$, $p < .01$). The results suggest that some of adults treated *yǐwéi* 'think/falsely think' as a non-factive verb, while some of them treated it as a counter-factive verb. They tended to treat it as a non-factive verb in the "+ +" condition, while as a counter-factive verb in the "+ –" condition.

Table 2. 27 Proportions of each type of responses to *yǐwéi* 'think/falsely think' (N = 208)

Groups	*Yǐwéi* 'Think/Falsely think'_"+ +"			*Yǐwéi* 'Think/Falsely think'_"+ –"		
	Yes	No	Maybe	Yes	No	Maybe
4;0 (N = 32)	36%	43%	22%	39%	44%	18%
5;0 (N = 55)	31%	41%	28%	43%	31%	26%
6;0 (N = 42)	20%	32%	48%	40%	21%	38%
7;0 (N = 31)	19%	24%	57%	40%	19%	41%
Adult (N = 48)	5%	31%	64%	53%	6%	41%

The most frequent responses of the 4;0 were "no" in both conditions. One-way ANOVAs yielded significant differences in their response types in the "+ +" condition, $F(2, 93) = 3.7$, $p = .03$, and in the "+ –" condition, $F(2, 93) = 8.69$, $p < .01$. Post-hoc (Tukey) analyses revealed that their "no" responses in the "+ +" condition were significantly more than "maybe" responses ($p = .02$), and their "yes" and "no" responses in the "+ –" condition were significantly more than "maybe" responses ("yes": $p = .01$; "no": $p < .01$). One sample t-tests revealed that the 4;0's "no" responses in the "+ –" condition were significantly above chance, $t(31) = 2.2$, $p = .04$. The results suggest that the 4;0 did not understand the non-factivity or counter-factivity conveyed

by *yǐwéi* ‘think/falsely think’, their performances indicate that they responded with a “no” bias to *yǐwéi* ‘think/falsely think’.

For 5;0, one-way ANOVA yielded significant differences in their response types in the “+ –” condition, $F(2, 162) = 4.47$, $p = .01$. Their “yes” responses in the “+ –” condition were significantly more than “maybe” responses ($p = .01$), and were significantly above chance, $t(54) = 2.22$, $p = .03$. The results suggest that some of the 5;0 treated *yǐwéi* ‘think/falsely think’ as a counter-factive verb in the “+ –” condition.

Unlike the 4;0 and 5;0, the highest proportions of the 6;0’s and 7;0’s responses to *yǐwéi* ‘think/falsely think’ in the “+ +” and “+ –” conditions were “maybe” and “yes” responses, respectively, which were the same with those of adults. One-way ANOVAs yielded significant differences in the 6;0’s and 7;0’s response types in the “+ +” condition, (6;0: $F(2, 123) = 8.73$, $p < .01$; 7;0: $F(2, 90) = 15.71$, $p < .01$) and the in “+ –” condition (6;0: $F(2, 123) = 4.08$, $p = .02$; 7;0: $F(2, 90) = 5.22$, $p = .01$). Post-hoc (Tukey) analyses revealed that their “maybe” responses in the “+ +” condition were significantly more than “yes” responses (6;0 and 7;0: $p < .01$) and “no” responses (6;0: $p = .05$; 7;0: $p < .01$), and their “yes” responses in the “+ –” condition were significantly more than “no” responses (6;0: $p = .03$; 7;0: $p = .02$), the 6;0’s “maybe” responses were marginally significantly more than “no” responses ($p = .06$), and the 7;0’s “maybe” responses in the “+ –” condition were significantly more than “no” responses ($p = .02$). One sample t-tests revealed that the 6;0’s and 7;0’s “maybe” responses in the “+ +” condition were significantly above chance (6;0: $t(41) = 2.78$, $p = .01$; 7;0: $t(30) = 3.92$, $p < .01$). The results indicate that the 6;0 and 7;0 tended to treat *yǐwéi* ‘think/falsely think’ as a non-factive verb in the “+ +” condition and as a counter-factive verb in the “+ –” condition, suggesting that they began to be aware of both the counter-factivity and non-factivity conveyed by *yǐwéi* ‘think/falsely think’.

Among the five age groups, one-way ANOVAs revealed significant differences in age groups in participants' "maybe" responses in the "+ +" condition, $F(4, 203) = 11.86$, $p < .01$, and in the "+ –" condition, $F(4, 203) = 3.5$, $p = .01$. Post-hoc (Tukey) analyses revealed that the 6;0's, 7;0's and adults' "maybe" responses in the "+ +" condition were significantly more than the 4;0's (6;0: $p = .01$; 7;0 and adults: $p < .01$) and 5;0's (6;0: $p = .03$; 7;0 and adults: $p < .01$), and the adults' "maybe" responses in the "+ –" condition were significantly more than the 4;0's ($p = .02$). The results suggest that the 6;0 and 7;0 experienced rapid development in understanding *yǐwéi* 'think/falsely think' in the "+ +" as a non-factive verb, and their understanding of it approaches to an adult-like level.

2.5.2.6 *Jiǎzhuāng* 'Pretend'

Table 2.28 shows the proportions of the adults' "no" and "yes" responses to *jiǎzhuāng* 'pretend' in the "+ +" and "+ –" conditions took up as high as 94% and 97%, respectively. One-way ANOVAs yielded significant differences in their response types in the "+ +" condition, $F(2, 141) = 766.78$, $p < .01$, and in "+ –" condition, $F(2, 141) = 988.18$, $p < .01$. Post-hoc (Tukey) analyses revealed that the adults' "no" and "yes" responses in the "+ +" and "+ –" conditions, respectively, were significantly more than the other two responses, with all p values less than .01. One sample t-tests revealed that their "no" and "yes" responses in the "+ +" and "+ –" conditions, respectively, were significantly above chance ("no"_"+ +": $t(47) = 26.03$, $p < .01$; "yes"_"+ –": $t(47) = 29.67$, $p < .01$). The results indicate that the adults treated *jiǎzhuāng* 'pretend' as a counter-factive verb.

Table 2. 28 Proportions of each type of responses to *jiǎzhuāng* 'pretend' (N = 208)

Groups	*Jiǎzhuāng* 'Pretend'_"+ +"			*Jiǎzhuāng* 'Pretend'_"+ –"		
	Yes	No	Maybe	Yes	No	Maybe
4;0 (N = 32)	18%	69%	13%	54%	39%	8%
5;0 (N = 55)	12%	70%	17%	71%	17%	13%
6;0 (N = 42)	15%	75%	10%	74%	14%	12%
7;0 (N = 31)	6%	85%	10%	83%	8%	8%
Adult (N = 48)	0%	94%	6%	97%	0%	3%

For children's performance on *jiǎzhuāng* 'pretend', one-way ANOVAs yielded significant differences in their response types in the "+ +" condition at 4;0, $F(2, 93) = 46.79$, $p < .01$, at 5;0, $F(2, 162) = 87.52$, $p < .01$, at 6;0, $F(2, 123) = 84.47$, $p < .01$, and at 7;0, $F(2, 90) = 160.5$, $p < .01$, and in the "+ –" condition at 4;0, $F(2, 93) = 20.69$, $p < .01$, at 5;0: $F(2, 162) = 96.78$, $p < .01$, at 6;0, $F(2, 123) = 73.55$, $p < .01$, and at 7;0, $F(2, 90) = 142.64$, $p < .01$. Post-hoc (Tukey) analyses revealed that the 4;0's to 7;0's "no" responses in the "+ +" condition were significantly more than "yes" and "maybe" responses, the 4;0's "yes" and "no" responses in the "+ –" condition were significantly more than "maybe" responses, and the 5;0's to 7;0's "yes" responses in the "+ –" condition were significantly more than "no" and "maybe" responses, with all p values less than .01. One sample t-tests revealed that the children's "no" and "yes" responses in the "+ +" and "+ –" conditions respectively were significantly above chance ("no"_"+ +": 4;0: $t(31) = 6.34$, $p < .01$; 5;0: $t(54) = 8.89$, $p < .01$; 6;0: $t(41) = 8.53$, $p < .01$; 7;0: $t(30) = 12.11$, $p < .01$; "yes"_"+ –": 4;0: $t(31) = 3.36$, $p < .01$; 5;0: $t(54) = 9.58$, $p < .01$; 6;0: $t(41) = 8.51$, $p < .01$; 7;0: $t(30) = 11.43$, $p < .01$). The results indicate that the children were able to treat *jiǎzhuāng* 'pretend' as a counter-factive verb at 4;0.

One-way ANOVAs yielded significant differences in age groups in participants' "no" responses to *jiǎzhuāng* 'pretend in the "+ +" condition, $F(4, 203) = 6.36$, $p < .01$, and "yes" responses in the "+ –" condition, $F(4, 203) = 13.92$, $p < .01$. Post-hoc (Tukey) analyses revealed that adults' "no" responses in the "+ +" condition were significantly more than children's (4;0 and 5;0: $p < .01$; 6;0: $p = .01$), the adults' "yes" responses in the "+ –" condition were significantly more than the children's (4;0 to 6;0: $p < .01$), the 6;0's and 7;0's "yes" responses in the "+ –" condition were significantly more than the 4;0's (6;0: $p = .02$; 7;0: $p < .01$). The results suggest the children experienced rapid development in the course of the acquisition of *jiǎzhuāng* 'pretend' at 6;0 and 7;0, and their understanding of it as a counter-factive verb approached to an adult-like level at 7;0.

2.5.2.7 *Performances on three types of factivity verbs*

The adults' performances on the six factivity verbs indicated that they treated *zhīdào* 'know' in all three conditions as a factive verb, *juédé* 'think' and *tīngshuō* 'hear' in all three conditions as non-factives, *jiǎzhuāng* 'pretend' in the "+ +" and "+ –" conditions as a counter-factive verb. For *fāxiàn* 'discover', the adults treated it as a factive verb in the "+ +" and "+ –" conditions, while in the "– +" condition, some of them tended to treat it as a factive verb, some of them might treat it based on other aspects rather than factivity. For *yǐwéi* 'think/falsely think', some of adults tended to treat it as a non-factive verb, particularly in the "+ +" condition, while some of them tended to treat it as a counter-factive verb in the "+ –" condition. The results showed that not all adults treated *fāxiàn* 'discover', *tīngshuō* 'hear' and *yǐwéi* 'think/falsely think' as any one of the three types of factivity verbs as neatly as *zhīdào* 'know', *juédé* 'think' and *jiǎzhuāng* 'pretend', therefore, in this section, the *zhīdào* 'know', *juédé* 'think' and *jiǎzhuāng* 'pretend' are employed to examine the participants' performances on the

verb factivity. As the maximum score for *zhīdào* 'know' and *juédé* 'think' is 15, and for *jiǎzhuāng* 'pretend' is 10, the proportion of the score of each verb of each participant was generated by dividing the raw score by 15 for *zhīdào* 'know' and *juédé* 'think', and by 10 for *jiǎzhuāng* 'pretend'. The proportions of the scores of the three verbs were used in subsequent analyses in this section.

A two-way mixed ANOVA (5 age groups x 3 verbs) was conducted to examine the participants' performances on verb factivity and the interaction of age groups and factivity. The results showed that there were a significant age group x verbs interaction $F(7.15, 362.96) = 5.38$, $p < .01$, indicating that the participants' perforamnces on verb factivity significantly differed in factivity types and age. Follow-up ANOVAs revealed that there were significantly differences among the three types of factivity verbs in the four child age groups (4;0: $F(2, 93) = 26.58$, $p < .01$; 5;0: $F(2, 162) = 37.55$, $p < .01$; 6;0: $F(2, 123) = 10.30$, $p < .01$; 7;0: $F(2, 90) = 8.55$, $p < .01$), and there were significant differences among the five age groups within each factivity verb (*zhīdào* 'know': $F(4, 203) = 27.07$, $p < .01$; *juédé* 'think': $F(4, 203) = 39.86$, $p < .01$; *jiǎzhuāng* 'pretend': $F(4, 203) = 13.30$, $p < .01$). Post-hoc (Tukey) analyses showed that the children performed signficanly better on the factive *zhīdào* 'know' than the non-factive *juédé* 'think', with all p values less than .01, and the 5;0 performed significantly better on the counter-factive *jiǎzhuāng* 'pretend' than on the non-factive *juédé* 'think'. The adults performed significantly on the three factivity verbs than the children (*zhīdào* 'know' and *juédé* 'think': 4;0 to 7;0, $p < .01$; *jiǎzhuāng* 'pretend': 4;0 to 6;0, $p < .01$). For the factive *zhīdào* 'know', the 7;0 significantly outperformed the 4;0 ($p = .01$) and 5;0 ($p < .01$). For the non-factive *juédé* 'think', the 7;0 and 6;0 significantly outperformed the 4;0 (6;0 and 7;0: $p < .01$) and 5;0 (6;0: $p = .01$; 7;0: $p < .01$). For the

counter-factive *jiǎzhuāng* ‘pretend’, the 7;0 significantly outperformed the 4;0 ($p < .01$).

The results indicate that the factive *zhīdào* ‘know’ and counter-factive *jiǎzhuāng* ‘pretend’ were easier than the non-factive *juédé* ‘think’ for Mandarin-speaking children to understand, and the children at 6;0 and 7;0 experienced rapid developing in understanding verb factivity, however, their understanding of the factive *zhīdào* ‘know’ and non-factive *juédé* ‘think’ did not reach an adult-like level at 7;0.

2.5.3 Summary

According to Li (2014), *zhīdào* ‘know’ is a factive, *juédé* ‘think’ and *tīngshuō* ‘hear’ are non-factives, *jiǎzhuāng* ‘pretend’ is a counter-factive, *fāxiàn* ‘discover/be aware’ is a factive verb in its ‘discover’ meaning and a non-factive in its ‘be aware’ meaning, and *yǐwéi* ‘think/falsely think’ is both a non-factive verb and a counter-factive verb. The adults’ performances in the experimental study showed that they treated *zhīdào* ‘know’ and *fāxiàn* ‘discover/be aware’ in the “+ +” and “+ –” conditions as factives, *juédé* ‘think’ as a non-factive, *jiǎzhuāng* ‘pretend’ as a counter-factive, around 80% of them treated *tīngshuō* ‘hear’ as a non-factive, while around 10% of them treated it as a factive, and they treated *yǐwéi* ‘think/falsely think’ as both a non-factive and a counter-factive. Therefore, the results in the experimental study provided empirical evidence to support Li’s (2014) classifications of the target verbs.

With regard to the children’s performances on the factivity verbs, the results suggest that the 4;0 were able to understand *zhīdào* ‘know’ in all three conditions and *fāxiàn* ‘discover’ in the “+ +” and “+ –” conditions as factives, and *jiǎzhuāng* ‘pretend’ as a counter-factive verb. The 6;0 began to understand *juédé* ‘think’ as a non-factive verb.

For *yǐwéi* ‘think/falsely think’, some of the 4;0 had a slight “no” bias to it, the 5;0 began to understand it in the “+ –” condition as a counter-factive verb, and the 6;0 began to be aware the non-factivity and counter-factivity conveyed by it. The children experienced rapid development in the course of the acquisition of *zhīdào* ‘know’ in all three conditions at 7;0 and of *juédé* ‘think’ in all three conditions, *fāxiàn* ‘discover’ and *jiǎzhuāng* ‘pretend’ in the “+ +” and “+ –” conditions at 6;0, however, they did not reach an adult-like understanding of *zhīdào* ‘know’, *juédé* ‘think’ and *fāxiàn* ‘discover’ at 7;0. The 7;0’s understanding of *jiǎzhuāng* ‘pretend’ in the “+ +” and “+ –” conditions and *yǐwéi* ‘think/falsely think’ in the “+ +” condition approached to an adult-like level. For *tīngshuō* ‘hear’, the children did not understand the non-factivity conveyed by it even at 7;0. The findings of this experimental study are in line with those from a few previous studies in that the 4;0 were able to understand factivity conveyed by some verbs (Abbeduto & Rosenberg, 1985; Aravind & Hackl, 2017; Cheung *et al*., 2009; Macnamara *et al*., 1976; Schulz, 2003; Yi *et al*., 2013), and are consistent with some studies in that the development of factivity is not complete even by primary school children (Falmagne *et al*., 1994; Harris, 1975; Scoville & Gordon, 1980). Therefore, the results suggest that child’s understanding of factivity starts at preschool at around 4;0 and continues to develop after 7;0 (Falmagne *et al.*, 1994; Harris, 1975; Léger, 2007), and support that the acquisition of factivity proceeds on a verb-by-verb basis (Falmagne *et al*., 1994; Scoville & Gordon, 1980).

2.6 Discussion and conclusion

The corpus and experimental studies provided a comprehensive understanding of Mandarin-speaking children’s knowledge of verb factivity. The corpus study provided information about children’s use of target verbs in their natural spontaneous speech,

and the experimental study provided information about children's comprehension of these verbs in different conditions. There are several intriguing findings with regard to the children's use and understanding of these verbs in the corpus and experimental studies, respectively. For instance, the children were able to produce *juédé* 'think' at quite an early age, whereas they were not able to understand it from the perspective of factivity until at quite a late age. For *yǐwéi* 'think/falsely think', both children and adults used it as a counter-factive in the corpora, while they comprehended it as a counter-factive as well as a non-factive in the experimental study. These intriguing findings are discussed in this section.

The results from the corpus study showed that the children were able to use *juédé* 'think' at quite an early age at 2;4 in the corpora, whereas they did not perform above chance in understanding the non-factivity conveyed by it until they were at 6;0 in the experimental study. Test sentences with *juédé* 'think' in the experimental study were constructed with 3PS as sentence subjects, conveying speakers' uncertainty about the truth value of complement clauses. A comprehensive understanding of the non-factivity conveyed by *juédé* 'think' requires one to equip with several aspects of knowledge such as (1) the syntactic structure of sentential complement, (2) some verbs have the feature of presupposing the truth value of complement clauses, while some do not have, (3) the possibility of events' occurrence and some verbs denotes such possibility, (4) *juédé* 'think' is a verb that does not have such presupposition but only denotes possibilities of events' occurrence, and (5) speakers' belief about the possibility of events' occurrence according to *juédé* 'think' they selected. The lack of any one aspects of the above knowledge may lead the failure in understanding the non-factivity conveyed by *juédé* 'think'. Therefore, the process of obtaining a correct indeterminate response to the non-factive *juédé* 'think' is complex and requires an

abstraction on a metalinguistic level (Schulz, 2003). The children's use of *juédé* 'think' in the corpora was mainly restricted in the the "+ +" condition with 1PS as sentence subjects. The first emergence of it in the "+ +" condition with 3PS was at 4;5, which is two years later than the first emergence of it in the "+ +" condition with 1PS at 2;4. It is likely that children's early use of *juédé* 'think' with 1PS functioned as a discourse marker rather than conveying non-factivity. The children might memorize sentences with *juédé* 'think' with 1PS as sentence subjects being followed with complement clauses as a whole at an early age and use it without understanding the mental concepts it refers to, therefore it explains why Mandarin-speaking children were able to use *juédé* 'think' before they were able to comprehend its non-factivity.

Another intriguing finding in this chapter is about *yǐwéi* 'think/falsely think'. Both adults and children always used *yǐwéi* as a counter-factive in its meaning 'falsely think' in the corpora, whereas they comprehended it as a counter-factive verb as well as a non-factive verb in the experimental study. The discrepancy may be explained by different contexts in which sentences with *yǐwéi* were produced in the corpora and were used in the experimental study. In the corpora, sentences with *yǐwéi* were produced in the context that speakers found that something happened out of their expectation, which was emphasized by the use of adverbs such as 本来 *běnlái* 'original/at first', 其实 *qíshí* 'in fact' and 原来 *yuánlái* 'turn out to be', or sentence final particle such as 呢 *ne*, like the sentences (24.1) and (24.2), whereas test sentences with *yǐwéi* in the experimental study were presented in a context where there was no such use of adverbs or sentence final particles to form obvious contrasts between the events of complement clauses and speakers' beliefs or the reality. Although the results in the experimental study showed that the participants treated *yǐwéi* as both a non-factive verb and a counter-factive verb, their understandings of *yǐwéi* differ in the "+

+" and "+ –" conditions. It was more likely for them to treat *yǐwéi* as a non-factive verb in the "+ +" condition, while as a counter-factive verb in the "+ –" condition. As *yǐwéi* itself has a sense of negation when it is used as 'falsely think', it is possible that the use of negation expresses a sense of contrast as well apart from adverbs and sentence final particles. Therefore, the use of *yǐwéi* in negation may form a strong contrast and thus makes its 'falsely think' meaning salient. The findings of *yǐwéi* 'think/falsey think' in this chapter suggest that the participants were sensitive to discourse contexts, and the use of adverbs, sentence final particles, and negation markers when producing and understanding factivity verbs.

Not all target verbs were detected in the corpora. For instance, adults and children seldom used or did not use *jiǎzhuāng* 'pretend', *tīngshuō* 'hear' and *fāxiàn* 'discover' in the "– +" condition in the corpora. As noted earlier in this chapter, there are three possibilities about the infrequent use or absence of these verbs in the corpora. The first is that participants' have acquired these verbs, while the data in the corpora may not cover them, as participants' speech was not sampled all the time or these verbs were not elicited in certain contexts. The second is that participants have not acquired these verbs (Schulz, 2003). The third is that these verbs or these verbs in certain conditions themselves are seldom used in oral language. The first and second possibilities could be supported by the results of the experimental study. Although children seldom produced *jiǎzhuāng* 'pretend', only one sentence with it was uttered by one child aged 3;4, the children performed fairly well in understanding it as a counter-factive verb at 4;0 in the experimental study. For *tīngshuō* 'hear', only two sentences with it were produced by adults and no sentences with it were uttered by children in the corpora. Majority of adults treated it correctly as a non-factive verb, while children even at 7;0 did not master it as a non-factive verb in the experimental study. Therefore, together

with the findings from the experimental study, children have mastered *jiǎzhuāng* ‘pretend’ as a counter-factive verb at an early age, while they did not master *tīngshuō* ‘hear’ as a non-factive verb even at 7;0, thus the seldom use of *jiǎzhuāng* ‘pretend’ in the corpora may be due to methodological issues of speech sampling and the absence of *tīngshuō* ‘hear’ may be explained by methodological issues of speech sampling as well as the second possibility, that is the children did not master it yet.

With regard to *fāxiàn* ‘discover’, adults and children produced sentences with it in the “+ +” and “+ –” conditions, but not in the “– +” condition in the corpora. The absence of *fāxiàn* ‘discover’_“– +” may be explained by discourse contexts that were inappropriate to elicit sentences with it, it may as well be explained by the third possibility, that is *fāxiàn* ‘discover’_“– +” itself is infrequently used in Mandarin. When searching *fāxiàn* ‘discover’ as a keyword in the Chinese National Corpus (Jin *et al*., 2005), 4821 sentences were detected, however only 93 (2%) of them were used with negation, this confirms that *fāxiàn* ‘discover’ is infrequently used in the “– +” condition in Mandarin.

To summarize, this chapter examined Mandarin-speaking adults’ and children’s use of factivity verbs in a corpus study and their understanding of factivity in an experimental study. For *zhīdào* ‘know’, *fāxiàn* ‘discover’ and *jiǎzhuāng* ‘pretend’, children were able to use and understand them at around 4;0. For the non-factive *juédé* ‘think’, although children were able to produce it at quite an early age, they did not begin to understand its non-factivity until at 6;0. For *tīngshuō* ‘hear’, children were not found being able to use it in the corpora or to understand it even at 7;0 in the experimental study. *Yǐwéi* was used as a counter-factive verb in its meaning “falsely think” by both adults and children, whereas it was understood as both a counter-factive verb and a non-factive verb in the experimental study.

Chapter 3

3.1 Introduction

Substantial studies have found that language is closely related to ToM. To examine how the two are related, researchers are interested in which aspects of language and specific linguistic forms relate to various components of ToM particularly. A considerable body of research has investigated the relation between various aspects of language such as mental state verbs (MSVs), sentential complement structure and verb factivity and FB reasoning, the core component of ToM (Cheung *et al*., 2009; de Villiers & Pyers, 2002; Hale & Tager-Flusberg, 2003; Mo *et al*., 2014; Ruffman *et al*., 2002). Most of previous studies have focused on first-order FB reasoning, the advanced higher order FB reasoning such as second-order FB reasoning is less investigated. Among various linguistic forms, verb factivity is specific for sharing a common neural representation with first-order FB reasoning, thus provides a good window to examine the relation between language and ToM (Chen *et al*., 2012; Cheung *et al*., 2012). Although previous studies have revealed that verb factivity relate to and play important roles in first-order FB reasoning, it is unclear whether the relationship extends to second-order FB reasoning. To date, very few well-documented studies have been conducted to investigate the role of verb factivity in children's first-order FB understanding, sparse well-documented studies, to my best knowledge, have examined the role of verb factivity in children's second-order FB reasoning. Apart from language, executive functioning (EF) has been found relating closely to ToM development as well (Carlson *et al*., 2002; Carlson, Moses, & Claxton, 2004). However, it remains unclear whether or not and how specific linguistic forms

such as sentential complementation and verb factivity contribute uniquely to first-order and second-order FB reasoning when controlling for EF.

3.2 The current study

The main purpose of this chapter was to investigate the relation between the understanding of verb factivity and the performance on first-order and second-order FB tasks in TD Mandarin-speaking children when controlling for verbal mental ability, sentential complement, and EF. Two questions were asked: (1) Whether Mandarin-speaking children's understanding of all three types of factivity verbs relates to their first-order and second-order FB reasoning or not? (2) Whether their understanding of verb factivity plays a unique role in predicting their first-order and second-order FB reasoning when controlling for other related factors such as complementation and EF?

Verb factivity is conveyed in sentences with complement clauses, and a comprehensive understanding of it requires one to understand lexical semantic meaning of main clause predicates, sentential complement structure, propositions of complement clauses (zero-order belief), sentence subjects' beliefs about the propositions of complement clauses (first-order belief), speakers' beliefs about subjects' beliefs about the propositions of complement clauses (second-order belief) and then to infer speakers' beliefs about the propositions of complement clauses (first-order belief) (Scoville & Gordon, 1980). Therefore, I propose that verb factivity relates closely to first-order and second-order FB reasoning. Three predictions were generated: (1). Verb factivity would play a significant role in both first-order and second-order FB reasoning because verb factivity expressed in sentential complement structure is in its nature representation of mental representation by means of linguistic

feature and a comprehensive understanding of it requires first-order as well as second-order representations of beliefs. (2). If verb factivity contributes uniquely to FB reasoning, it should remain significant after controlling for complementation, EF, age and verbal mental ability.

3.3 Method

3.3.1 Participants

The present study involved the 160 native Mandarin-speaking children in the experimental study in Chapter 2. On top of the 160 children, 12 native Mandarin-speaking adults (age range: 19;0 to 35;5, mean = 27;7, SD = 4;8) participated in the FB tasks as a control group.

3.3.2 Tasks

3.3.2.1 Verbal mental ability test

The participants' verbal mental ability was assessed by the PPVT-R (Sang & Miao, 1990). There were 175 test trials, and correct response for each trial scored 1.

3.3.2.2. Nonverbal intelligence

The participants' nonverbal intelligence was estimated by Raven's Coloured Progressive Matrices (Raven, Raven, & Court, 1998). Children younger than 5;0 only received the 12 trials in set A. There were 60 trials. Correct response for each trial scored 1.

3.3.2.3 Memory for sentential complement

The memory for complement task was adapted from de Villiers and Pyers (2002) and Durrleman *et al*. (2016). In previous studies, the MSV ‘think’ and the communication verb ‘say’ were used. As the use of MSVs in the complement task may influence the correlation between FB and sentential complement structure. Therefore, the current study employed the communication verb ‘say’ as the main clause predicate, being followed by a complement clause. In each trial, there were two pictures (e.g., Figure 3.1 and Figure 3.2) and three sentences (e.g., (24.1) to (24.3)). Figure 3.1 was presented first being accompanied by sentence (24.1), and then Figure 3.2 was presented and accompanied by test sentence (24.2). Test question (24.3) was played with an arrow pointing to Figure 3.1. Pictures and test sentences were played by a notebook computer. Test sentences were audio recorded by a native Mandarin-speaking female. There were 12 test trials, and correct response for each trial scored 1.

(24.1) 妈妈 说 芳芳 头发 上 有 个 虫子。
Māma shuō Fāng Fang tóufà shàng yǒu gè Chóngzi.
Mom say Fang Fang hair on have CL worm.
‘Mom says that there is a worm in Fang Fang’s hair.’

(24.2) 但是 你 看， 这 只是 树叶。
Dànshì nǐ kàn, zhè zhǐshì shùyè.
But you look, this only leaf.
‘But look, this is only a leaf.’

(24.3) 妈妈 说 芳芳 头发 上 有 什么?
Māma shuō Fāng Fang tóufà shàng yǒu shénme?
Mom say Fang Fang hair on have what?
‘What did mom say is in Fang Fang’s hair?’
(correct response: 虫子 *chóngzi* ‘worm’)

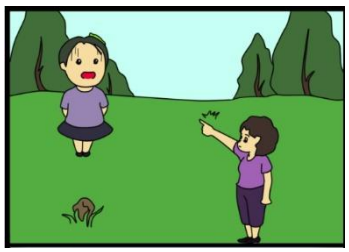

Figure 3. 1 One sample of test trials in the memory for complement task

Figure 3. 2 One sample of test trials in the memory for complement task

3.3.2.4 Executive functioning

Two components of EF: inhibitory control and working memory were examined. The Dimensional Change Card Sort (DCCS) (Zelazo, 2006) task and the Day-Night Stroop (DNS) (Gerstadt, Hong, & Diamond, 1994) task were employed to estimate participants' inhibitory control, and the Digit Span Test (DST) (Davis & Pratt, 1995), including forward and backward digit span tests were employed to assess participants' working memory capacities.

3.3.2.4.1 Dimensional Change Card Sort task

The DCCS task (Zelazo, 2006) includes a standard version and a border version. The standard version is suitable for participants with MA between 2;6 and 5;0, and the border version is suitable for participants with MA between 5;0 and 7;0. Two cards showing a red boat and a blue rabbit, respectively, are target cards. In the standard version, six cards showing red rabbit and six cards showing blue boat are test cards. The standard version includes two rounds. Participants were required to sort six bivalent test cards (three red rabbit cards and three blue boat cards) according to one dimension (e.g., color: red and blue) in the first round, and then the other six cards according to the other dimension (e.g., shape: rabbit and boat) in the second round. The border version includes 12 test cards, with three cards showing a red rabbit with a

black border, three cards showing a red rabbit without black border, three cards showing a blue boat with a black border and three cards showing a blue boat without black border. Participants received the border version if they passed at least five test trials in both rounds in the standard version. In the border version, children were required to sort cards with black border according to color and cards without black border according to shape. Test cards in both standard version and in border version were in pseudo-random order with the same card occurring no more than twice consecutively. During the test, no corrective feedback was provided. Correct response for each trial scored 1, scores of both the standard version and the border version ranged from 0 to 12, and the total score of the DCCS task ranged from 0 to 24.

3.3.2.4.2 Day-Night Stroop task

The DNS task (Gerstadt *et al*., 1994) assesses participants' inhibitory control of the prepotent response of matching a word (e.g., 'sun' or 'moon') they say to an object shown (e.g., a card depicting the moon or a card depicting the sun). The DNS task includes eight test cards showing the sun and eight showing the moon. Participants were required to say 'moon' for each card showing the sun and 'sun' for each card showing the moon. After two warm-up items, participants received 16 test trials in pseudo-random order with the same card occurring no more than twice consecutively. During the test, no corrective feedback was provided. Correct response for each trial scored 1, therefore, the score of the DNS test ranged from 0 to 16.

3.3.2.4.3 Working memory test

The participants' working memory was measured by the digit span test (DST) (Davis & Pratt, 1995), including the forward and backward digit span tests. A total of 28 test

trials were equally distributed in the two subtests. Test trials for the forward and backward digit tests were of three- to nine-digit length and two- to eight-digit length, respectively, with two trials for each digit length. Before the forward and backward digit tests, there were five practice trials that were of three- and two-digit length, respectively. Participants received test trials until they responded correctly to one practice trial, otherwise, the test ends. For test trials, a correct response to one of two digits with the same length leads to the next two trials which were longer by one digit. If participants responded incorrectly to both two digits with the same length, the test ends. Correct response for each test trial scored 1, therefore, the score of the DST ranged from 0 to 28.

3.3.2.5 False belief task

The participants' FB understanding was measured by four first-order and four second-order FB tasks. The four first-order FB tasks included two change-of-location tasks (Wimmer & Perner, 1983), and two unexpected-content tasks (Gopnik & Astington, 1988; Perner *et al*., 1987). The four second-order FB tasks included the ice-cream van story (Perner & Wimmer, 1985), the hidden toy story (Astington, Pelletier, & Homer, 2002), the soccer practice story (Miller, 2013a) and the cake story (Miller, 2013b). All first-order and second-order FB stories, except for the two unexpected-content tasks, were administered in the form of storytelling, being companied by colored pictures depicting the stories. Meta-analyses showed that children's performance on FB tasks did not differ significantly no matter FB tasks were acted out or were presented in pictures or videos (Liu *et al*., 2008; Wellman *et al*., 2001). The contents of the stories were audio-recoded by a native Mandarin-speaking female. The stories were administered to participants by notebook computers. The two unexpected-content tasks were acted out by examiners, an M & M candy box and a cookie box with real

contents being pencils and stickers, respectively, were used. The details of FB stories are presented in the Appendix.

A few previous studies have documented that the use of the MSV *yǐwéi/ji5wai3* 'falsely think' in FB probe test questions was positively related to Chinese-speaking children's FB performance (Mandarin: Lee *et al*. (1999); Cantonese: Tardif *et al*. (2004)). To control for the influence of MSVs like *think* and *falsely think* to children's FB performance, the communication verb *shuō* 'say' was used in FB test questions in this study. There were one test question and one explanation in the change-of-location task, one self-belief test question, one self-belief explanation question, one other-belief test question and one other-belief explanation question in the unexpected-content task, and one test question and one explanation question in each second-order FB story. First-order FB tasks included six test questions and six explanation questions, and second-order FB tasks included four test questions and four explanation questions. Correct response for each question scored 1, therefore, scores of first-order and second-order FB tasks ranged from 0 to 12 and from 0 to 8, respectively.

3.3.2.6 Verb factivity task

Children's understanding of verb factivity was assessed by the TVJ task as described in the experimental study in Chapter 2.

3.3.3 Procedure

Each child received the test individually in a quiet room in the respective kindergarten and primary school. The whole testing lasted around 90 minutes. For kindergarten children, the testing was divided into three 30-minute sessions. The verbal mental

ability, non-verbal intelligence, and memory for complements tests were administered in the first session. The EF, FB, and verb factivity tests were administered in the second and third sessions. The four first-order and second-order FB tasks were equally distributed into the second and third sessions. For primary schoolers, the testing was divided into two 45-minute sessions. The verbal mental ability, non-verbal intelligence, memory for complements and, EF tests were administered in the first session, FB and verb factivity tasks were administered in the second session. First-order FB tasks were always administered before second-order FB tasks in each session. Participants received test questions only if they responded correctly to all control questions in each FB story. The 80 test trials of verb factivity task were divided into MSVs group and behavioral verbs group which were administered in the second and third sessions for kindergarten children. The rest trials of the memory for complements and verb factivity tasks and the test questions of FB tasks could be played three times at the most if participants did not hear them clearly. The order of FB and verb factivity tests was counterbalanced. The 12 adults received FB tasks on the campus of the Hong Kong Polytechnic University.

3.4 Results

The data from four children were dropped due to mistakes made during FB tasks. Therefore, subsequent analyses were based on the data from 156 children (79 boys, age range: 4;2 to 7;6, mean = 5;11, SD = 0;11) and 12 adults. Table 3.1 shows the distribution of the participants. In the following sessions, children's performances on each task are presented first, and then the correlation analyses amongst tested variables. In the last session, regression analyses are conducted to check the role of verb factivity in first-order and second-order FB performance.

Table 3. 29 Information of participants (N = 168)

Groups	Age		
	Mean	**SD**	**Range**
4;0 (N = 32, 15 male)	4;7	0;3	4;2 to 4;11
5;0 (N = 52, 24 male)	5;6	0;3	5;0 to 5;11
6;0 (N = 42, 23 male)	6;6	0;3	6;0 to 6;11
7;0 (N = 30, 17 male)	7;2	0;2	7;0 to 7;6
CHI (N = 156, 79 male)	5;11	0;11	4;2 to 7;6
Adults (N = 12, 4 male)	27;7	4;8	19;0 to 35;5

Table 3.2 shows the means and standard deviations of verbal mental ability (PPVT-R), nonverbal intelligence (Raven's), inhibitory control (DCCS and DNS), working memory (DST), and memory for complement tasks of each age group of the children and of the whole sample of the children.

Table 3. 30 Means and standard deviations (SD) of tasks (N = 156)

Tasks	4;0 (N = 32)		5;0 (N = 52)		6;0 (N = 42)		7;0 (N = 30)		CHI (N = 156)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Raven's	**7.25**	1.74	**18.08**	4.93	**24.24**	7.23	**25.77**	6.60	18.99	8.7
PPVT-R	**70.63**	13.18	**92.37**	20.33	**97.93**	22.11	**108.83**	21.64	92.57	23.37
DCCS	**17.56**	4.51	**20.27**	2.40	**21.07**	2.8	**22.00**	2.49	20.26	3.39
DNS	**14.41**	2.65	**14.83**	2.76	**15.52**	1.69	**15.93**	0.25	15.14	2.23
DST	**10.66**	3.81	**12.33**	3.19	**13.50**	2.66	**14.03**	2.03	12.63	3.21
Comp	**8.72**	3.39	**7.56**	4.84	**11.31**	1.98	**11.40**	2.19	9.54	3.86

Note: PPVT-R = Peabody Picture Vocabulary Test - Revised; DCCS = Dimensional Change Card Sort test; DNS = Day-Night Stroop test; DST = Digit Span Test; Comp = Memory for complement test

The children's performances on all tests except for the memory for complement test in Table 3.2 increased with age. One-way ANOVAs yielded significant differences among the four age groups in their performances on the PPVT-R ($F(3, 152) = 20.71$,

$p < .01$), Raven's ($F(2, 121) = 18.69$, $p < .01$)[6], DCCS ($F(3, 152) = 12.49$, $p < .01$), DNS ($F(3, 152) = 3.31$, $p = .02$), DST ($F(3, 152) = 8.1$, $p < .01$), and complementation ($F(3, 152) = 12.62$, $p < .01$) tests. Post hoc (Tukey) tests revealed that the 4;0 performed significantly poorer than the older age groups on the PPVT-R (5;0 to 7;0: $p < .01$), DCCS (5;0 to 7;0: $p < .01$), DNS (7;0: $p = .03$), DST (6;0 and 7;0: $p < .01$), and complementation (6;0: $p = .01$; 7;0: $p = .02$). The 5;0 performed significantly poorer on the PPVT-R than the 7;0 ($p < .01$), and on Raven's and complementation tests than the 6;0 and 7;0, with all p values less than .01. The results suggest that the children experienced rapid developments in inhibitory control and working memory tests at 5;0, and in PPVT-R, and complementation tests at 6;0.

For the complementation task, it is intriguing that the 4;0 performed better than the 5;0, although it did not reach a significant level. As there are two contrasting objects in each trial, in the context, children are likely to choose one of them to answer test questions, therefore, there are two choices in each trial. In this case, the chance level of the complementation test is 6. Noted that the average score of the 4;0's performance on the complementation test is 9.1, which is significantly higher than the chance ($p < .01$). In this line, it is likely that most of the four-year-olds were able to comprehend sentential complement structure. Therefore, the unexpected result that the 5;0 performed poorer than the 4;0 may be explained by the 5;0' overinterpretation of the test sentences of the complementation task.

[6] The one-way ANOVA on Raven's test included the 5;0 to 7;0 groups, as the 4;0 did not receive the whole Raven's test, they only received Raven's set A test.

3.4.1 Verb factivity

According to the results in the verb factivity comprehension study reported in Chapter 2 in this thesis, the children's performances on the three factivity verbs (the factive verb *zhīdào* 'know', the non-factive verb *juédé* 'think' and the counter-factive verb *jiǎzhuāng* 'pretend') were employed to examine the relationship between verb factivity and FB understanding. There were five test trials with *zhīdào* 'know' and *juédé* 'think' in the "+ +", "+ –" and "– +" conditions, and with *jiǎzhuāng* 'pretend' in the "+ +" and "+ –" conditions. Correct response to each test trial was worth for 1 score. The scores for *zhīdào* 'know' and *juédé* 'think' ranged from 0 to 15, and for *jiǎzhuāng* 'pretend' ranged from 0 to 10. As the maximum scores of the three verbs were different, the proportion of the score of each verb of each participant was generated by dividing the raw score by 15 for *zhīdào* 'know' and *juédé* 'think', and by 10 for *jiǎzhuāng* 'pretend'. The proportions of the scores of the three verbs were used in subsequent analyses in this chapter. Table 3.3 shows means and standard deviations of each verb at each age group.

Table 3. 31 Means and standard deviations (SD) of factivity verbs (N = 156)

Group	***Zhīdào* 'Know'**		***Juédé* 'Think'**		***Jiǎzhuāng* 'Preted'**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
4;0 (N = 32)	0.62	0.19	0.24	0.28	0.62	0.24
5;0 (N = 52)	0.59	0.25	0.29	0.28	0.71	0.27
6;0 (N = 42)	0.68	0.22	0.48	0.33	0.75	0.27
7;0 (N = 30)	0.78	0.20	0.59	0.34	0.84	0.22
CHI (N = 156)	0.66	0.23	0.39	0.33	0.72	0.27

Table 3.3 shows that the means of each age group's performance on the factive verb *zhīdào* 'know' (4;0: $t(31) = 8.45$, $p < .01$; 5;0: $t(51) = 7.37$, $p < .01$; 6;0: $t(41) = 10.14$,

$p < .01$; 7;0: $t(29) = 12.46$, $p < .01$) and the counter-factive verb *jiǎzhuāng* 'pretend' (4;0: $t(31) = 6.63$, $p < .01$; 5;0: $t(51) = 9.97$, $p < .01$; 6;0: $t(41) = 9.81$, $p < .01$; 7;0: $t(29) = 12.50$, $p < .01$) were significantly above chance (0.33). For the non-factive verb *juédé* 'think', only the 6;0 and 7;0 performed significantly above chance (6;0: $t(41) = 2.93$, $p = .01$; 7;0: $t(29) = 4.17$, $p < .01$). The findings indicate that the children were able to understand *zhīdào* 'know' and *jiǎzhuāng* 'pretend' as a factive verb and a counter-factive verb respectively at 4;0, and *juédé* 'think' as a non-factive verb at 6;0.

A four age groups x three factivity verbs mixed-model repeated ANOVA yielded a significant main effect of verb factivity types $F(1.74, 264.96) = 67.17$, $p < .01$, and a significant main effect of age groups $F(3, 152) = 16.16$, $p < .01$. There was no significant interaction of age groups and verb factivity types $F(5.23, 264.96) = 1.58$, $p = .16$. Follow-up one-way ANOVAs yielded significant differences among the four age groups' performances on *zhīdào* 'know' $F(3, 152) = 5.2$, $p < .01$, on *juédé* 'think' $F(3, 152) = 9.85$, $p < .01$, and on *jiǎzhuāng* 'pretend' $F(3, 152) = 3.97$, $p = .01$. Post hoc (Turkey) tests revealed that the 7;0 performed significantly better on *zhīdào* 'know' than the 4;0 ($p = .02$) and the 5;0 ($p < .01$), the 6;0 performed significantly better on *juédé* 'think' than the 4;0 ($p = .01$) and the 5;0 ($p = .02$), the 7;0 performed significantly better on *juédé* 'think' than the 4;0 and 5;0 (4;0 and 5;0: $p < .01$), and the 7;0 performed significantly better on the counter-factive verb *jiǎzhuāng* 'pretend' than the 4;0 ($p = .01$). Within each age groups, follow-up one-way ANOVAs yielded significant differences among all three factivity verbs (4;0: $F(2, 93) = 26.65$, $p < .01$; 5;0: $F(2, 1523) = 32.56$, $p < .01$; 6:0: $F(2, 123) = 10.29$, $p < .01$; 7;0: $F(2, 87) = 7.47$, $p < .01$). Post hoc (Tukey) analyses revealed that the four groups of children's performances on *juédé* 'think' were significantly poorer than those on *zhīdào* 'know' (4;0 to 6;0: $p < .01$; 7;0: $p = .01$) and *jiǎzhuāng* 'pretend' (4;0 to 7;0: $p < .01$). The

results suggest that the children experienced rapid development in understanding the non-factive verb *juédé* ‘think’ at 6;0, and the factive verb *zhīdào* ‘know’ and the counter-factive verb *jiǎzhuāng* ‘pretend’ at 7;0, and the factive verb *zhīdào* ‘know’ and the counter-factive verb *jiǎzhuāng* ‘pretend’ were easier than the non-factive verb *juédé* ‘think’for each age group of the children to understand.

3.4.2 False belief tasks

Among the 156 children, five (3%) children (one 4;0, three 5;0 and one 6;0), four (3%) children (two 4;0 and two 5;0), one 7;0, and one 5;0 failed the control questions of change-of-location task 1 and 2, unexpected content task 1 and 2, respectively, 31 (20%) children (12 4;0, 15 5;0, three 6;0 and one 7;0), 14 (9%) children (seven 4;0 and seven 5;0), 28 (18%) children (six 4;0, 13 5;0, five 6;0 and four 7;0), and nine (6%) children (four 4;0 and five 5;0) failed the control questions of second-order FB task 1, 2, 3 and 4, respectively. It indicates that most of the children were able to remember FB stories. The coding criteria of justifications for explanation questions were adapted from the method used in Perner and Wimmer (1985). Participants’ justifications of correct and incorrect responses to first-order and second-order FB tasks are summarized as below:

Justifications of correct responses to change-of-location tasks

1. Initial location: Justifications that referred to the initial location of the football (for change-of-location task 1) or cake (for change-of-location task 2). For example, 因为他之前把足球放在箱子里的。*Yīnwèi tā zhīqián bǎ zúqiú fàngzài xiāngzi li de*. Because he before BA football put box inside DE. ‘Because he put the football in the box previously.’

2. First-order other belief: Justifications that mentioned other's belief. For example, 他不知道他的妹妹把他的足球放进篮子里了， 所以他就以为他的足球还在箱子里。*Tā bù zhīdào tā de mèimei bǎ tā de zúqiú fàng jìn lánzi li le, suǒyǐ tā jiù yǐwéi tā de zúqiú hái zài xiāngzi li.* He not know he DE younger sister BA he DE football put in basket inside SFP, therefore he then falsely think he DE football still at box inside. 'Because he does not know that his younger sister put his football into the basket, he falsely thinks that his football is still in the box.'

Justifications of incorrect responses to change-of-location tasks

1. Zero-order reality: The object's current location was mentioned. For example, 因为妹妹放在篮子里面了。*Yīnwèi mèimei fāng zài lánzi lǐmiàn le.* Because younger sister put in basket inside SFP. 'Because the younger sister put the ball into the basket.'
2. Various: Justifications that included amendments of the stories, for example, 因为他看见妹妹拿球放篮子里了。*Yīnwèi tā kànjiàn mèimei ná qiú fàng lánzi li le.* Because he see younger sister take ball put basket inside SFP. 'Because he saw his younger sister put the ball into the basket.' The answers such as "do not know" and no responses were classed into this category.

Justifications of correct responses to unexpected content tasks

1. First-order self/other belief: Justifications that mentioned participant's own or other's beliefs. For example, 因为我以为是糖， 我看到图片。*Yīnwèi wǒ yǐwéi shì táng, wǒ kàndào túpiàn.* Because I falsely think is candy, I see reach picture. 'Because I falsely thought there were candies, I saw the picture.' 因为她看到图片， 以为是糖。*Yīnwèi tā kàn dào túpiàn, yǐwéi shì táng.* Because she see reach

picture, falsely think is candy. ‘Because she saw the picture, she falsely thought they were candies.’

2. Zero-order appearance: Justifications that referred to the appearance of the candy/cookie box. For example, 因为外面图案是巧克力。*Yīnwèi wàimiàn tú'àn shì qiǎokèlì.* Because outside picture is chocolate. ‘Because the picture outside of the box shows chocolate.’

Justifications of incorrect responses to unexpected content tasks

1. First-order self/other belief: Justifications that referred to participants’ own or other’s beliefs. For example, 因为我看到里面就是笔。*Yīnwèi wǒ kàn dào lǐmiàn jiùshì bǐ.* Because I see reach inside exactly pen. ‘Because I saw that there were pens in the box.’ 因为她猜是笔。*Yīnwèi tā cāi shì bǐ.* Because she guess is pen. ‘Because she guessed that they were pens.’
2. Zero-order reality: The real contents of the box were mentioned. For example, 因为里面装的是蜡笔。*Yīnwèi lǐmiàn zhuāng de shì làbǐ.* Because inside pack DE is caryon. ‘Because there are crayons in the box.’
3. Zero-order self/other’s motive: Participants’ own or other’s motives were mentioned. For example, 因为她喜欢吃糖。*Yīnwèi tā xǐhuān chī táng.* Because she like eat candies. ‘Because she likes eating candies.’
4. Various: Justifications that included amendment of stories, for example, 因为这是琪琪的盒子。*Yīnwèi zhè shì Qíqi de hézi.* Because this is Qiqi DE box. ‘Because this is Qiqi’s box.’ The answer of “do not know” and no responses were classified into this category.

Justifications of correct responses to second-order FB tasks

1. Belief-belief: Justifications showing that participants embedded one protagonist's epistemic state in the other protagonist's. Sullivan, Zaitchik and Tager-Flusberg (1994) named this type of justification explicit second-order reasoning. For example, 因为莉莉没看见大伟，莉莉觉得大伟不知道飞机在抽屉了。*Yīnwèi Līli méi kànjiàn Dàwěi, Līli juédé Dàwěi bù zhīdào fēijī zài chōutì le.* Because Lili no see Dawei, Lili think Dawei no know airplane at drawer SFP. 'Because Lili did not saw Dawei, Lili thinks that Dawei does not know that the toy airplane is in the drawer.'
2. Belief-information: Relevant information is embedded in one protagonist's belief. Sullivan *et al*. (1994) named this type of justification implicit second-order reasoning. For example, 因为他不知道芳芳跟卖冰激凌的叔叔说过话。*Yīnwèi tā bù zhīdào Fāngfang gēn mài bīngjīlíng de shūshu shuō guò huà.* Because he no know Fangfang with sell ice-cream DE uncle say EXP talk. 'Because he did not know that Fang Fang talked to the ice-cream man.'
3. Initial location: Justifications that mentioned the initial location of an objective or an event. For example, 因为卖冰激凌的叔叔说一个下午都在公园。*Yīnwèi mài bīngjīlíng de shūshu shuō yí gè xiàwǔ dōu zài gōngyuán.* Because sell ice-cream uncle DE say one CL afternoon all at park. 'Because the ice-cream man said that he would be at the park the whole afternoon.'

Justifications of incorrect responses to second-order FB tasks

1. First-order self/other belief: The knowledge or belief of one protagonist on the basis of the stories was mentioned. For example, 因为他在公园看到那个卖冰激凌的叔叔说要去学校。*Yīnwèi tā zài gōngyuán kàn dào nàgè mài bīngjīlíng de shūshu shuō yào qù xuéxiào.* Because he at park see reach that sell ice-cream DE

uncle say will go school. ‘Because he saw the ice-cream man in the park who said that he would go to the school.’

2. Zero-order reality: Information based on the stories was mentioned. For example, 因为卖冰激凌的叔叔去学校了。*Yīnwèi mài bīngjīlíng de shūshu qù xuéxiào le.* Because sell ice-cream DE uncle go school SFP. ‘Because the ice-cream man went to the school.’
3. Various: Irrelevant information and amendments of the stories were mentioned. For example, 因为她妈妈告诉他了。*Yīnwèi tā māma gàosù tā le.* Because she mother tell he SFP. ‘Because her Mom told him.’ The answer of “do not know” and no responses were classified into this category.

The performances on the two change-of-location FB tasks and on the two unexpected content FB tasks were significantly correlated with each other, and the performances on the four second-order FB tasks were significantly correlated with each other as well, therefore the scores on the four first-order FB tasks and on the four second-order FB tasks were summed to obtain a first-order FB total score and a second-order FB total score for each child, respectively. The scores of first-order and second-order FB tasks ranged from 0 to 12 and 0 to 8, respectively. Table 3.4 shows the means and standard deviations of first-order and second-order FB tasks.

Table 3.4 demonstrates that almost all adults responded correctly to all test questions of first-order and second-order FB tasks. One-way ANOVAs were conducted to examine whether or not the five age groups performed differently on first-order and second-order FB tasks, with age group as a between-subjects variable. The results showed significant differences in the five age groups’ performance on first-order FB tasks ($F(4, 163) = 10.04$, $p < .01$) and second-order FB tasks ($F(4, 163) = 21$, $p < .01$).

Post hoc (Tukey) tests revealed that the 4;0 performed significantly poorer on first-order and second-order FB tasks than the 6;0 (first-order FB: $p < .01$; second-order FB: $p = .02$), the 7;0 (first-order FB: $p < .01$; second-order FB: $p = .01$) and adults (first-order FB and second-order FB: $p < .01$), the 5;0 performed significantly poorer on first-order and second-order FB tasks than the 6;0 (first-order FB: $p = .03$; second-order FB: $p < .01$), the 7;0 (first-order FB: $p = .03$; second-order FB: $p < .02$) and adults (first-order FB: $p = .01$; second-order FB: $p < .01$), the 6;0 and the 7;0 performed significantly poorer on second-order FB tasks than adults (6;0 and 7;0: $p < .01$). The results suggest that the children experienced rapid developments in first-order and second-order FB reasoning at 6;0, their understanding of first-order FB reasoning reached an adult-like level at 6;0, whereas their understanding of second-order FB reasoning did not reach an adult-like level at 7;0 and continued to develop after 7;0.

Table 3. 32 Means and standard deviations (SD) of first-order and second-order FB tasks (score range) (N = 168)

Groups	**First-order FB (0-12)**		**Second-order FB (0-8)**	
	Mean	**SD**	**Mean**	**SD**
4;0 (N = 32)	6.97	4.55	1.75	2.08
5;0 (N = 52)	8.44	3.30	1.69	1.98
6;0 (N = 42)	10.38	2.58	3.40	2.73
7;0 (N = 30)	10.57	2.19	3.63	2.66
CHI (N = 156)	9.07	3.51	2.54	2.50
ADT (N = 12)	12.00	0.00	7.83	0.58

To compare the performances on first-order and second-order FB tasks within each age group, paired-samples t-tests were conducted. As the total scores of first-order and second-order FB tasks were different (12 for the first-order FB and 8 for the second-order FB), the proportions of each participant's first-order and second-order FB scores

were calculated by dividing 12 and 8, respectively. Figure 3.3 illustrates the participants' performances on first-order and second-order FB tasks. There were significant differences between the children's performances on first-order FB tasks (4;0: mean = 0.58, SD = 0.38; 5;0: mean = 0.7, SD = 0.28; 6;0: mean = 0.87, SD = 0.22; 7;0: mean = 0.88, SD = 0.18) and second-order FB tasks (4;0: mean = 0.22, SD = 0.26; 5;0: mean = 0.21, SD = 0.25; 6;0: mean = 0.43, SD = 0.34; 7;0: mean = 0.45, SD =0.33), 4;0: t (31) = 6.87, $p < .01$; 5;0: $t(51) = 11.47$, $p < .01$; 6;0: $t(41) = 8.9$, $p < .01$; 7;0: $t(29) = 7.53$, $p < .01$. It shows that except for adults, all age groups of children performed significantly better on first-order FB tasks than on second-order FB tasks.

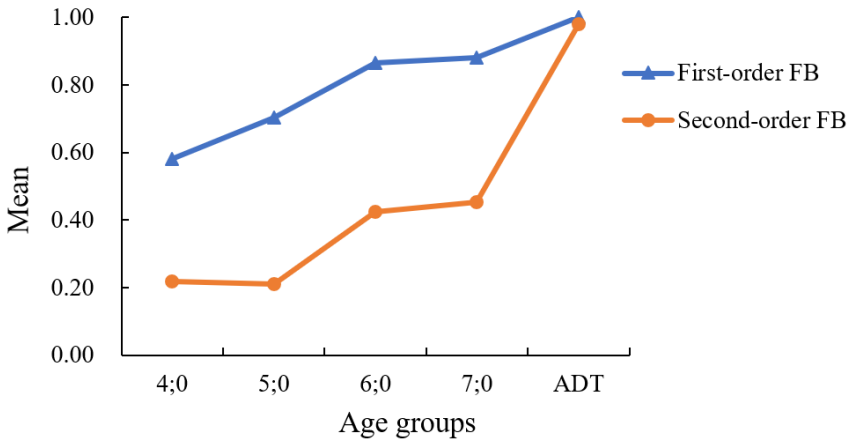

Figure 3. 3 Means of first-order and second-order FB tasks

Table 3.5 demonstrates the number of participants responding correctly to both test and explanation questions of each FB task. Around 50% to 60% of the 4;0, 60% to 70% of the 5;0 and 80% to 90% of the 6;0 and 7;0 were able to pass first-order change-of-location FB tasks and unexpected content other-FB tasks, and around 80% of the 4;0 and 5;0, around 100% of the 6;0 and 7;0 were able to pass unexpected content self-FB tasks. This suggests that self-FB reasoning was easier than other-FB reasoning for

Mandarin-speaking children and the 6;0's self-FB reasoning reached an adult-like level. For second-order FB tasks, around 10% to 30% of the 4;0 and 5;0 and 30% to 50% of the 6;0 and 7;0 were able to pass them. The results suggest that Mandarin-speaking children's first other-FB and second-order FB reasoning continued to develop after 7;0.

Table 3. 33 Number (proportion) of participants responding correctly to FB tasks (N = 168)

	CL1	CL2	UC1S	UC1O	UC2S	UC2O	2FB1	2FB2	2FB3	2FB4
4;0 (N = 32)	15	14	25	17	24	14	2	4	7	9
	52%	48%	78%	59%	75%	48%	7%	14%	24%	28%
5;0 (N = 52)	38	38	37	31	42	30	8	5	16	10
	73%	73%	71%	60%	81%	58%	15%	10%	31%	19%
6;0 (N = 42)	35	35	41	34	40	31	20	14	12	18
	83%	83%	98%	81%	95%	74%	51%	36%	31%	46%
7;0 (N = 30)	25	28	29	24	29	23	12	13	11	16
	83%	93%	97%	80%	97%	77%	40%	43%	37%	53%
ADT (N = 12)	12	12	12	12	12	12	11	12	12	12
	100%	100%	100%	100%	100%	100%	92%	100%	100%	100%

Note: CL1 = change-of-location task 1; CL2 = change-of-location task 2; UC1S = unexpected content task 1 self-belief; UC1O = unexpected content task 1 other-belief; UC2S = unexpected content task 2 self-belief; UC2O = unexpected content task 2 other-belief; 2FB1 = second-order FB task 1; 2FB2 = second-order FB task 2; 2FB3 = second-order FB task 3; 2FB4 = second-order FB task 4.

3.4.3 Simple correlations

Table 3.6 presents simple correlations amongst variables investigated in this chapter. As the DCCS, DNS and DST tasks assessed participants' EF ability, a composite score of EF was formed by adding up the scores of the three tasks. As the 4;0's total score of the Raven's test was different from those of the older age groups, the Raven's test was not included in the correlation analysis of the whole sample. Table 3.6 shows that PPVT-R, complementation and all three factivity verbs correlated with both first-order and second-order FB, suggesting that verbal mental ability, specific sentential complement structure and verb factivity conveyed by all three types of factivity verbs

correlated to FB reasoning. In addition, EF correlated with both first-order and second-order FB reasonings as well as the language abilities including verbal mental ability, complementation, the non-factive *juédé* ‘think’and the counter-factive *jiăzhuāng* ‘pretend’.

Table 3. 34 Simple correlations (N=156)

Variables	1	2	3	4	5	6	7	8
1. Age	-							
2. PPVT-R	.53**	-						
3. EF	.51**	.45**	-					
4. Comp	.38**	.30**	.31**	-				
5. *Zhīdào* ‘know’	.28**	.30**	0.14	.21**	-			
6. *Juédé* ‘think’	.41**	.27**	.36**	.28**	-0.03	-		
7. *Jiăzhuāng* ‘pretend’	.30**	.17*	.30**	.20*	.34**	0.14	-	
8. First-order FB	.42**	.37**	.36**	.43**	.37**	.20*	.28**	-
9. Second-order FB	.35**	.36**	.45**	.28**	.30**	.25**	.20*	.52**

** $p < 0.01$, * $p < 0.05$, two tails, Note: Comp = memory for complement task

3.4.4 Regressions

Hierarchical multiple linear regressions were conducted to examine the unique contribution of verb factivition to first-order and second-order FB reasoning when controlling for the effects of age, verbal mental ability, EF and complementation. The dependent variable was children’s first-order or second-order FB performance, the independent variables included age, PPVT-R, EF, sentential complement, and verb factivity (the factive verb *zhīdào* ‘know’, the non-factive verb *juédé* ‘think’and the counter-factive verb *jiăzhuāng* ‘pretend’). Age, PPVT-R, EF and complementation were force-entered into regressions at the first to fourth steps, and verb factivity was as the final step.

Table 3.7 shows the effect of verb factivity in children's first-order FB performance when controlling for age, PPVT-R, EF and complementation. It shows that among the three factivity verbs, only the factive verb *zhīdào* 'know' predicted first-order FB after controlling for the other factors, accounting for an additional 5% of variance in children's first-order FB performance.

Table 3. 35 Hierarchical multiple regression analyses: Predicting first-order FB from verb factivity (N = 156)

	R^2 change	**F change ***	**B**	**SE**	**Beta***
Step 1					
Age	0.17	32.14**	0.11	0.02	0.42**
Step 2					
PPVT-R	0.03	6.37*	0.03	0.01	0.21*
Step 3					
EF	0.02	3.06	0.07	0.04	0.15
Step 4					
Comp	0.07	14.17**	0.22	0.06	0.28**
Step 5					
***Zhīdào* 'know'/**	0.05/	10.78**/	3.02/	0.92/	0.23**/
***Juédé* 'think'/**	0.00/	0.19/	-0.31/	0.71/	-0.03/
***Jiǎzhuāng* 'pretend'**	0.02	3.17	1.47	0.83	0.13a

** p < .01, * p < .05, two tails

Table 3.8 shows the effect of verb factivity in second-order FB reasoning when controlling for age, PPVT-R, EF and complementation. It demonstrates that the factive verb *zhīdào* 'know' significantly predicted second-order FB performance when controlling for the effects of age, PPVT-R, EF and complementation, accounting for an 3% of variance in second-order FB performance.

Table 3. 36 Hierarchical multiple regression analyses: Predicting second-order FB from verb factivity (N = 156)

	R^2 change	F change *	B	SE	Beta*
Step 1					
Age	0.12	21.64**	0.07	0.02	0.35**
Step 2					
PPVT-R	0.04	7.91*	0.02	0.01	0.24*
Step 3					
EF	0.07	14.22**	0.11	0.03	0.32**
Step 4					
Comp	0.01	2.22	0.07	0.05	0.12
Step 5					
***Zhīdào* 'know'/**	0.03/	6.88*/	1.87/	0.71/	0.19*/
***Juédé* 'think'/**	0.00/	0.37/	0.33/	0.54/	0.05/
***Jiǎzhuāng* 'pretend'**	0.00	0.30	0.35	0.64	0.04

** p < .01, * p < .05, two tails

The results of regression analyses indicated that verb factivity conveyed by the factive verb *zhīdào* 'know' was a significant predictor of both first-order and second-order FB reasoning when controlling for age, verbal mental ability, EF and complementation, this suggests a role verb factivity played in the course of child's development from first-order to second-order FB reasoning.

3.5 Discussion and conclusion

The results in this chapter indicated that verb factivity significantly predicted children's first-order as well as second-order FB reasoning even when controlling for the effects of age, PPVT-R, EF and sentential complement structure. This finding partially confirmed my predictions that verb factivity is closely related to and uniquely contributes to first-order as well as second-order FB reasoning. The factive verb *zhīdào*

'know' and the counter-factive verb *jiǎzhuāng* 'pretend' carry presuppositions, and it was expected that both of them would be significant predictors of first-order and second-order FB reasoning according to my predictions, whereas only the factive verb *zhīdào* 'know' significantly predicted first-order and the second-order FB reasoning, the counter-factive verb *jiǎzhuāng* 'pretend' did not.

Although both *zhīdào* 'know' and *jiǎzhuāng* 'pretend' convey verb factivity, presupposing speakers' beliefs about the truth and falsity of complement clauses respectively, subtle differences between them may explain their different roles in FB reasoning. *Zhīdào* 'know' is an MSV, while *jiǎzhuāng* 'pretend' is a behavioral verb. Sentences with MSVs like (25) convey sentence subjects' beliefs about complement clauses in a rather direct way, compared to sentences with behavioral verbs like (26) which do not directly express sentence subjects' beliefs, instead, they express sentence subjects' behaviors at the first place. Therefore, the use of the mental state factive verb *zhīdào* 'know' is more salient to express speakers' and sentence subjects' beliefs and is more likely to provide an environment for interlocutors to interact with and pay attention to speakers' and sentence subjects' intentions and beliefs about the events described in complement clauses, thus to infer speakers' beliefs about sentence subjects' beliefs, which involves first-order and second-order belief reasoning, whereas the behavioral counter-factive verb *jiǎzhuāng* 'pretend' conveys speakers' beliefs and is more salient to express sentence subjects' behaviors, which makes interlocutors tend to focus on sentence subjects' behaviors. This may be one possible explanation for the finding that the mental state factive verb *zhīdào* 'know' rather than the behavioral counter-factive verb *jiǎzhuāng* 'pretend' significantly predicted children's FB performances.

(25). Peter: "John *zhīdào* 'know' that the cake was in the fridge."

(26). Peter: "Mary *jiǎzhuāng* 'pretend' that the cake was in the fridge."

Compared to Cheung *et al*. (2009) which investigated the role of verb factivity in Chinese-speaking children's first-order FB reasoning as well, the current findings are in line with their findings in that verb factivity significantly predicted children's first-order FB performance, whereas are inconsistent with their findings in the types of factivity verbs that contributed to FB reasoning. Cheung *et al*. (2009) found that verb factivity conveyed by the mental state counter-factive verb *ji5wai4* 'falsely think' but not the mental state factive verb *zi1dou3* 'know' significantly predicted children's first-order FB reasoning when controlling for general language, non-verbal intelligence, and sentential complement, whereas the current study found that verb factivity conveyed by the mental state factive verb *zhīdào* 'know' but not the counter-factive verb *jiǎzhuāng* 'pretend' significantly predicted children's performance on first-order FB tasks after controlling for verbal mental ability, EF and complementation. The discrepancies may be explained by methodological differences between the two studies. Although the factives *zi1dou3*/*zhīdào* 'know' were employed in both Cheung *et al*. (2009) and the current study, the use of them in the two Chinese languages may be different. In Cantonese, there are two verbs that express 'know', *zi1* and *zi1dou3*. The data from Cantonese corpora from the CHILDES database (MacWhinney, 2000) showed that *zi1* 'know' was used much more frequently than *zi1dou3* 'know' in both Cantonese-speaking adults' and children's spontaneous speech. It is likely that *zi1dou3* 'know' is used relatively less frequently in Cantonese than *zhīdào* 'know' in Mandarin. In this case, Cantonese-speaking children's performance on *zi1dou3* 'know' would be different from Mandarin-speaking children's performance on *zhīdào* 'know', thus the two factives *zi1dou3* 'know' in

Cantonese and *zhīdào* ‘know’ in Mandarin differ in their roles in first-order FB reasoning.

Another reason that explains the discrepancies in the findings of Cheung *et al*. (2009) and the current study is that the counter-factives selected in the two studies were different and differed in mental status. *Ji5wai4* ‘falsely think’ used in Cheung *et al*. (2009) is a mental state counter-factive verb and expresses sentence subjects’ beliefs about complement clauses directly, while *jiǎzhuāng* ‘pretend’ used in the current study is a behaviorial counter-factive verb and is more likely to express sentence subjects’ behaviors. Therefore, taking into consideration of the findings in *Cheung et al*. (2009) and in the current study, I propose that verbs that have both features of mental state and factivity are more likely to contribute to FB reasoning, compared to verbs that only have the feature of mental state or factivity.

Although verb factivity was a significant predictor of first-order and second-order FB reasonings, it was not the unique one. With regard to first-order FB reasoning, apart from verb factivity, sentential complement was a significant predictor of it as well, which lends support to the findings of previous research that sentential complement played a crucial role in first-order FB reasoning (de Villiers & de Villiers, 2000; de Villiers & Pyers, 2002). However, sentential complement was not a significant predictor of second-order FB reasoning, which provides evidence to support Lind and Bowler’s (2009) speculation that sentential complement may not hold throughout the course of ToM development. The current findings suggest that linguistic forms such as sentential complement, of which the representational structure shares similary with first-order but not second-order FB would be a significant predictor of first-order rather than second-order FB reasoning. As for second-order FB reasoning, on top of verb factivity, EF was a significant predictor of it as well.

In conclusion, this chapter examined the role of verb factivity conveyed by all three types of factivity verbs in 4;0 to 7;0 TD Mandarin-speaking children's first-order and second-order FB performances. The findings indicated that verb factivity conveyed by the mental state factive verb *zhīdào* 'know' rather than the counter-factive verb *jiǎzhuāng* 'pretend' or the non-factive verb *juédé* 'think' was a significant predictor of children's first-order as well as second-order FB performances when controlling for age, verbal mental ability, EF and complementation. Apart from verb factivity, sentential complement was a significant predictor of children's first-order FB performance, whereas its role did not extend to children's second-order FB performance. On the contrary, EF was a significant predictor of children's second-order rather than their first-order FB performance. The findings from this chapter suggest that different levels of FB reasoning are facilitated and promoted by different aspects of language and provide evidence to support that language plays a role as a more specific representational tool in the development of FB reasoning.

Chapter 4

4.1 Introduction

Although a number of studies have investigated the role of language in terms of verbal ability and sentential complements in autistic children's FB performances, no well-documented studies have explored the role of verb factivity in autistic children's FB reasoning. As noted earlier in this thesis, verb factivity provides a good basis for exploring the relation between language and FB as it shares similar mental representation with FB and common neural basis with FB (Chen *et al*., 2012; Cheung *et al*., 2012). This chapter investigated the relation between verb factivity and first-order and second-order FB reasoning in Mandarin-speaking autistic children and their CA-VMA-matched TD peers. Specifically, two questions were examined (1) whether verb factivity is related to autistic children's FB reasoning, and (2) which type of factivity verbs relates to autistic children's FB reasoning. Section 4.2 presents the information of the participants and tasks used. Section 4.3 reports the results and section 4.4 discusses and concludes major findings in this chapter.

4.2 Method

4.2.1 Participants

A total of 15 verbal Mandarin-speaking children (13 boys) with ASD partcipated in this study. They were aged 4;6 to 7;4 (mean age = 6;1, SD = 0;9) and were from the a training center for children with special needs in Shenzhen, a city in southern China. Parent consent forms were obtained before the testing. They were previously diagnosed with ASD by psychiatrists in hospital by the Chinese Classification of

Mental Disorders Version 3 (CCMD-3) (Chinese Society of Psychiatry, 2001). As five autistic children obtained relatively low scores on the PPVT-R test, a group of ten TD children (five boys, age range: 5;4 to 7;6, mean age = 6;5, SD = 0;8) who were CA- as well as VMA-matched (measured by PPVT-R) (CA-VMA-matched) with ten autistic children (eight boys, age range: 5;4 to 7;4, mean age = 6;4, SD =0;7) in a pairwise manner were selected from children reported in Chapter 3 as a control group. Table 4.2 presents the information (Gender, age, verbal mental ability and Raven's) of the ten autistic children and the CA-VMA-matched TD children.

Table 4. 37 Information of autistic children (N = 10) and CA-VMA-matched TD children (N = 10)

Code	Gender	Age	PPVT-R	Raven's
ASD1	M	5;4	77	21
ASD2	M	5;10	78	29
ASD3	M	5;11	68	22
ASD4	F	6;4	60	17
ASD5	F	6;5	62	12
ASD6	M	6;6	117	25
ASD7	M	6;6	68	23
ASD8	M	6;7	87	12
ASD9	M	6;11	67	11
ASD10	M	7;4	72	37
CA-VMA1	F	5;4	77	12
CA-VMA2	F	5;9	78	19
CA-VMA3	M	5;10	72	25
CA-VMA4	M	6;4	70	22
CA-VMA5	F	6;7	67	23
CA-VMA6	F	6;7	118	13
CA-VMA7	F	6;6	70	17
CA-VMA8	M	6;7	89	27
CA-VMA9	M	7;0	71	21
CA-VMA10	M	7;6	72	17

4.2.2 Tasks and procedure

The children reported in this chapter received verbal mental ability, non-verbal intelligence, EF, memory for sentential complement, verb factivity, and FB tasks as described in Chapter 2 and Chapter 3. The autistic children received the tasks in a quiet room in the training center, some of them were accompanied by one of their teachers or caretakers. They received a pencil bag and stickers after finishing the whole test as a reward for participation. The verbal mental ability, non-verbal intelligence, complementation, and EF tests were administered before FB and verb factivity tests.

4.3 Results

This section presents the results from the data of children with ASD and their CA-VMA-matched TD peers. Table 4.2 shows the means (proportions) and standard deviations of the two groups' performances on the verbal mental ability, non-verbal intelligence, EF, and complementation tasks. It demonstrates that the autistic children performed poorer than TD children on all tasks except for Raven's and the DNS tasks, however, Mann-Whitney U tests revealed that there were no significant differences between autistic children's and their CA-VMA-matched TD peers' performances on non-verbal intelligence, EF, and complementation tasks.

Table 4. 38 Means (Proportions) and standard deviations (SD) of tasks in ASD and TD matched groups (N = 20)

Tasks	ASD (N = 10)		TD (N = 10)	
	Mean (proportion)	**SD**	**Mean (proportion)**	**SD**
PPVT-R (0-175)	75.60 (43%)	16.61	78.40 (45%)	15.24
Raven's (0-60)	20.90 (35%)	8.29	19.60 (33%)	4.93
DCCS (0-24)	16.40 (68%)	7.52	20.10 (84%)	2.13
DNS (0-16)	15.80 (99%)	0.63	14.90 (93%)	3.48
DST (0-28)	11.50 (41%)	1.72	13.00 (46%)	2.94
Comp (0-12)	7.70 (64%)	2.67	8.40 (70%)	5.80

Note: PPVT-R = Peabody Picture Vocabulary Test - Revised; DCCS = Dimensional Change Card Sort test; DNS = Day-Night Stroop test; DST = Digit Span Test; Comp = Memory for complement test

4.3.1 Verb factivity

Table 4.3 presents the percentages of each type of responses to the factive verb *zhīdào* 'know', the non-factive verb *juédé* 'think' and the counter-factive verb *jiǎzhuāng* 'pretend' in autistic children and CA-VMA-matched TD children. For *zhīdào* 'know', it demonstrates that autistic children performed similarly with TD children in the "+ –" condition, with "no" responses taking up around 60%. Both groups' "no" responses in the "+ –" condition were significantly above chance (ASD: $t(9) = 2.84$, $p = .02$; TD: $t(9) = 3.28$, $p = .01$), and were significantly more than their "yes" and "maybe" responses (Wilcoxon signed-rank test: "yes": ASD: $Z = -2.1$, $p = .04$; TD: $Z = -2.0$, $p = .05$; "maybe": ASD: $Z = -2.09$, $p = .04$; TD: $Z = -2.61$, $p < .01$). Different from autistic children, TD children's "yes" responses in the "+ +" and "– +" conditions are significantly above chance ("+ +": $t(9) = 3.46$, $p < .01$; "– +": $t(9) = 3.02$, $p = .01$). Although the pattern of the most frequent responses to *zhīdào* 'know' in the "+ +" - "+ –" - "– +" conditions was "yes" - "no" - "yes" in both ASD and TD groups, only TD

children's correct responses in terms of verb factivity in the three conditions were significantly above chance. Therefore, the results suggest that TD children, but not autistic children were able to understand *zhīdào* 'know' in terms of verb factivity.

Table 4. 39 Percentages of each type of responses to each verb in ASD and TD matched groups (N = 20)

Verbs		"+ +"			"+ –"			"– +"		
		"Yes"	"No"	"Maybe"	"Yes"	"No"	"Maybe"	"Yes"	"No"	"Maybe"
Zhīdào 'know'	ASD (N = 10)	44%	34%	22%	22%	58%	20%	38%	34%	28%
	TD (N = 10)	64%	28%	8%	22%	64%	14%	58%	32%	10%
Juédé 'think'	ASD (N = 10)	54%	30%	14%	32%	48%	20%	32%	42%	24%
	TD (N = 10)	34%	40%	26%	38%	32%	30%	36%	30%	34%
Jiǎzhuāng 'pretend'	ASD (N = 10)	38%	42%	20%	26%	56%	18%			
	TD (N = 10)	10%	76%	14%	78%	14%	8%			

For *juédé* 'think', none of the three types of responses in each condition were significantly above chance, and there were no significant differences among all three types of responses in each condition in the two groups. The results suggest that both groups of children did not understand *juédé* 'think' as a non-factive verb.

For *jiǎzhuāng* 'pretend', Table 4.3 shows that the two groups performed differently on it. TD children responded with significantly more "no" responses in the "+ +" condition and "yes" responses in the "+ –" condition than autistic children (Mann-Whitney U: "+ +": $U = 19$, $p = 0.16$; "+ –": $U = 5$, $p < .01$), whereas autistic children responded with significantly more "no" responses in the "+ –" condition than TD children (Mann-Whitney U: $U = 11.5$, $p < .01$). Among all three types of responses, TD children's "no" responses in the "+ +" condition were significantly above chance (($t(9) = 5.48$, $p < .01$) and significantly more than their "yes" and "maybe" responses (Wilcoxon signed-rank test: "yes": $Z = -2.83$, $p < .01$; "maybe": $Z = -2.57$, $p = .01$) and their "yes" responses in the "+ –" condition were significantly above chance ($t(9) = 7.09$, $p < .01$) and significantly more than "no" and "maybe" responses (Wilcoxon

signed-rank test: "no": Z = -2.68, p < .01; "maybe": Z = -2.82, p < .01). The results suggest that TD children understood *jiǎzhuāng* 'pretend' as a counter-factive verb, while autistic children did not.

To compare the two groups' overall performances on the three factivity verbs, scores of correct responses to these verbs were coded in terms of factivity. As noted in Chapter 2 earlier in this thesis, correct responses to *zhīdào* 'know' in the "+ +", "+ –" and "– +" conditions were "yes", "no" and "yes", to *juédé* 'think' in the three conditions were "maybe" and to *jiǎzhuāng* 'pretend' in the "+ +" and "+ –" conditions were "no" and "yes". As the total scores of each verb were different, the proportion of the score of each verb was calculated by dividing scores of *zhīdào* 'know' and *juédé* 'think' by 15, and of *jiǎzhuāng* 'pretend' by 10. Table 4.4 shows the means of the proportions of correct responses to all three verbs of the two groups. It demonstrates that autistic children performed poorer on all three verbs than the CA-VMA-matched TD children. Mann-Whitney U tests revealed that autistic children performed significantly poorer than the CA-VMA-matched TD children on the factive verb *zhīdào* 'know' (U = 24, p = .05) and on the counter-factive verb *jiǎzhuāng* 'pretend' (U = 2.5, p < .01), but not on the non-factive verb *juédé* 'think'.

Table 4. 40 Means (Proportions) and standard deviations (SD) of factivity verbs in ASD and TD matched groups (N = 20)

Groups	***Zhīdào* 'know'**		***Juédé* 'think'**		***Jiǎzhuāng* 'pretend'**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
ASD (N = 10)	0.47	0.15	0.19	0.20	0.34	0.16
TD (N = 10)	0.63	0.19	0.35	0.28	0.79	0.17

4.3.2 False belief tasks

Table 4.5 shows the number of autistic children and the CA-VMA-matched TD children passing control and test questions of each FB story. Eight out of ten CA-VMA-matched TD children passed first-order and second-order FB tasks, while only four and two out of ten autistic children passed first-order and second-order FB tasks, respectively. For the four autistic children who passed first-order FB tasks, only one passed both test and explanation questions, and the two who passed second-order FB tasks only passed test questions but not explanation questions. Whereas the eight TD children who passed first-order FB tasks passed both test and explanation questions. Among the eight TD children who passed second-order FB tasks, six of them passed both test and explanation questions.

Mann-Whitney U tests revealed that autistic children performed significantly poorer than the CA-VMA-matched TD children on test and explanation questions of first-order FB stories (test questions: CL1: $U = 25$, $p = .03$; CL2: $U = 20$, $p < .01$; UC1_other: $U = 25$, $p = .01$; UC2_self: $U = 20$, $p < .01$; UC2_other: $U = 25$, $p = .01$; explanation questions: CL1: $U = 15$, $p < .01$; CL2: $U = 15$, $p < .01$; UC2_self: $U = 20$, $p < .01$; UC2_other: $U = 30$, $p = .03$). The two groups did not perform significantly differently in their performances on reality or memory control questions of first order FB tasks. In the four second-order FB stories, there were four reality questions, three memory questions, three first-order belief questions, four second-order FB test questions and explanation questions. Mann-Whitney U tests revealed that autistic children did not perform significantly differently from CA-VMA-matched TD children on reality control questions, but performed significantly or marginally significantly poorer than CA-VMA-matched TD children in memory questions (second-order FB2_control 2: $U = 20$, $p < .01$; second-order FB3_control 1: $U = 30$, p

= .03; second-order FB4_control 2: U = 20, p < .01), in first-order belief questions (second-order FB1_control 2: U = 30, p = .03; second-order FB1_control 3: U = 15, p < .01), in second-order FB test questions (second-order FB1: U = 35, p = .07; second-order FB4: U = 35, p = .07), and in second-order FB explanation questions (second-order FB1: U = 35, p = .07; second-order FB2: U = 30, p = .03). In sum, autistic children did not perform significantly different from TD children on reality questions of first-order or second-order FB tasks, nor did they perform differently on memory questions of first-order FB tasks from TD children. However, they performed significantly poorer than TD children on test and explanation questions of first-order and second-order FB tasks, and on memory questions of second-order FB tasks. The results suggest that autistic children had impairments in both first-order and second-order FB reasoning. Their poor performances on first-order FB tasks could not be due to their failure to remember stories because they performed equally well as TD children on reality and memory control questions of first-order FB tasks. For second-order FB reasoning, EF, to some extent, accounts for their poor performance on second-order FB tasks.

Table 4. 41 Number of children passing questions in first-order and second-order FB tasks in ASD and TD matched groups (N = 20)

FB tasks	Questions	ASD (N = 10)	TD (N = 10)
First-order FB_CL1	Control_memory	9	10
	Control_reality	8	9
	Test	3	8
	Explanation	1	8
First-order FB_CL2	Contro_memory	9	10
	Control_reality	7	9
	Test	2	8
	Explanation	1	8
First-order FB_UC1	Control_memory	10	10
	Self_test	2	6
	Self_explanation	1	6
	Other_test	0	5
	Other_explanation	0	5
First-order FB_UC2	Control_memory	10	10
	Self_test	1	7
	Self_explanation	1	7
	Other_test	0	5
	Other_explanation	0	4
Second-order FB1	Control 1_reality	9	10
	Control 2_first-order belief	6	10
	Control 3_first-order belief	3	10
	Test	0	3
	Explanation	0	3
Second-order FB2	Control 1_reality	8	10
	Control 2_memory	4	10
	Test	1	4
	Explanation	0	4
Second-order FB3	Control 1_memory	6	10
	Control 2_reality	6	9
	Control 3_first-order belief	6	9
	Test	1	2

Table 4.5 continued …

	Explanation	0	2
Second-order FB4	Control 1_reality	9	10
	Control 2_memory	4	10
	Test	0	3
	Explanation	0	1

Note: CL = change-of-location task, UC = unexpected content task

Table 4.6 presents the means and standard deviations of autistic children's and CA-VMA-matched TD children's performances on FB tasks. Mann-Whitney U tests revealed that autistic children performed significantly poorer than TD children on first-order FB tasks ($U = 16$, $p < .01$) as well as on second-order FB tasks ($U = 14$, $p < .01$). As noted earlier, autistic children did not perform significantly different on Raven's, EF, memory for sentential complement tasks or the non-factive *juédé* 'think' from the CA-VMV-matched TD children, but performed significantly poorer on the factive verb *zhīdào* 'know' and the counter-factive verb *jiǎzhuāng* 'pretend'. Therefore, the results suggest that the autistic children's understanding of verb factivity and first-order and second-order FB reasoning may be linked, independent of verbal mental, non-verbal intelligence, EF or complementation abilities.

Table 4. 42 Means (Proportions) and standard deviations (SD) of first-order and second-order FB tasks in ASD and TD matched groups (N = 20)

Tasks	**ASD (N = 10)**		**TD (N = 10)**	
	Mean (proportion)	**SD**	**Mean (proportion)**	**SD**
First-order FB (0-12)	1.20 (10%)	2.49	7.70 (64%)	4.76
Second-order FB (0-8)	0.20 (3%)	0.42	2.20 (22%)	1.93

4.4 Discussion and conclusion

The findings from this chapter provided evidence to support that verb factivity is likely to relate to first-order as well as to second-order FB reasonings in Mandarin-speaking children with ASD. The autistic children performed significantly poorer on first-order and second-order FB tasks as well as on verb factivity than their CA-VMA-matched TD peers independent of non-verbal intelligence, EF and complementation.

In line with previous research (Baron-Cohen, 1989; Baron-Cohen *et al*., 1985; Colle *et al*., 2007; Happé, 1995; Zhang *et al*., 2016), the current findings indicate that the autistic children in this investigation had impairments in understanding both first-order and second-order FB reasoning, with 60% (six out of ten) and 80% (eight out of ten) of them failing first-order and second-order FB tasks, respectively. The autistic children were matched with TD children in CA and VMA, on top of that, they did not differ significantly in non-verbal intelligence, EF and sentential complement. Therefore, their poor performances on FB reasoning can not be attributed to those factors.

With regard to autistic children's and their CA-VMA-matched TD peers' performances on the verb factivity task, the findings are inconsistent with those from Yi *et al*. (2013). The autistic children in the current sample performed poorly on all three factivity verbs (*zhīdào* 'know', *juédé* 'think' and *jiǎzhuāng* 'pretend') and significantly poorer than the CA-VMA-matched TD children in *zhīdào* 'know' and *jiǎzhuāng* 'pretend'. Whereas, Yi *et al*. (2013) found that the autistic children in their sample performed quite well in understanding *zhīdào* 'know', and their performance in it did not significantly differ from those of CA-matched and VMA-matched TD children. The discrepancies between the findings in Yi *et al*. (2013) and this study

about autistic children's understanding of *zhīdào* 'know' may be explained by methodological differences in the two studies. Yi *et al.* (2013) used a hidden object task (Moore *et al*., 1989), while this study employed a TVJ task (Abbeduto & Rosenberg, 1985). Test sentences in Yi *et al.* (2013) were constructed with 1PS, while in this study were with 3PS. Although the autistic children in Yi *et al.* (2013) performed well in *zhīdào* 'know', they did not understand *yǐwéi* (used as 'falsey think'), and their performance on it was significantly poorer than their CA-matched TD peers. Besides, Yi *et al.* (2013) found that the autistic children's poor performance on *yǐwéi* 'falsey think' could not be explained by age, verbal ability or EF. In this study, the autistic children were both CA- and VMA-mathced with TD children, in addition, the two groups of children did not differ significantly in their performances on EF. Therefore, this study is consistent with Yi *et al.* (2013) in finding that Mandarin-speaking autistic children had deficits in understanding factivity even after controlling for age, verbal ability and EF.

A few studies have documented the important role of sentential complement in autistic children's FB reasoning (Lind & Bowler, 2009; Tager-Flusberg, 2000; Tager-Flusberg & Joseph, 2005). If autistic children depend on the knowledge of sentential complement specifically to bootstrap their meta-representation capacity, the children who pass FB tasks were expected to perform better on the complement task that those who did not. Among the ten autistic children in this investigation, there were four children that passed first-order FB tasks and two children that passed second-order FB tasks. The mean scores of the four first-order and two second-order FB autistic passers (8 and 8.5 respectively) were higher than those of first-order and second-order FB autistic failers (7.5). Therefore, the data of the current sample imply a possible role complementation plays in autistic children's FB reasoning. Although autistic

children's performance on the complementation task, on the whole, did not significantly differ from their CA-VMA-matched TD peers', the distribution of their performance on the complementation task was quite different from that of TD children (see Table 4.7). It shows that autistic children's scores varied from 3 to 12, while TD children's did not vary much, with three children obtaining 0 and seven children obtaining 12 scores. The results suggest that autistic children's understanding of sentential complements remained unstable, and it is possible that they may be able to employ the knowledge of complementation as a compensatory to pass FB tasks when their understanding of it becomes stable.

Table 4. 43 Distribution of children with different performances on the complementation tasks in ASD and TD matched groups (N = 20)

ASD (N = 10)		**TD (N = 10)**	
Score (0 - 12)	**No.**	**Score (0 - 12)**	**No.**
12	1	0	3
10	2	12	7
9	1		
8	1		
7	2		
6	1		
5	1		
3	1		

In conclusion, this chapter investigated Mandarin-speaking autistic children's understanding of verb factivity and first-order and second-order FB reasoning. Autistic children were carefully matched with TD children in CA as well as in VMA. In addition, the two groups of children were not significantly different in non-verbal intelligence, EF or sentential complement abilities. Among all three factivity verbs,

autistic children performed significantly poorer than their CA-VMA-matched TD peers on the factive verb *zhīdào* 'know' and the counter-factive verb *jiǎzhuāng* 'pretend' which carry presupposition, but not on the non-factive verb *juédé* 'think' which does not carry presupposition. For FB reasoning, autistic children performed significantly poorer than CA-VMA-matched TD children as well on both first-order and second-order FB tasks. Therefore, the findings of this chapter suggest a possible link between verb factivity and first-order and second-order FB reasoning independent of non-verbal intelligence, EF, and sentential complement in Mandarin-speaking autistic children.

Chapter 5

5.1 Summary

The main purpose of this dissertation was to investigate the relation between verb factivity and first-order and second-order FB reasoning in Mandarin-speaking children with and without ASD. Before addressing the main purpose, Mandarin-speaking adults' and children's use and understanding of six verbs (*zhīdào* 'know', *fāxiàn* 'discover/be aware', *juédé* 'think', *tīngshuō* 'hear', *yǐwéi* 'think/falsely think', *jiǎzhuāng* 'pretend') were examined from the perspective of factivity in a corpus study and an experimental study, respectively.

The corpus study provided information about whether children used the target verbs or not, how they used these verbs, and the first emergences of these verbs. Among the six verbs, utterances with some verbs or with some verbs in some conditions were not detected. No utterances with *tīngshuō* 'hear' in all three conditions, with *fāxiàn* 'discover/be aware', *juédé* 'think', *yǐwéi* 'think/falsely think' in the "– +" condition and with *jiǎzhuāng* 'pretend' in the "+ –" and "– +" conditions were found in child's speech. Although children were able to use *zhīdào* 'know' at 2;1, their early use of it did not convey factivity, and they did not begin to use it as a factive verb until they reached 3;0. It was the same for *juédé* 'think' which emerged early at 2;4 as well, whereas it was used as a non-factive verb after 3;0. Although *fāxiàn* 'discover/be aware' could be used as a factive verb and a non-factive verb, and *yǐwéi* 'think/falsely think' could be used as a non-factive verb as well as a counter-factive verb, they were only used as a factive verb and a counter-factive verb by both adults and children in the corpora, respectively.

In the experimental study, *zhīdào* ‘know’ was treated as a factive verb, *juédé* ‘think’ and *tīngshuō* ‘hear’ were treated as non-factive verbs in the “+ +”, “+ –” and “– +” conditions, and *fāxiàn* ‘discover’ was treated as a factive verb and *jiǎzhuāng* ‘pretend’ was treated as a counter-factive verb in the “+ +” and “+ –” conditions by adults. *Yǐwéi* was treated as a non-factive verb ‘think’ as well as a counter-factive verb ‘falsely think’ in the “+ +” and “+ –” conditions by adults. According to adults’ performances on these verbs, how and when children treated each verb were examined. The results indicated that children were able to treat *zhīdào* ‘know’ in the three conditions and *fāxiàn* ‘discover’ in the “+ +” and “+ –” conditions as factive verbs, and *jiǎzhuāng* ‘pretend’ in the “+ +” and “+ –” conditions as a counter-factive verb at 4;0. The children were not found being able to treat *juédé* ‘think’ as a non-factive verb until they reached 6;0. For *tīngshuō* ‘hear’, even the oldest children, the 7;0 were not able to understand it as a non-factive verb. For *yǐwéi* ‘think/falsely think’, it seemed that the 4;0 did not understand it in terms of verb factivity, the 5;0 began to be aware of the counter-factivity it conveyed, and the 6;0 began to be aware of both the counter-factivity and non-factivity it conveyed.

Three verbs, *zhīdào* ‘know’, *juédé* ‘think’ and *jiǎzhuāng* ‘pretend’ that were treated as a factive verb, a non-factive verb and a counter-factive verb respectively were employed to examine the relation between verb factivity and FB reasoning in both TD and autistic children. Apart from children’s understanding of verb factivity and FB, their verbal mental, complementation, EF abilities were assessed as well. For TD children, only the understanding of the factive verb *zhīdào* ‘know’ was a significant predictor of their performances on first-order and second-order FB tasks when controlling for the effects of age, verbal mental ability, EF and complementation. However, verb factivity conveyed by the factive verb *zhīdào* ‘know’ was not the

unique significant predictor of the performances on first-order and second-order FB tasks. Complementation and EF, as well, were significant predictors of first-order and second-order FB performances, respectively. The autistic children performed significantly poorer than their CA-VMA-matched TD peers on verb factivity and first-order and second-order FB tasks, but not on the other tasks, which suggests a possible link between verb factivity and first-order and second-order FB reasoning in children with ASD.

5.2 Significance

The current studies reported in this dissertation examined verb factivity understanding in Mandarin-speaking children and adults and explored the relation between all three types of factivity verbs and first-order and second-order FB reasoning in Mandarin-speaking children with and without ASD. The findings from this dissertation have empirical as well as theoretical significances.

5.2.1 Empirical significance

The results of this dissertation have several empirical and practical significances. First, the results of the experimental study on verb factivity understanding in Mandarin-speaking adults and children provide empirical evidence for the categorization of different types of factivity verbs and the developing knowledge of the target factivity verbs. Second, the findings of verb factivity in Mandarin-speaking adults' and children's speech and in the experimental study may be applied in natural language processing of verb factivity such as information retrieval and extraction. Third, in the experimental study on the relation between verb factivity and FB understanding in TD

children and in autistic children, the results showed that verb factivity conveyed by the mental state factive verb *zhīdào* 'know' was a significant predictor of children's first-order and second-order FB reasoning and sentential complement structure was a significant predictor of first-order FB reasoning in TD children, and verb factivity was likely to relate to first-order and second-order FB reasoning in autistic children. These findings may provide insights for teachers and clinicians to develop curriculum and interventions to help TD children and children who suffer from delays or deficits in ToM with ToM understanding and development. Mental state factivity verbs and sentential complement structure could be used to design stories, games, activities, and treatments to assist individuals to pay attention to their own and others' mental states, and to develop representations of mental states.

5.2.2 Theoretical significance

The studies reported in this dissertation enriched the literature in the acquisition of verb factivity and in the relation between language and ToM development. The findings of the corpus and experimental studies on verb factivity provide evidence from Mandarin Chinese on the hypothesis that the acquisition of verb factivity precedes on a verb-by-verb basis (Falmagne *et al*., 1994; Scoville & Gordon, 1980). The results of studies on the relation between verb factivity and FB reasoning would shed light on the issues under debate on the relation between language and ToM such as which particular aspects of language contribute to FB reasoning and how do these aspects of language contribute to FB reasoning. Verb factivity and sentential complement significantly predicted FB reasoning even when controlling for verbal mental ability and EF. These findings are in line with the findings from previous studies that verb factivity and sentential complement play specific roles in children's

FB reasoning (Cheung *et al*., 2009; de Villiers & Pyers, 2002; Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003; Mo *et al*., 2014), and suggest that both semantics and syntax are important to children's FB understanding. The results in this dissertation support the hypothesis that language plays a facilitating role in ToM development. The new finding of the current studies is that different aspects of linguistic forms contribute differently in the course of ToM development. Sentential complement significantly predicted first-order FB reasoning, its role did not extend to second-order FB reasoning. Verb factivity significantly predicted first-order as well as second-order FB reasoning.

5.3 Remaining issues and future studies

A number of issues on the relation between language and ToM remain unsolved. For example, whether verb factivity is causally related and contributed to first-order and second-order FB reasoning, or the other way around. To answer questions about causal relationship, longitudinal studies or training studies may be conducted. With regard to future studies, children's understanding of sentential complement, verb factivity, and FB reasoning may be assessed longitudinally so as to investigate how their early language abilities are related to their later FB reasoning or vice versa. Trainings on verb factivity and sentential complements may as well be conducted to investigate whether earlier training improves children's FB performances later or not.

The corpus and experimental studies on verb factivity only examined six factivity verbs, in future studies, more verbs could be involved to investigate verb factivity in Mandarin more systematically. Verbs in several dimensions may be explored. For example, (1) factives (e.g., 'know') vs. semi-factives (e.g., 'see') vs. non-factives (e.g.,

'think' vs. counter-factives (e.g., 'pretend') (Leech, 1981; Li, 2015; Yuan, 2014), (2) behavioral verbs (e.g., 'hear') vs. MSVs (e.g., 'think'), and (3) verbs with high certainty (e.g., 'sure') vs. low certainty (e.g., 'guess'). Apart from TVJ task, varied tasks such as But-Not task (Falmagne *et al*., 1994; Schulz, 2003) and sentence-picture matching task (Zimmerer, Varley, Deamer, & Hinzen, 2019) could as well be used to assess child's knowledge of factivity. As the results of the experimental study on verb factivity understanding showed that even the oldest children, the 7;0 did not understand *tīngshuō* 'hear' from the perspective of verb factivity, future studies could extend the age range of participants to examine the developmental knowledge of factivity verbs more comprehensively.

Yǐwéi 'think/falsely think' has features of both a non-factive verb as well as a counter-factive verb, and the findings of the experimental study in Chapter 2 showed that adults and children treated it as a non-factive verb as well as a counter-factive verb. However, previous studies that examined *yǐwéi* 'think/falsely think' only treated it as a counter-factive verb (Chen *et al*., 2012; Lee *et al*., 1999; Yi *et al*., 2013), and did not take into consideration that participants might understand it as a non-factive verb as well. In future studies, more discourse contexts such as strong contrary of two events or beliefs, adverbs, sentence final particles, and stressed intonation could be used in tasks which attempt to assess participants' understanding of *yǐwéi* 'think/falsely think' as a counter-factive verb.

Appendix

False belief task stimuli

Change-of-location story 1 (Wimmer & Perner, 1983)

“这是哥哥，这里有一个足球和一个箱子。这是妹妹，这里有一个篮子。哥哥要去找朋友玩儿，他把足球摆进箱子里。哥哥就出去了。妹妹呢，走过来拿哥哥的足球玩，然后摆进她的篮子里。妹妹要去超市买东西，她也出去了。一会儿之后，哥哥回来了。”

控制问题 1: “一开始的时候，哥哥把足球放在哪里的呀?”

控制问题 2: “足球现在在哪里呀?”

测试问题: “现在，我问哥哥，‘哥哥，足球在哪里啊?’ 哥哥会说在哪里啊?”

解释问题: “为什么呢?”

Change-of-location story 2 (Wimmer & Perner, 1983)

“这是妈妈，这里有一个碗。这是小明，他有一块蛋糕，这里有一个盒子。小明现在不想吃蛋糕，他把蛋糕放进盒子里。然后，小明就去公园玩了。妈妈呢，拿小明的蛋糕，摆进碗里。然后，妈妈要去超市买东西，她也出去了。一会儿之后，小明回来了。”

控制问题 1: “一开始的时候，小明把蛋糕放在哪里的呀?”

控制问题 2: “蛋糕现在在哪里呀?”

测试问题: “现在，我问小明，‘小明，你的蛋糕在哪里啊?’，小明会说在哪里啊?”

解释问题: “为什么呢?”

Unexpected-content story 1 (Gopnik & Astington, 1988; Perner *et al*., 1987)

[测试员展示一个糖果盒子], 说: “你告诉我, 这个盒子里面是什么呀?”

[测试员把盒子打开, 给被试看里面的铅笔], 问: “这是什么呀?”

[测试员请被试把铅笔放回盒子里, 然后盖上盖子。]

“请你帮忙把笔摆进去吧。”

控制问题: “你还记得这个盒子里是什么吗?”

[如果被试正确回答了控制问题, 则继续测试问题。]

Self 测试问题: “打开个盒之前, 你觉得盒子里是什么呀?”

Self 解释问题: “为什么呢?”

[测试员展示一个小女孩], 说: “这个是琪琪, 她从来都没见过这个盒子。现在, 我问琪琪, ‘琪琪, 这个盒子里是什么啊?’”

Other 测试问题: “琪琪会说是什么呀?”

Other 解释问题: “为什么呢?”

Unexpected-content story 2 (Gopnik & Astington, 1988; Perner *et al*., 1987)

[测试员展示一个饼干盒子], 说: “你告诉我, 这个盒子里面是什么呀?”

[测试员把盒子打开, 给被试看里面的玩具勺子], 问: “这是什么呀?”

[测试员请被试把勺子放回盒子里, 然后盖上盖子]。

“请你帮忙把盒子摆进去吧。”

控制问题: “你还记得这个盒子里是什么吗?”

[如果被试正确回答了控制问题, 则继续测试问题。]

Self 测试问题: “打开个盒之前, 你觉得盒子里是什么呀?”

Self 解释问题: “为什么你觉得个盒子里面是 _____呀?”

[测试员展示一个小男孩], 说:

“这个是子谦, 他从来都没见过这个盒子。现在, 我问子谦, ‘子谦, 这个盒子里是什么啊?’”

Other 测试问题 1: “子谦会说是什么呀?”

Other 测试问题 2: “为什么呢?”

The ice-cream van story (Perner & Wimmer, 1985)

“这是程程, 这是芳芳。他们住在附近的村子里。早上, 他们来公园玩。在公园里, 有一个叔叔在卖冰激凌。芳芳想买冰激凌, 但是她把钱放在家里了。芳芳很不开心。‘没关系的’ 卖冰激凌的叔叔说, ‘你可以回家拿钱，然后再回来买，我整个下午都会在这里的。’ ‘太好啦,’ 芳芳说: ‘那我下午再来买吧, 我一定会记得带钱的。’ 然后芳芳就回家了。现在, 程程一个人在公园里玩。咦? 奇怪的是, 卖冰激凌的叔叔要离开公园。程程问: ‘你要去哪儿呀?’ 卖冰激凌的叔叔说: ‘我要去学校那边。公园里没有人买冰激凌, 学校那边可能会有人买冰激凌。’ 卖冰激凌的叔叔去学校的时候, 经过芳芳的家。芳芳在窗户这儿, 看到了冰激凌车。芳芳问: ‘你要去哪儿呀?’ 卖冰激凌的叔叔说: ‘我要去学校, 那边可能会有人买冰激凌。’ 芳芳说: ‘幸好我看见你了。’ 现在程程不知道芳芳跟卖冰激凌的叔叔说过话。程程不知道!’ 现在程程也回家了。吃完午饭后, 程程想去找芳芳玩儿。程程来到芳芳家, 开门的是芳芳的妈妈。程程问: ‘请问芳芳在家吗?’ 芳芳的妈妈说: ‘她出去买冰激凌了。’”

控制问题 1: “芳芳知道卖冰激凌的叔叔在学校那边吗?”

控制问题 2: “芳芳去哪儿买冰激凌了?”

控制问题 3: “程程知道卖冰激凌的叔叔跟芳芳说过话吗?”

“记住: 程程不知道芳芳跟卖冰激凌的叔叔说过话, 他不知道的。”

测试问题: “现在, 程程要去找芳芳, 我问程程, ‘程程, 芳芳去哪儿了啊?’, 程程会说芳芳去哪儿了?”

解释问题: “为什么呢?”

The hidden toy story (Astington *et al*., 2002)

“这是大伟, 这是莉莉。莉莉在大伟家玩儿。妈妈给大伟买了一个很好玩的玩具飞机。莉莉很想玩, 但是大伟不给她玩。‘大伟, 你过来一下’ 妈妈叫大伟。大伟把飞机放在箱子里, 然后就去妈妈那儿了。妈妈和大伟在厨房里说话。大伟不在的时候, 莉莉把玩具拿出来玩儿。然后, 莉莉把飞机放在大伟的抽屉里面。大伟回来的时候, 看见莉莉把飞机放在抽屉面里了。大伟看见莉莉了, 但是莉莉没看见大伟。大伟过来, 对莉莉说, ‘好吧, 我给你玩一下飞机吧。’

大伟就去拿飞机。”

控制问题 1: “在去见妈妈之前, 大伟把飞机放在哪里的?”

控制问题 2: “莉莉玩了飞机之后, 把飞机放在哪里了?”

控制问题 3: “大伟知道飞机现在在哪里吗?”

“记住: 莉莉不知道大伟看见飞机放在抽屉里面了, 莉莉不知道。”

测试问题: “现在, 我问莉莉, ‘莉莉, 大伟会在哪里找飞机啊?’, 莉莉会说在哪里啊?”

解释问题: “为什么呢?”

The soccer practice story (Miller, 2013a)

“这是小涛，这是浩浩，他们是好朋友，他们今天下午要去球场练球。下午，小涛先到球场。小涛看见有维修工人来球场。老师说: ‘今天球场要维修，我们不能再球场踢球了，我们要去公园踢球了。’ 这个时候，浩浩还没有到球场，小涛想去浩浩家告诉他，今天要去公园练球。小涛还没到浩浩家的时候，浩浩接到老师的电话，老师说: ‘今天球场要维修，我们要去公园踢球了。’ 浩浩说: ‘好的，谢谢老师，待会儿在公园见。’ 现在小涛不知道浩浩跟老师说过话，小涛不知道。小涛来到浩浩家，浩浩的妈妈在家。小涛问: ‘阿姨好，请问浩浩还在家吗?’浩浩的妈妈说: ‘浩浩去练习踢球了。’”

现实问题: “浩浩去了哪儿练球?”

记忆问题: “在维修工人到球场之前，小涛和浩浩本来要在哪里练球?”

“记住: 小涛不知道浩浩跟老师说过话，小涛不知道。”

测试问题: “小涛要去找浩浩。现在，我问小涛，‘小涛，浩浩去哪里了啊?’，小涛会说去哪里了啊?”

解释问题: “为什么呢?”

The cake story (Miller, 2013b)

“这是子轩，这是他的姐姐晴晴。妈妈做了个蛋糕，子轩和晴晴很喜欢吃蛋糕。他们吃了很多了，但是还剩下一些。他们把剩下的蛋糕放在橱柜里。然后，子轩和晴晴就出去玩了。他们在外面的时候，妈妈把蛋糕从橱柜里拿出来，放进了冰箱。晴晴进来喝水。妈妈说: ‘晴晴，我把蛋糕放进冰箱了。’ 晴晴打开冰箱，看见了蛋糕。在晴晴打开冰箱的时候，子轩在外面，通过窗户看到蛋糕在冰箱里。

晴晴没看见子轩，她没看见子轩。晴晴又出去玩了。一会儿之后，子轩进屋想吃蛋糕。”

现实问题: “蛋糕现在在哪里?”

记忆问题: “开始的时候，在妈妈移动蛋糕之前，蛋糕在哪里?”

“记住: 晴晴不知道子轩看见蛋糕在冰箱里，晴晴不知道。”

测试问题: 现在，我问晴晴，‘晴晴，子轩会在哪里找蛋糕啊?’，晴晴会说子轩会在哪里找蛋糕?”

解释问题: “为什么呢?”

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