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Narrative coherence of Mandarin-speaking children with high-functioning autism spectrum disorder: An investigation into causal relations

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Abstract

Previous research has shown that individuals with autism spectrum disorder (ASD) had difficulty integrating narrative information coherently. The majority of these studies focused on people narrating in English; however, little is known about the narrative abilities of Mandarin-speaking individuals with ASD. This study investigates the ability of Mandarin-speaking children with ASD to achieve narrative coherence. The data consist of narratives from 18 children with high-functioning ASD (M_{age}: 8.23) and 18 typically developing children (M_{age}: 7.03), matched on language and cognitive abilities. The narratives were elicited using *Frog, where are you?* Narrative coherence was assessed in terms of causal statements and causal networks. The results reveal no group differences in basic narrative measures or in overtly marked causal statements. The two groups of children were equally sensitive to the relative causal importance of story events. However, the narratives of children with ASD were less causally connected and less coherent. These findings are discussed with regard to their relationship to pragmatic deficits and the cognitive preference of children with ASD.

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Introduction

Autism spectrum disorder (ASD), classified as a neurodevelopmental disorder, is characterized by deficits in social communication and interaction, and restricted repetitive interests/behaviors (American Psychiatric Association [APA], 2013). Narrative discourse has been regarded as a key component in social communication, since it involves an integration of social-emotional, cognitive, and linguistic abilities (Norbury, Gemmell, & Paul, 2014). Given this, narratives have been seen as vehicles for exploring the pragmatic and social-cognitive abilities in individuals with ASD (Colle, Baron-Cohen, Wheelwright, & van der Lely, 2008; Diehl, Bennetto, & Young, 2006).

Previous studies reported that individuals with ASD have relatively unimpaired phonological abilities (Bartolucci & Pierce, 1977; Kjelgaard & Tager-Flusberg, 2001). Several studies have also noted that syntax is not specifically impaired in ASD (Pierce & Bartolucci, 1977; Shulman & Guberman, 2007). In contrast, some research has shown limited narrative abilities in ASD (for review, see Stirling, Douglas, Leekam, & Carey, 2014) and related the deficits in narrative performance to social impairments of this population (Tager-Flusberg, 2000). Some investigations of narratives and ASD have demonstrated that, when individuals with ASD and control groups were matched on language abilities, few quantitative differences were found in basic narrative measures such as story length and syntactic complexity (Colle et al., 2008; Diehl et al., 2006). Several studies, however, reported qualitative differences in the structure of narratives. For instance, individuals with ASD were found to have limited use of causal language (Losh & Capps, 2003), and to produce poorer high-point macrostructure (McCabe, Hillier, & Shapiro, 2013). It has also been suggested that individuals with ASD have difficulties arranging narrative information at the global level, such as maintaining topics, connecting topics with subtopics, and integrating narrative events (Jolliffe & Baron-Cohen, 2000; Landa, 2000). In addition, their narratives showed a consistent lack of high-point (Goldman, 2008), and were more likely to contain pragmatic violations, consisting of bizarre or irrelevant utterances (Loveland & Tunali, 1993). Taken together, individuals with ASD were comparable to control groups in basic narrative measures; however, the former showed difficulties organizing narrative information into a thematically integrated whole, and thus were deficient in the overall coherence of their narratives.

Narrative coherence and causal relations

Narrative coherence refers to the global representation of story meaning and connectedness. Some researchers have assessed coherence in terms of episodic components in stories (e.g., Fernández, 2013; Kupersmitt, Yifat, & Blum-Kulka, 2014; Stein & Glenn, 1979); several researchers, however, have suggested that narrative coherence is created through the construction of temporal and causal relations between events in a story, and acknowledged both temporal coherence and causal coherence (e.g., Habermas & Bluck,

2000; Kupersmitt et al., 2014; Trabasso & Sperry, 1985). With regard to individuals with ASD, because they were found to rely overly on a temporal strategy to integrate narrative information (Jolliffe & Baron-Cohen, 2000), investigations based on temporal relations may underestimate their difficulty in narrative coherence. Instead, measures of causal relations are considered more likely to illuminate narrative deficits in this population (Diehl et al., 2006).

Causal relations can be expressed in terms of overtly marked causal statements and non-overtly marked ones. For overtly marked causal statements, causal connectives are used to explicitly mark causal relations between related propositions. For non-overtly marked causal statements, in contrast, no causal connective is required to link propositions. In English, causal connectives, such as *because*, are the canonical device to indicate causality and to achieve coherence (Schiffrin, 1987). Accordingly, most of the early investigations of narratives and English-speaking individuals with ASD relied on overtly marked causal statements to measure causal connectivity. For instance, Tager-Flusberg (1995) found that children with ASD had difficulty using causal statements to elaborate causal relations between story events. In contrast, Tager-Flusberg and Sullivan (1995) and Capps, Losh, and Thurber (2000) observed that individuals with ASD were as able as comparison groups to use causal statements in narratives. In a later investigation with participants matched more strictly, Losh and Capps (2003), however, reported that children with ASD had difficulty inferring causal relations within and across story events and hence were less likely to include causal statements in their narratives. In particular, children with ASD showed difficulties employing causal explanations of behaviors and psychological states.

The inconsistencies in previous findings pertaining to the use of causal statements in ASD may be attributed to methodological issues. The first issue is concerned with the selection of participant groups and matching variables. With the exception of Losh and Capps's (2003) research, individuals with ASD in the other three studies had lower cognitive abilities, which make it difficult to determine whether the deficiency in building causal relations is specific to ASD or the result of impairment in intellectual functioning. To better understand the ability of individuals with ASD in this regard, researchers are thus recommended to include participants with higher cognitive abilities (Losh & Capps, 2003). In addition, comparison across different studies is complicated by differences in the ways causal statements were measured and computed. For instance, Tager-Flusberg (1995) suggested that causal statements mainly involve causal connectives. In Tager-Flusberg and Sullivan's (1995) study, however, causal connectives and other lexical connectives were grouped into one complex connective category, and the group difference was tested for this complex category, not specifically for causal connectives. In the study by Capps et al. (2000), it is unclear whether the frequency was exclusively based on the identified instances of causal connectives. Finally, Losh and Capps's metric involved not only the number of causal connectives but also the nature of causal explanations. In view of these variations, it is not conclusive whether individuals with ASD have deficits in forging causal relations to achieve narrative coherence.

Not confined to overtly marked causal statements, Trabasso and Sperry (1985) proposed a causal network model to assess causal relations in a narrative in terms of causal chains and causal connections. A causal chain consists of a sequence of events that form the gist of a story; a causal connection refers to the overtly or non-overtly marked causal

relation between a pair of narrative events. As seen above, previous research (Tager-Flusberg & Sullivan, 1995) mostly focused on overtly marked causal relations, while Trabasso and Sperry's causal network model takes into account both overtly and non-overtly marked causal relations. Furthermore, compared with studies that used instances of causal connectives between adjacent sentences to index individuals' ability to integrate information (e.g., McCabe et al., 2013; Norbury & Bishop, 2003), this model allows researchers to examine causal relations for adjacent and non-adjacent story events (for details, see Data Analysis).[1] Trabasso and Nickels (1992) applied the causal network model to analyze the English speakers' corpus of narrations of *Frog, where are you?* (Mayer, 1969). More significantly, they extended the investigation into the nature and distribution of causal connections by identifying four types of causal connections: enablement, motivation, psychological causation, and physical causation. Their study indicates the potential applicability of the causal network model to examine the interconnectivity and nature of causal relations in narrative discourse.

Through analyses based on causal networks, Diehl et al.'s (2006) research lends credence to this model by capturing the limitations of children with ASD in maintaining narrative coherence. According to Diehl et al., the measures of causal chains showed that children with ASD and typically-developing (TD) children were equally sensitive to the relative causal importance of story events. However, the measures of causal connections revealed that the narratives of children with ASD were less coherent than those of TD controls. Diehl et al. demonstrated that deficiencies in narrative coherence in children with ASD are quantifiable.

Though detecting intact sensitivity to causal importance of story events in children with ASD, Diehl et al. (2006) noted that some methodological issues prevented them from drawing strong conclusions. For one thing, participants' performance might have been influenced by the task instructions. Because participants were told beforehand that they would need to recall the story, the recall task seemed more like a memory than a narrative task. As a result, this might attenuate participants' difficulties in achieving narrative coherence. For another, in the story they used, some of the events with more causal importance occur at the end of the story. Previous research has shown that children with ASD have a strong recency bias, so they would have an advantage in recalling items from the end of a list (Renner, Klinger, & Klinger, 2000). Given this, if Diehl et al.'s children with ASD had a similar recency bias, they might receive high scores reflecting gist recall rather than narrative competence. Scores such as these would overestimate the affected children's sensitivity to the causal chain of the story. Intriguing as Diehl et al.'s findings may seem, they lead us to speculate whether the assertion about the sensitivity of children with ASD in causal importance of story events would be supported if the narrative task involved is less memory-reliant.

Narrative coherence in Mandarin-speaking children with ASD

While many investigations have examined narrative performance of English-speaking individuals with ASD, the data on narrative abilities of Mandarin-speaking children with ASD are relatively sparse (Chen, 2007; Chen & Chang, 2005; Hsu, 2009; Tsou &

Cheung, 2007). Most of these studies were concerned with the structure or the evaluative part of narratives; however, they revealed very little about the ability of children with ASD to achieve narrative coherence. Chen's (2007) study is one rare endeavor which examined both causal relations and coherence of narratives by Mandarin-speaking children with ASD. Following Diehl et al.'s (2006) method, Chen relied on the criterion of necessity to assess causal connections between adjacent narrative events and her metric involved a mixture of overtly and non-overtly marked causal relations. In addition, she examined narrative coherence by means of another method, the Narrative Assessment Profile (McCabe & Bliss, 2003). In contrast to Diehl et al.'s findings, children with ASD in Chen's study were as able as TD children in establishing causal relations, whereas their narratives were less coherent. Nevertheless, Chen did not further clarify the relationship between the intact ability to forge causal relations and the impaired narrative coherence in children with ASD. Two other studies also investigated causal relations in narratives (Chen & Chang, 2005; Tsou & Cheung, 2007). Chen and Chang (2005) reported that Mandarin-speaking children with ASD had difficulty establishing causal relations in narratives, which is consistent with previous findings (Diehl et al., 2006; Losh & Capps, 2003). But they did not clearly state how causal relations were identified and computed, which makes it difficult for subsequent research to replicate their findings.

In contrast to Chen and Chang's (2005) results, Tsou and Cheung (2007) found that children with ASD were comparable to TD controls in establishing causal relations, as measured by causal connectives; however, the authors speculated that children with ASD might have difficulty in processing the underlying causal connectivity among episodic elements in the story. Even so, Tsou and Cheung failed to address the discrepancy between the comparable ability in forging causal relations and the deficient knowledge of causal connectivity in children with ASD. As seen above, due to lack of consistency in criteria for identifying causal relations in previous studies, we still do not have enough knowledge about the ability of Mandarin-speaking children with ASD to maintain coherence in narratives.

Despite the comprehensive analyses of causal relations, structure, and syntactic complexity of narratives, Tsou and Cheung's (2007) study was limited to preschool children with ASD. As previous studies on TD children have indicated, from preschool years through middle-childhood, children's narrative skills undergo substantial developments in measures of referential cohesion, narrative structure, global coherence, and the use of connectives (Colozzo & Whitely, 2014; Gamannossi & Pinto, 2014; Mäkinen, Loukusa, Nieminen, Leinonen, & Kunnari, 2014; Peterson & McCabe, 1988). To gain insights into the narrative abilities in Mandarin-speaking children with ASD, therefore, investigations with school-age children should also be the focus for further research.

In addition, research has shown that Chinese speakers use significantly more non-overtly marked causal statements than overtly marked ones in discourse, which suggests that causal connectives may not be the first choice for Chinese speakers to indicate causal relations (Chang & Su, 2012; Sah, 2015). In view of this, studies on Mandarin-speaking individuals with ASD need to examine not only overtly marked causal statements but also non-overtly marked ones. This should afford more extensive, and more culturally appropriate, evidence on Mandarin-speaking individuals' ability in forging causal relations and hence in maintaining narrative coherence.

Furthermore, much of the prominent research on English-speaking individuals with ASD has examined narrative data based on the frog story (e.g., Diehl et al., 2006; Losh & Capps, 2003; Tager-Flusberg, 1995), whereas only two studies on Mandarin children with ASD have used this material (Chen, 2007; Tsou & Cheung, 2007). The limited availability of work based on a common stimulus story renders cross-linguistic comparisons unfeasible and thus hinders our understanding of the narrative abilities in this population.

The present study of narrative coherence was an attempt to address these concerns by focusing on elementary school children with ASD, examining both overtly and non-overtly marked causal statements and eliciting narratives based on the frog story. These features make it possible to compare and validate findings of the previous, frog-story-based studies on children with ASD (Chen, 2007; Diehl et al., 2006; Losh & Capps, 2003; Tsou & Cheung, 2007). To this end, we based our analyses on overtly marked causal statements and causal networks, which include causal-chain events and causal connections, to address the following research questions:

1. Is there any difference between Mandarin-speaking children with ASD and TD children in basic narrative measures?
2. Is there any difference between Mandarin-speaking children with ASD and TD children in the use of overtly marked causal statements?
3. Is there any difference between the two groups of children in producing causal-chain events?
4. Is there any difference between groups in establishing causal connections between narrative events?
5. Is there any difference between groups in using events of different levels of causal connectedness?

In sum, the purpose of this study was to examine narrative coherence of Mandarin-speaking children with high-functioning ASD. On the basis of previous research, no differences between groups were expected relative to basic narrative measures or the use of overtly marked causal statements. With respect to causal networks, given that children with ASD have been reported to have difficulty integrating narrative information, we predicted that they would be less likely than TD controls to produce causal-chain events and establish causal connections. Therefore, their narratives would be less causally connected and less coherent. Finally, children with ASD were expected to be less inclined than TD children to employ causal explanation relative to psychological states.

Method

Participants

Eighteen Mandarin-speaking children with ASD (M_{age}: 8.23) and 18 TD children (M_{age}: 7.03) participated in this study (Table 1). All the participants were male and were early elementary school students (1st and 2nd grade). Children with ASD were referred by

Table 1. Group characteristics.

	ASD (N = 18) M[a] (SD)	TD (N = 18) M (SD)	t or F	p
Chron. age	8.23 (.97)	7.03 (.49)	−4.46***	.000
Verbal IQ	94.73 (21.19)	101.89 (11.29)	1.71	.20
Performance IQ	99.27 (25.04)	104.89 (13.59)	0.72	.40
Full-Scale IQ	96.07 (21.91)	103.06 (9.95)	1.63	.21
Receptive language	30 (7.43)	29.78 (3.69)	3.50	.07
Expressive language	32.82 (9.13)	33 (6.74)	3.29	.08

[a]The means reported here and in the following tables represent the group means prior to co-varying for age.
***$p < .001$.

special education teachers affiliated with eight different elementary schools in Taipei City and New Taipei City. Their diagnoses were established from school records and clinical judgment by qualified clinicians. All the children with ASD met DSM-IV (APA, 1994) criteria for Autistic Disorder based on the Autism Diagnostic Interview–Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994); they were all high-functioning with Full-Scale IQs (FSIQs) above 80 on the WISC-III (Chinese version) (Chen, 1997), and with sufficient language abilities to create narratives.

The control group comprised TD children, with no concerns about ASD, learning disabilities or language delays. The two groups of participants were matched on FSIQs using WISC-III and on receptive and expressive language scores from the Language Impairment Checklist for School Children–Revised (LICSC–R;[2] Lin, Huang, Huang, & Xuang, 2009). Participants' intelligence and language abilities were evaluated by a multidisciplinary team consisting of speech-language pathologists and clinical psychologists.

Material

The present study aimed to replicate prior research by using the wordless picture book *Frog, where are you?* (Mayer, 1969). None of the participants was familiar with this book, though it has been introduced to children in Taiwan recently. The frog story is a typical children's story with a hero, a problem, a series of actions following the problem, and a happy ending. It provides a valuable means of investigating typological differences (for a bibliography of related studies, see Strömqvist & Verhoeven, 2004). It is regarded as a valuable tool for exploring narrative abilities of both typically and atypically developing children (e.g., Berman & Slobin, 1994; Colle et al., 2008; Diehl et al., 2006; Losh & Capps, 2003; Winskel, 2007). This book depicts a readily understood plot with an elaborate series of events which enable narrators to provide various links among events. Furthermore, the story has sufficient complexity which allows us to examine how participants established causal relations among narrative events; it is, therefore, suitable for our research goal.

Data collection

Participants were interviewed by a trained research assistant. Rapport was first established between the participant and the experimenter. The interviews were carried out individually with each participant and consisted of an initial warm-up conversation followed by a story-telling task based on *Frog, where are you?* Prior to story-telling, the experimenter explicitly said to the participant that she had no knowledge about this particular story book. Then, the participant was first asked to look through the entire book on his own and then to tell a story while looking at the pictures. Each interview was audio-taped and subsequently transcribed.

Data analysis

Basic narrative measures. Participants' basic narrative measures include narrative length and variety of words. The total number of clauses in each narrative was tallied to quantify narrative length. A clause consists of a verb and its arguments, and corresponds roughly to a single event. The variety of words was analyzed in terms of the total number of different words used in each narrative.

Overtly marked causal statements. Causal connectives were used to explicitly mark cause–consequence relations in the story. Therefore, we identified overtly marked causal statements in terms of causal connectives. For instance, *yin1wei4 fa1xian4 xiao3 qing1wa1 bu2jian4 le0* 'because (he) realizes the little frog has gone' was coded as an overtly marked causal statement since the prototypical causal marker *yin1wei4* ('because' in Mandarin Chinese) was used to introduce the account (Chang & Su, 2012).

Causal networks. Causal networks, consisting of causal connections and causal chain, were used to examine overtly and non-overtly marked causal relations for adjacent and non-adjacent story events.

Causal connections. A causal connection is established between a pair of events when the criterion of necessity is satisfied (Diehl et al., 2006; Trabasso & Sperry, 1985).[3] The necessity was tested by using the counterfactual argument of the form: If not A then not B. That is, if Event A had not happened in the story, then Event B would not have happened. Accordingly, Event A is a cause of, or a condition for Event B, and the two events are considered causally connected. For instance, in the story, Event A is 'the dog smashed the jar'; the ensuing Event B is 'the boy was angry with the dog.' If the dog had not smashed the jar, the boy would not be angry with the dog. As such, these two events were judged as causally connected. Based on this criterion, we identified causal connections between events, which not only signal causal dependency between events but also quantify relative importance of an event to the story. Causal connections between events are represented by the arrows in Appendix 1.

Causal chain. The causal chain refers to the sequence of events that form the gist of the story (Diehl et al., 2006; Trabasso & Sperry, 1985). To determine the causal chain, we

first identified the opening and closing events. The opening events include two parts: the setting events and the initiating events. The former provide essential background information about the protagonists, time, and place; the latter include the episodes that initiate the ensuing plot. The closing events are the statements that delineate the protagonists' goal attainment or failure. The events with causes and consequences which can be traced from the opening through the closing of the narrative were coded as the causal-chain events. See Appendix 1 for illustrations of the causal-chain events, as represented by the circled items.

Following previous researchers (Davis, O'Neil-Pirozzi, & Coon, 1997; Diehl et al., 2006), we assessed narrative coherence in terms of the density for causal-chain events and for causal connections. The densities were obtained by dividing the total number of causal-chain events/causal connections in each story by the total number of clauses in that story, respectively.

Types of causal connections. To further examine the nature and distribution of causal connections in narratives, the taxonomy of causal relations proposed by Trabasso and colleagues (Trabasso & Nickels, 1992; Trabasso & Sperry, 1985; Trabasso, van den Broek, & Suh, 1989) was followed. In Trabasso and colleagues' system, four types of causal relations were differentiated: enablement, motivation, psychological causation, and physical causation. According to Trabasso et al. (1989), a pair of statements containing goal-oriented verbs, such as 'want' or 'decide,' was considered as having the relation of *motivation*, whereas if a pair of statements involved internal state or reaction, their relation was coded as *psychological causation*. Given the fact that internal state or psychological state explanations include a variety of information relative to desires, beliefs, thoughts, intentions, and emotions (Begeer, Malle, Nieuwland, & Keysar, 2010; Colle et al., 2008; Norbury & Bishop, 2003), we collapsed *motivation* and *psychological causation* into one category and used a three-category system instead: enablement, psychological causation, and physical causation. We coded a relation as physical causation if a pair of events involves mechanical or physical causality. Finally, enablement involves behaviors or conditions which are necessary but not sufficient to cause other behaviors or conditions, but they are not causes relative to the psychological or physical criteria stated above. As illustrated in Appendix 1, Event 11 is the psychological reaction to the occurrence of Event 10. Event 18 physically causes Event 19: The beehive falls off the tree (Event 19), given one's knowledge of the physical world, because the dog forcefully shakes the tree (Event 18). Event 33 enables Event 34. In addition, to examine the distribution of the three types of causal connections, we calculated the proportion of each type of causal connection to total causal connections used in each participant's narrative.

Levels of causal connectedness. Four levels of causal connectedness were differentiated based on the number of causal connections one event has in relation to other events in the story, namely, C_0, C_1, C_2, and C_{3+}. The C_0 level refers to an individual, discrete event which has no connection with other events in the story; the C_1 level refers to an event which has connection with only one other event; events of the C_2 level have connections with two other events. Events with three or more connections were collapsed into the C_{3+} level because they were used infrequently across all participants. The C_0, C_1, C_2, and C_{3+}

Table 2. Number of clauses and number of different words.

	ASD (*N* = 18) *M* (SD)	TD (*N* = 18) *M* (SD)	*F*	*P*	$\eta^2_{partial}$
Number of clauses	41.89 (14.38)	42 (9.32)	.21	.65	.01
Number of different words	123.89 (41.06)	108.22 (25.71)	.82	.37	.02

levels of causal connectedness are illustrated by Events 1, 5, 20, and 22,[4] respectively, in Appendix 1.

Reliability. Coding was carried out by one trained coder. A second coder coded 20% of the narratives, selected at random, for reliability. Kappa coefficients assessing inter-coder reliability exceeded .87 for all measures.

Results

The first research question pertains to participants' basic narrative measures, including narrative length and variety of words. A *t* test showed that children with ASD were significantly older than TD controls; results were therefore analyzed using age as a covariate. A repeated measures analysis of covariance (ANCOVA) detected no significant differences between groups regarding basic narrative measures (Table 2).

The second research question focuses on the use of causal connectives to overtly mark causal relations between story events. The mean numbers of causal connectives used in the narratives of children with ASD and TD children were 11 and 10, respectively. No significant group difference was detected regarding this, $t_{(34)} = -.11$, $p = .92$.

The third and fourth research questions relate to the production of causal-chain events and causal connections in narratives. As displayed in Figure 1, children with ASD seemed less likely to produce causal-chain events and to establish causal connections. However, ANCOVA, with age and number of clauses as the covariates, showed no significant group difference in causal-chain events. By contrast, a significant group difference for causal connections was detected, indicating that TD children established significantly more causal connections than did children with ASD (see Table 3 for data on causal-chain events and causal connections).

Although the ANCOVAs showed no between group differences on the language abilities, the SDs of the ASD group were much higher than those of the TD group (Table 1). To further analyze the association between language abilities and participants' performances on causal chains and causal connections, we performed a partial correlation analysis, controlling for the effects of age. As shown in Table 4, receptive and expressive language abilities did not correlate with causal scores within the TD group; however, expressive language ability was negatively correlated with the production of causal-chain events within the ASD group ($r = -.57$, $p < .05$), such that increasing expressive ability was associated with fewer causal-chain events.

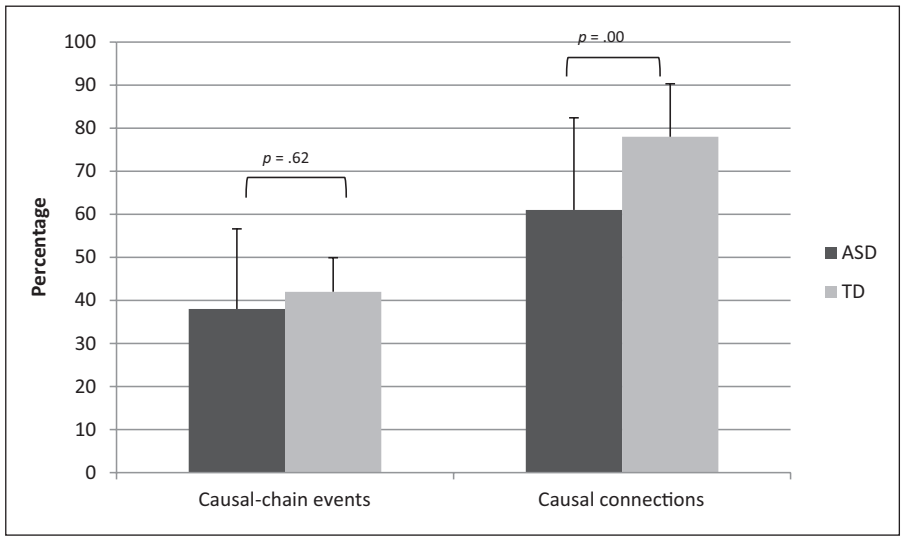

Figure 1. Comparisons between groups for density of causal-chain events and that of causal connections.
Significance level: *$p < .05$.

Table 3. Number and density of causal-chain events and causal connections.

	ASD ($N = 18$) M (SD)	TD ($N = 18$) M (SD)	F	P	$\eta^2_{partial}$
Number of causal-chain events	14.44 (4.37)	17.06 (1.83)			
Density of causal-chain events	.38 (.19)	.42 (.08)	.26	.62	.01
Number of causal connections	25.83 (12.75)	33 (9.52)			
Density of causal connections	.61 (.21)	.78 (.12)	12.57*	.00	.28

*$p < .05$.

In addition to the amount of causal connections, we further examined the types of causal connections used by the two groups of children. Results from ANCOVA, with age as the covariate, revealed a significant main effect of Type, $F(2, 33) = 4.40$, $p = .02$. Post hoc comparisons revealed significant pair-wise differences between enablement and physical causality and between psychological and physical causality, indicating significantly larger proportions of enablement and psychological causality elaborated in narratives. However, the difference between enablement and psychological causality was non-significant. Post hoc analyses further showed that TD children were more likely to refer to physical causality than children with ASD, $F(1, 33) = 5.99$, $p = .02$. No significant group differences were found in enablement, $F(1, 33) = 1.11$, $p = .30$, or psychological causality, $F(1, 33) = .10$, $p = .92$ (Table 5).

Table 4. Correlation matrix for causal-chain events, causal connections, receptive language, and expressive language abilities.

TD	CCE	CC	RLA	ELA
CCE	–			
CC	−.19	–		
RLA	−.06	.43	–	
ELA	−.34	.30	.68**	–
ASD	**CCE**	**CC**	**RLA**	**ELA**
CCE	–			
CC	.21	–		
RLA	−.51	.36	–	
ELA	−.57*	.09	.59*	–

CCE, causal-chain events; CC, causal connections; RLA, receptive language ability; ELA, expressive language ability.
*$p < .05$; ** $p < .01$.

Table 5. Proportion (%) and statistical result for types of causal connections.

	ASD (N = 18) M (SD)	TD (N = 18) M (SD)	F	p	$\eta^2_{partial}$
Enabling	47.76 (19.72)	51.42 (14.32)	1.11	.30	.03
Psychological	48.09 (19.25)	41.75 (15.81)	0.10	.92	.00
Physical	4.15 (3.83)	6.83 (4.09)	5.99*	.02	.15

*$p < .05$.

The last research question examines the pattern of causal connectedness within stories. We calculated the proportions of events from each level of causal connectedness within each participant's story. Because the data were in percentages, arc sine transformations were carried out on the percentage data to normalize the distribution. After that, ANCOVA was performed on the data and a significant Group × Type interaction was detected, $F(3, 96) = 7.23$, $p < .01$, $\eta^2_{partial} = .18$.

Further examination revealed that the two groups of children showed preferences for different levels of causal connectedness. Table 6 presents the proportion and statistical result for each level of causal connectedness. Results from ANCOVA, with age and number of clauses as the covariates, showed significant group differences for the C_0, C_2, and C_{3+} levels of causal connectedness. Regarding the C_1 level, however, no significant group difference was found. As displayed in Figure 2, children with ASD were significantly more likely to employ events of the C_0 level than were TD children. Reverse patterns were shown for the events of C_2 and C_{3+} levels, indicating that children with ASD were less likely to use events with two or more causal connections than were TD children.

Table 6. Proportion (%) and statistical result for each type of causal connectedness.

	ASD (N = 18) M (SD)	TD (N = 18) M (SD)	F	p	$\eta^2_{partial}$
C_0	24 (16)	13 (4.3)	13.63*	.00	.30
C_1	37 (10.9)	38 (8.1)	.40	.53	.01
C_2	27 (12.3)	31 (7.4)	4.73*	.04	.13
C_{3+}	12 (8.3)	18 (.06)	5.43*	.03	.15

*p < .05.

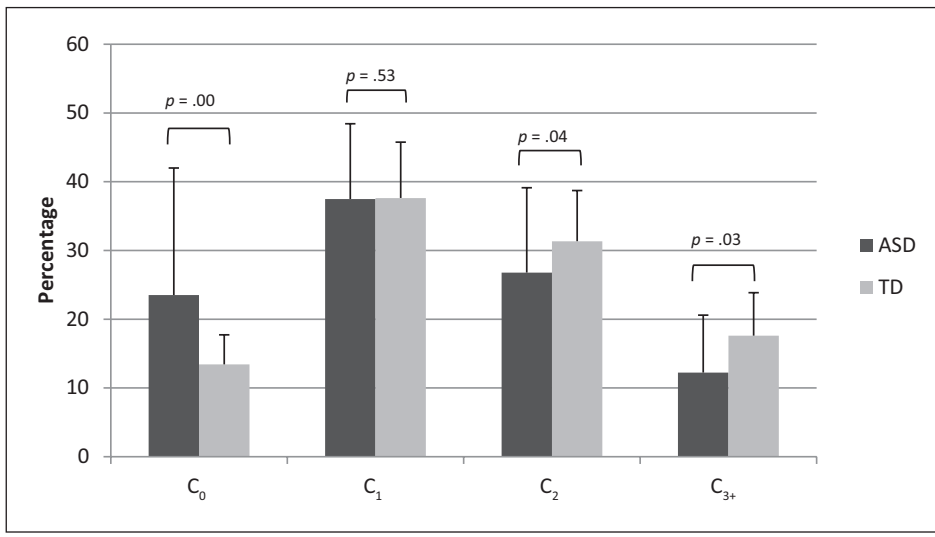

Figure 2. Comparisons between groups for different levels of causal connectedness.
Significance level: *p < .05.

These analyses, then, showed that the two groups of children were comparable in basic narrative measures and in the use of overt causal statements, which are in line with our expectations. The prediction of less causally connected stories in the ASD group is also borne out. However, contrary to expectations, children with ASD were as able as TD children in producing causal-chain events and in making psychologically causal connections.

Discussion

Basic narrative measures

This study examined the ability of Mandarin-speaking children with high-functioning ASD to achieve narrative coherence. Consistent with our expectations, there were no

significant group differences in narrative length and variety of words. This replicates prior research that revealed intact performance regarding basic narrative measures in individuals with ASD who were matched with comparison groups on language abilities (Diehl et al., 2006; Losh & Capps, 2003; Tager-Flusberg & Sullivan, 1995; Tsou & Cheung, 2007).

Overtly marked causal statements

The two groups of children did not differ in their use of overtly marked causal statements. This is in line with previous findings that ASD and comparison groups were comparable in using overtly marked causal statements (Capps et al., 2000; McCabe et al., 2013; Tager-Flusberg & Sullivan, 1995). However, other studies have revealed that individuals with ASD had difficulties in this regard (Losh & Capps, 2003; Tager-Flusberg, 1995). One possible reason for such discrepancies in findings is the different metrics used to analyze causal statements across studies. Some of the studies measured causal statements on the basis of explicit causal connectives (McCabe et al., 2013; Tager-Flusberg, 1995; Tager-Flusberg & Sullivan, 1995), while others coded causal statements in terms of both lexical items and the nature of causal explanations (Losh & Capps, 2003). In addition, participants varied in ages (children, adolescents, or adults) and cognitive abilities (low cognitive ability or high-functioning), which further complicates comparison across studies.

On the other hand, our result replicates Tsou and Cheung's (2007) finding on Mandarin-speaking children with ASD. It is worth noting that these two studies used similar matching variables to select participants and both measured explicit causal connectives. More importantly, the present study extends Tsou and Cheung's research to show that not only preschool (Tsou & Cheung's study) but also school-age (the present study) Mandarin-speaking children with ASD were comparable to TD children in using overtly marked causal statements. According to Chang and Su (2012), when the propositional and causal relation between utterances is self-evident, Chinese speakers may choose not to mark the relation with a lexical connective. In other words, causal connectives may not be the first choice for Chinese speakers to indicate causality. As shown in previous studies (Chang & Su, 2012; Sah, 2015), Chinese speakers prefer using non-overtly marked causal statements over overtly marked ones in discourse. Such a discourse tendency may presumably lead to the scarce instances of causal connectives found in the present study and thus have limited our power to detect group differences for overtly marked causal statements. Similar discourse tendency is also evident in mother–child conversations of Chinese speakers (Huang, 2003). As Huang indicated, Chinese speakers' temporal reference often depends on exploitation of discourse-pragmatic resources, rather than on use of specific linguistic forms. She further suggested that the investigation of Chinese children's acquisition of temporality should explore implicit discourse-pragmatic features rather than focus primarily on linguistic forms. In view of all these, measures of causal connectives may not be a sensitive indicator of the difference in narrative coherence between Mandarin-speaking children with ASD and TD children. To better understand the ability of Mandarin-speaking children with ASD in this regard, future studies should examine not only overtly but also non-overtly marked causal relations.

Causal networks

In addition to causal connectives, we also examined children's production of causal-chain events and causal connections in narratives. It is worth noting that the memory-reliant recall task in Diehl et al.'s (2006) research and the comparatively less memory-reliant story-telling task of the present study delivered similar results, indicating that children with ASD were as able as TD children to construct causal-chain events. The results also suggest that the memory strength in ASD, as reported by Renner et al. (2000), may not be solely responsible for the intact performance of children with ASD in constructing causal-chain events. Though counter to our prediction, this intact performance reflects that children with ASD were as sensitive as TD children to the relative causal importance of narrative events.

Although children with ASD showed intact sensitivity to the causal chain of the story, they were less likely than TD controls to build causal connections between events. In agreement with our prediction, the analyses for patterns of causal connectedness also revealed significant group differences. That is, children with ASD were less apt to produce narrative events with higher numbers of causal connections, and hence their narratives were less coherently connected. Overall, these results support findings of previous frog-story-based studies (Diehl et al., 2006; Tsou & Cheung, 2007).

In view of the greater variation in language abilities within the ASD group, we were also interested in the extent to which language abilities were associated with participants' performances on causal relations reported above. Though language abilities were not significantly related to the causal scores within the TD group, expressive language ability was negatively correlated with the score of causal-chain events within the ASD group. This negative correlation seems surprising. It suggests that increasing expressive language ability was associated with fewer causal-chain events in the ASD group. This result, however, is in line with the finding of Norbury et al. (2014) that, for children with ASD, better language ability was associated with fewer story-theme-related propositions. One possible explanation for this negative correlation, as suggested by Norbury et al., is that the verbally able children with ASD would contribute information that was not necessarily relevant to the story themes, though they appeared to be verbose. Clearly, this interpretation opens to further empirical inquiry.

In addition to replicating Diehl et al.'s (2006) research, the present study went further to examine the types of causal connections employed by children with ASD. Our results revealed that both groups of children showed preferences for enablement and psychological causation but made less use of physical causation when relating events in their narratives. These findings are consistent with some of the results from Trabasso and Nickels's (1992) developmental study of TD children. According to Trabasso and Nickels, the most frequent type of causal relation used by children across ages is enablement; the least frequent type is physical causation; motivation and psychological causation stand intermediate between them. Taken together, these results showed that the type of physical causation was employed least often by both TD and ASD children. Contrary to our prediction, however, children with ASD were comparable to TD children in employing psychologically causal connections. This finding is different from the result of Losh and Capps (2003) that showed limited use of causal explanations for

psychological states in the ASD group. These inconsistent findings may result from differences in criteria for psychological states. In Losh and Capps's research, causal statements relative to emotions or cognition were coded as psychological-state explanations; in our study, however, psychological causation covered a wider range of information relative to emotions, cognition, desires, and intentions (Begeer, Malle, Nieuwland, & Keysar, 2010; Colle et al., 2008; Norbury & Bishop, 2003).

Another equally interesting finding obtained here is that the use of physical causation was less in the ASD group compared with the TD group. This has not been reported in the literature before. Although the reasons for these subtle differences are unclear, one possible interpretation for the different performances is that these early elementary students were not fully competent in establishing causal relations in their narratives. Although both groups of children inferred and encoded psychologically and physically casual relations, such abilities may continue to develop throughout the school-aged years. It would be illuminating to follow these children up into adolescence to gain more insights into their strengths and weaknesses in this regard.

The final advantage of analyzing causal connections is that it allows us to examine how story events are causally interconnected and hence enables us to extend Losh and Capps's (2003) research by showing a clearer picture for their argument that children with ASD had impairments in building underlying causal relations both within and across story episodes. Our findings also provide support for Tsou and Cheung's (2007) presumption that Mandarin-speaking children with ASD had deficiency in underlying causal relations, which failed to be reflected by measures of causal connectives in their study. On the other hand, the insufficient causal connections detected here contrast with Chen's (2007) finding. Though both Chen's and our study relied on the criterion of necessity to assess causal relations, the two studies differed in the scope of investigation: our study examined causal relations for adjacent as well as non-adjacent events, whereas Chen's investigation was limited to only adjacent events. One finding of McCabe and Peterson's (1985) research is relevant here. These authors reported that children occasionally used causal connectives to mark causal relations for non-adjacent sentences. From this view, one way of looking at the above-mentioned discrepancy in research findings is that researchers should examine causal relations for not only adjacent but also non-adjacent events in order to gain a more comprehensive understanding about children's ability to build causal relations. Finally, the significant group differences in narrative coherence measured by causal relations contrast with previous research which found no group differences in narrative structure by measures of isolated episodic components (Tager-Flusberg, 1995). This discrepancy in research findings suggests that the system of causal networks serves as a sensitive means for assessing narrative coherence by examining how narrative information is causally interconnected at a deeper level. Hence, research based on this system may provide further insights into narrative abilities in ASD.

Suggestions for future studies

Regarding the fewer causal connections in the narratives of children with ASD, an explanation in terms of linguistic deficits can be ruled out because our participants were matched on language abilities. A more likely interpretation is to relate such deficits to the

limited ability of children with ASD to adapt their speech to the listener. Previous research has demonstrated that individuals with ASD had difficulty taking listeners' needs into account when constructing narratives (Colle et al., 2008). In particular, deficient pragmatic skill such as this was argued to underlie impaired narrative coherence in ASD (Landa, 2000; Loveland & Tunali, 1993). As indicated by Diehl et al. (2006), the less coherent stories produced by children with ASD might be due to their inability to understand what the listener needs. In line with this reasoning, it is possible that our children with ASD forged insufficient causal relations and showed impaired narrative coherence because they had limited appreciation of the listeners' needs. Further research relating causal connectivity in narratives to pragmatic deficits in ASD is needed to advance our understanding about the nature of impaired narrative coherence in ASD.

The difficulty of children with ASD in achieving narrative coherence may also be explained from an information-processing perspective. Frith (1989) advanced the Weak Central Coherence (WCC) theory to explain information-processing performance in ASD. According to this theory, most people have a natural built-in tendency to integrate incoming information so as to construct higher-level meaning. By contrast, individuals with ASD favor the processing of parts/detail over the processing of wholes/meaning. The WCC account suggests that this information-processing bias underlies the central disturbance in ASD. Actually, in the first description of infantile autism, Kanner had already reported his patients' 'inability to experience whole' (Kanner, 1943, p. 38). Research on narratives and ASD has also provided support for the WCC account (Barnes & Baron-Cohen, 2012; Nuske & Bavin, 2011). For instance, individuals with ASD were found to have difficulties arranging sentences coherently and making global inferences (Jolliffe & Baron-Cohen, 2000).With regard to the present study, the preference for the C_0-level events and the impaired narrative coherence in children with ASD cannot be explained in terms of a deficiency in linguistic or general cognitive ability, because the two groups of children were comparable in these abilities. A more likely interpretation would be that children with ASD had a weaker drive to integrate information because they appeared to value individual events at the expense of the coherent whole. This unique cognitive style may thus make their narratives less coherent. Further research relating impaired narrative coherence to the WCC account is needed to test this relationship.

Limitations of the current study

Through investigations of causal relations, this study shows that the analysis of narrative practices represents a rich source for exploring communication disorders in clinical children (Manolitsi & Botting, 2011). Our results revealed subtle deficits of Mandarin-speaking children with ASD in the underlying force to achieve narrative coherence. However, two limitations in this study compromise our ability to discuss detected findings with authority. First, subtle differences between the two groups of children may have been attenuated because of our modest sample size. To ensure sufficient power to illuminate the narrative deficits in Mandarin-speaking children with ASD, follow-up studies with larger samples are needed. The second concern is whether these findings may be extended to less structured, conversational contexts. Because

this study examined narrative coherence in ASD in the highly structured storybook context, it is not clear whether the findings characterize the narrative performance of children with ASD in more socially demanding contexts of daily interactions. Thus, more investigations on the basis of different contexts are needed to illuminate the social pragmatic difficulties in children with ASD.

Conclusion

This study examined narrative coherence in children with ASD and TD children by analyzing causal statements and causal networks. The results revealed no group differences in basic narrative measures or in overt causal statements, which are consistent with other prior findings regarding diverse types of narratives. The two groups of children were equally sensitive to the relative causal importance of story events. However, the narratives of children with ASD were less causally connected and less coherent. It is interesting to note that increasing expressive language ability was associated with fewer causal-chain events in the ASD group. Another equally interesting finding is that physically causal connections were employed least often by both groups of children, while the ASD group was comparable to the TD group in employing psychologically causal connections. This study adds to a limited body of evidence suggesting that the causal network model provides an alternative for investigating narrative coherence by examining how narrative information is interconnected at a deeper level.

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Notes

1. Research has shown that causal networks provide explanations for the variance in story recall (Trabasso, Secco, & van den Broek, 1984) and, compared with measures of story grammar, serve as a more reliable predictor of the importance ratings for narrative events (Trabasso & Sperry, 1985).
2. LICSC–R (Lin, Huang, Huang, & Xuang, 2009) is a comprehensive language assessment instrument frequently used in Taiwan for the identification, diagnosis, and follow-up evaluation of language deficits in school-age children. As an individually administered test, LICSC–R assesses receptive and expressive language abilities for children aged 6 years through 12 years 11 months. The reliability of LICSC–R was estimated based on internal consistency, test-retest stability, and inter-scorer decision agreement. Its reliabilities of internal consistency are good to excellent, ranging from .88 to .95; the test-retest correlation is .82; inter-scorer agreement is .93. The validity scores based on the internal structure are .88 and .95.
3. The criterion of necessity was originally proposed by lawyers (Hart & Honore, 1959) and reviewed by the philosopher Mackie (1980). This criterion provides reliable identification of causal relations in stories and has been used extensively by researchers (e.g., Diehl, Bennetto, & Young, 2006; Trabasso & Sperry, 1985).
4. In Appendix 1, Event 1 is a discrete event and thus belongs to the C_0 level of causal connectedness. Event 5 is a C_1 level event for it has a causal connection with only one other event,

Event 6; that is, the daylight (in Event 5) enables the protagonists to realize their pet frog has gone (Event 6). Event 20 belongs to the C_2 level for it has connections with two other events, Events 19 and 24: Because the dog causes the beehive to fall off the tree (Event 19), the bees come out of the beehive (Event 20) so that they can chase the dog (Event 24). Finally, Event 22 is an event of the C_{3+} level since it relates to three other events, Events 17, 21, and 23. Because the boy looks into the hole in the tree (Event 21), the owl flies out (Event 22), which causes the boy to fall out of the tree (Event 23). And this chain effect results from the boy's climbing up the tree in the first place (Event 17).

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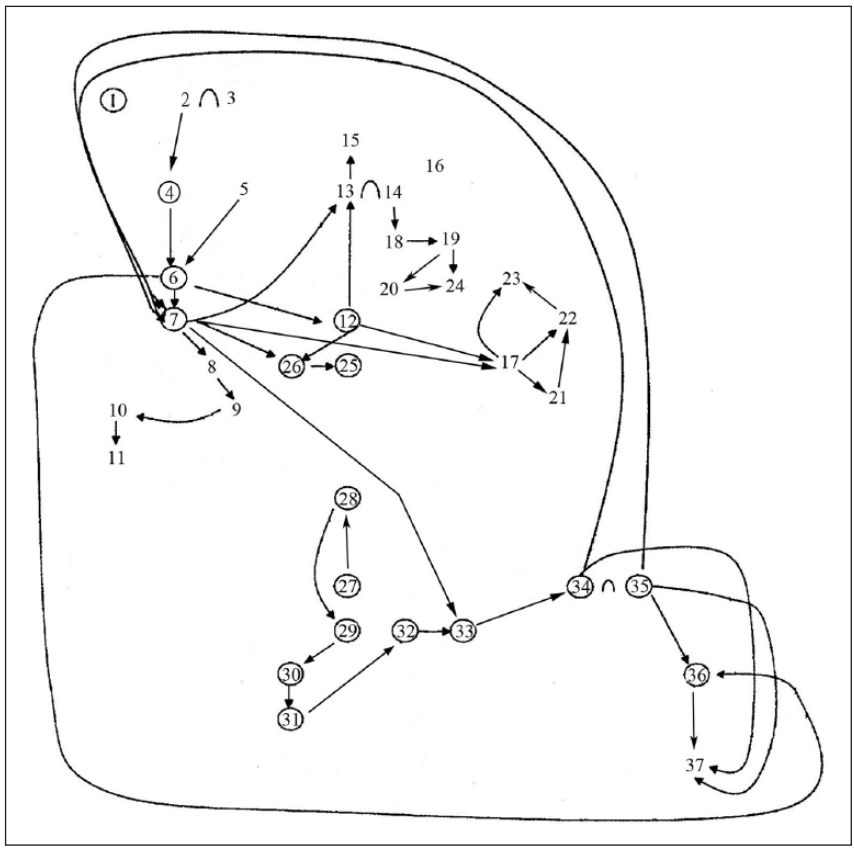
Appendix 1

The causal network and story events of the story narrated by one TD child.



Note: Each number in the map stands for one story event. Circled numbers are the events on the causal chain; causal connections between events are represented by arrows; arches connect co-occurring events. The story events corresponding to the numbers in the map are given below.

1. xiao nanhai you liang ge chongwu
   '(One) little boy has two pets.'
2. you yi tian xiao nanhai zai shuijiao
   'One day when the little boy is sleeping,'
3. han xiaogou zai shuijiao
   'and his dog is sleeping,'
4. qingwa jiu cong guanzi li pao chulai le
   'the frog runs out of the jar.'

5. ranhou tian liang le
   'Then the sky gets lighter,'
6. tanmen jiu faxian qingwa bujian le
   'they realize the frog has gone.'
7. tamen jiu daochu zhaozhaokan
   'They search everywhere.'
8. tamen dakai chuanghu
   'They open the window'
9. zhao qingwa
   'to look for the frog.'
10. ranhou xiaogou buxiaoxin ba qingwa de guanzi shuaihuai le
    'Then, the dog accidentally breaks the frog's jar.'
11. xiao nanhai jiu hen shengqi
    'The little boy is therefore very angry.'
12. ranhou tamen dao senlin fujin zhao
    'Then they search around in a forest.'
13. xiao nanhai zai dongkou li zhao
    'The little boy searches inside a hole.'
14. nage xiaogou kan shu shang de fengwo
    'That dog looks at the beehive in the tree.'
15. di limian pao chu yi zhi yanshu
    'A gopher runs out of the hole in the ground.'
16. fengwo li you mifeng
    'There are bees inside the beehive.'
17. xiao nanhai pa shang shu
    'The little boy climbs up a tree.'
18. xiaogou yonglidi yao shu
    'The dog forcefully shakes the tree.'
19. ta ba fengwo nong diaoxia shu
    'It causes the beehive to fall off the tree.'
20. mifeng dou pao chulai le
    'All the bees run out.'
21. xiao nanhai dao shu shang de dong li zhao
    'The little boy searches for (the frog) in the hole in the tree.'
22. yi zhi maotouying jiu fei chulai
    'An owl flies out.'
23. xiao nanhai jiu die xiaqu le
    'The little boy then falls down.'
24. mifeng jiu zhui zhe xiaogou pao
    'The bees then chase the dog.'
25. xiao nanhai pa shang shitou
    'The little boy climbs up a rock'
26. zhaozhaokan qingwa
    'to look for the frog.'

27. ranhou yi zhi lu pao chulai
    ‘Then a deer runs out.’
28. xiao nanhai jiu die dao ta shen shang
    ‘The little boy then falls onto the deer.’
29. lu jiu dai zhe xiao nanhai pao
    ‘The deer then carries the little boy around.’
30. ranhou tamen diao jin shanggu li le
    ‘Then they fall into the valley.’
31. zuihao tamen die jin chitang li
    ‘Finally they fall into the pond.’
32. tamen qilai dao an shang
    ‘They get up onto the bank.’
33. ranhou dao mudui qianmian zhao
    ‘Then (they) search for (it) in front of a pile of wood.’
34. zhaodao le liang zhi qingwa
    ‘(They) find two frogs.’
35. haiyou zhaoao shengxia de xiao qingwa
    ‘And find the rest of the little frogs.’
36. xiao nanhai jueding ba qingwa dai huijia
    ‘The little boy decides to take the frog home.’
37. jiu gen naxie qingwa shuo zaijian
    ‘Then (he) says good-bye to the other frogs.’