Acta Psychologica 205 (2020) 103059

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

Perspective-shifting are helpful for children in Chinese passive sentence comprehension

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ARTICLE INFO

Keywords:
Active sentence
Passive sentence
Animacy characteristics
Perspective-shifting
Mandarin Chinese

ABSTRACT

Passive sentences have been shown to be more difficult than active sentences for young children in English, German, Italian, Turkish, as well as Japanese, Korean. Many factors, such as syntactic structure, lexical-semantic, language experience, have been proved to affect passive sentence processing. In this paper, two experiments were carried out to investigate the role of perspective-shifting and animacy characteristics of agents and patients in processing passive sentences by 5~6 year-old Chinese children, using a sentence-picture matching task. The results were as follows: (1) Passive sentences were more difficult to comprehend than active sentences in Mandarin Chinese; (2) The ability of perspective-shifting played an important role in processing passive sentences. In sum, addressing sentences involving syntactic transformation is a complex cognitive activity for young children. Many factors, such as syntactic structure, lexical-semantic, language experience, and cognitive flexibility should be given full consideration.

1. Introduction

Sentence comprehension is a linguistically and cognitively challenging process for children, given that they need to hold linguistic information in memory and compute syntactic structures at the same time to comprehend sentences containing a series of semantic and syntactic information (Lee, Sung, & Sim, 2018). Active and passive sentences may be the optimum materials to investigate how children integrate semantic and syntactic information, because the two types are different in syntactic structure, but have the same semantic meaning. A well-established result of previous studies is that active sentences such as (1a) are easier to process than passive sentences such as (1b) for typically-developing children and children with agrammatic aphasia or Dyslexia. Such cases were widely found in English, Dutch, German, Italian, Turkish, Spanish, Russia, Greek, Chinese and Japan (Armon-Lotem et al., 2016; Babyonyshev, Ganger, Pesetsky, & Wexler, 2001; Bastiaanse & Edwards, 2004; Brooks & Tomasello, 1999; Burchert & De Bleser, 2004; Grodzinsky, Piñango, Zurif, & Drai, 1999; Huang, Zheng, Meng, & Snedeker, 2013; Linebarger, Schwartz, & Saffran, 1983; Luzzatti et al., 2001; Pierce, 1992; Suzuki, 2002; Terzi & Wexler, 2002; Yarbay, Duman, Altinok, Özgirgin, & Bastiaanse, 2011).

1a. The dog chased the cat.
1b. The cat was chased by the dog.

When talking about the difficulties in passive sentences, the most popular accounts, such as the non-canonical word order proposal (Armon-Lotem et al., 2016; Bever, 1970) and the transformational theory of syntax (Borer & Wexler, 1992), hold that the syntactic differences between active and passive sentences are the key factors. Unlike active sentences with the normal "*subject-verb-object*" word order, the word order is inversed in passives by moving an object to a subject position. The movement of syntactic elements inevitably leads to the mismatched mapping of thematic roles in passives (i.e., entities in the subject position act as patients, while entities in the object position act as agents). When encountering with passive sentences, readers need to shift their perspectives from sentence-initial nouns (*the patients*) to post-verbal nouns (*the agents*) to construct the right thematic relationship "*who-did-what-to-whom*", which would be costly and time-consuming.

If the non-canonical word order is indeed the underlying mechanism of the difficulties in passives, then perspective-shifting ability should have great impact on passives processing. The perspective-shifting refers to the ability to "see" things from another perspective or shift one's viewpoints from himself/herself to another person. (Farrant, Fletcher, & Mayberry, 2006; Hsiao & Gibson, 2003). There has been some evidence to suggest that perspective-shifting ability may play a direct role in sentence processing. Research into relative clause processing showed that the difficulties with object relative clauses were

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https://doi.org/10.1016/j.actpsy.2020.103059
Received 14 May 2018; Received in revised form 6 March 2020; Accepted 6 March 2020
Available online 18 March 2020
0001-6918/

mainly due to the fact that readers have to shift their perspectives from "agents" and "patients" frequently (Macwhinney & Pléh, 1988). In another study, MacWhinney (1977) also pointed out that speakers tend to take the perspective of participants who play active roles in events (notably, agents), and so they prefer active to passive sentences when the agent is part of the thought. As Suzuki (2002) pointed out, according to the changes of grammatical relations associated with particular thematic roles, passives are taken to mark the perspective of a patient-denoting sentence subject, so children need to adjust their perspectives to the sentence subject in comprehension of passives. It is easier for children with high perspective-shifting ability (i.e., good cognitive flexibility) to shift their perspectives between patients and agents.

Another factor associated with the difficulties in passives is the animacy of the patient and agent. According to the experience-based accounts, animate entities tend to appear in the subject position and act as agents, while inanimate entities tend to appear in the object position and act as patients (Malchukov, 2008). Readers are accustomed to regarding the sentence-initial noun phrase as agents and assign the thematic roles accordingly when patients were animate entities in passives processing. This bias is even stronger for children, because they tend to regard the first-noun-phrase as agent and it's difficult for them to revise an initial mis-parsing (Abbotsmith, Chang, Rowland, Ferguson, & Pine, 2017). This implies that passive sentences would systematically be interpreted as active sentences at first. Evidences have showed that passives with prototypical animacy characteristics (e.g., inanimate patients and animate agents) are relatively easier to comprehend than passives with non-prototypical animacy characteristics. To be specific, if the sentence-initial patient is an inanimate entity and the agent is an animate entity, readers are more likely to accept passives in their mind. For instance, 2 year olds interpret active sentences with animate agents and inanimate patients more accurately as opposed to inanimate agents and animate patients (Chan, Lieven, & Tomasello, 2009), and from around 3 years, children are better able to produce passives with animate rather than inanimate patients (Vasilyeva & Waterfall, 2012).

As mentioned above, the mis-matched mapping of thematic roles and the non-prototypical animacy characteristic of the agents and patients are the key factors for passive sentence comprehension. Which one is the essential factor and what would happen when the two factors co-occur? In this paper, two experiments about passives processing in Mandarin Chinese were designed to clarify the issues mentioned above.

1.1. Features of passive sentences in Mandarin Chinese and previous studies

Like English, Mandarin has a default subject-verb-object (SVO) word order (Sun & Givon, 1985). Thus, as in English, the first argument of a Mandarin sentence will typically be an agent (Philipp, Bornkessel, Bisang, & Swchlesewsky, 2008). Passive sentences are commonly used in Mandarin Chinese. Compared with English, some specificities of Chinese passives should be noticed. First, there are obvious morphosyntactic markers to express passive voice, such as "bei (被)"、"jiao (叫)"、 "rang (让)"、 "gei (给)," which is very helpful for readers to distinguish between active and passive sentences. Second, in English, the marker (e.g., *by-phrase*) of passives often occurs at the end of a sentence, while in Chinese, the markers (e.g., *bei\gei\rang\jiao*) appear between the two noun phrases and disambiguate the roles of adjacent argument (Li & Thompson, 1981). Third, the word order of passives is "NVN (e.g., *the cat was chased by the dog*)" in English, while in Chinese, the word order is "NNV (e.g., 小猫被小狗赶跑了，'*xiaomao bei xiaogou ganpao le*')." Forth, the length of passive sentence is longer than that of active sentence in English, but the two types of sentence have the same length in Mandarin Chinese. Despite the above differences, Chinese and English passives also share some common features. The most common one is that they both have non-canonical thematic mappings, i.e., the agent appears after the patient. Hence, Chinese readers also need to shift their perspectives frequently from patients to agents as do in English (Liu, 2014; Sun & Givon, 1985).

These unique features make Mandarin Chinese an interesting test case to retest the difficulties in passives and disentangle the influences of various potential factors in passive sentence processing. Up until now, no studies have been done to investigate how 5–6 year-old children process passive sentences in Mandarin Chinese, except for Huang et al. (2013). Using the visual-world paradigm, Huang et al. (2013) explored how Chinese children assign grammatical roles in the online processing of Mandarin Chinese. The results showed that children have a tendency to rapidly assign grammatical roles (incremental processing strategy), and the passives would be easier when no revision is required for an earlier role assignment. However, the animacy characteristics of the patients and agents was not manipulated in Huang et al.'s study, so it is still unclear what would happen when the patients and agents are from different animacy category? In the current study, we would investigate this issue using a sentence-picture matching paradigm. Additionally, other cognitive abilities, such as vocabulary, intelligence quotient (IQ) and working memory (WM), educational level of parents were tested, for considerable studies suggested that they have great roles in sentence processing (Murray, 2018; Payne & Stine–Morrow, 2012).

1.2. Current study

The purpose of this study is to explore the following questions:

i) Does the perspective-shifting ability influence passive\active sentences processing in Mandarin Chinese for 5–6 year-old children?
ii) Does the animacy characteristics of agents and patients influence passive \active sentences processing in Mandarin Chinese for 5–6 year-old children?
iii) What would happen when the above two factors co-occur?

The following two experiments were conducted to explore the comprehension of active\passive sentences by 5–6 year-old Mandarin-speaking children. This age group is of particular interest since it lies at the intersection of two relevant kinds of literature. Children of this age continue to struggle with passives (Huang et al., 2013) and also fail to revise initial misinterpretation (Choi & Trueswell, 2010). What's more, studies have found that 5–6 year-old children are sensitive to lexico-semantic constraints, such as intransitive or transitive, familiar or novel, animate or inanimate in sentence comprehension (Ambridge, Bidgood, Pine, Rowland, & Freudenthal, 2015; Arnon, 2010; Dittmar, Abbot-Smith, Lieven, & Tomasello, 2014).

We intended to explore the role of perspective-shifting in comprehending passive\active sentences with animate patients and inanimate agents in Experiment 1. If the mis-match of thematic roles is the underlying factor for the difficulty in passives, it would be more difficult for children with low ability in perspective-shifting to comprehend passive sentences than active sentences, but no differences would be found for children with high ability in perspective-shifting. If the difficulty in passives is mainly due to the non-prototypical animacy characteristics, it would be more difficult for both groups to process passive sentences, because the antecedent noun phrases (*patients*) in passive sentences are animate, and readers may mistake them as agents (*the doers of action*) easily. With the marker "*Bei* (被)" appearing, children came to realize their initial parsing was wrong, so they have to reject the initial parsing, but such cognitive operations were not easy for 5–6 year-old as Abbotsmith et al. (2017) proposed.

2. Experiment 1

2.1. Methods

2.1.1. Participants

Fifty-eight 5–6 year-old children from a kindergarten in Qufu district, China, volunteered to participate in this study. Ten of them were excluded due to some errors, leaving 48 children in the final data set. Specifically, four children failed to understand the task; three children could not control their actions and often paid their attentions to things unrelated to experimental tasks; two children cried for their mother; and one child's comprehension performance was too poor (whose scores were > 3 standard deviations below the mean). All the children were controlled in vocabulary, intelligence quotient, working memory and the education level of their parents by removing the 2SD outliers to exclude their influences on the results.

2.1.2. Tasks

2.1.2.1. Vocabulary. A lexical fluency task was used to test vocabulary. In this task, each child needed to finish five trials. In each trial, they were asked to produce as many words from the same category (e.g., *foods/toys/flowers/electric tools/kinship terms*) as they could in 1 min. After each trial, they would have a rest and then begin the next trial. The five trials were arranged in a random order for each child. The total number of words correctly produced was the final score of the child. Before the formal tasks, each child had 1–2 practice trials to get familiar with the procedure. The task took approximately 10 min.

2.1.2.2. Raven standard progressive matrices (RSPM). The Chinese version of the RSPM (Zhang & Wang, 1985) was used to assess non-verbal fluid intelligence for young children (5–16 years). There were five sub-tests (e.g., perception identification, imaging, comparison, analysis, abstract reasoning), and each sub-test contained 12 items. Each correct selection was counted as one score. Thus the total score was 60. Children were accompanied by teachers from the same kindergarten during the whole testing course. It took approximately 40 min to finish all the items for each child.

2.1.2.3. Working memory (WM). In this study, digital working memory was assessed through an interactive activity, which was created by ourselves based on previous studies (Lee et al., 2018; Sung, 2011). The procedure was as follows: after some warm-up activities to help children familiarize with the procedure, the experimenter would say: "Dear boy\girl, here is a grandpa\grandma (i.e., this role is played by another experimenter) who gets lost because of his\her poor memory. Can you help him\her to remember his\her address and house number? If you can successfully tell the address and house number to the policeman (i.e., this role is played by another experimenter) who is in the next room, you could get a small gift. Remember! You should tell the policeman the address first, and then the house number!". The number of characters of the house address was constant across all the trials, but the number of digits of the house number varied from 3 to 8. In the first trial, if the child could tell the policeman the house address and the house number successfully, then the next trial with one more digit would begin. If an error was made, either in the address or the house number or both, the child would do another trial with the same length. If the child was successful this time, then the number of digits would increase; if similar errors were made again, the whole task would be terminated. The maximal number of digits of the house number would be regarded as the child's working memory capacity.

2.1.2.4. Educational level. The education level of Children's parents was assessed using a 4-point scale (*1* = primary school; *2* = junior high school; *3* = senior high school; *4* = college). The questionnaires were brought home and returned by children after their parents finished them.

2.1.2.5. The ability of perspective-shifting. The perspective-shifting task was programmed using *E*-Prime 2.0 and administered on a Dell laptop with a 14-in. touch screen monitor. Each trial began with a four-block array with a colored block in each of the cardinal positions of a square (see Fig. 1). The observer was a cartoon image of an owl. Children saw the display for 3000 ms, and then the owl appeared in one of the three positions around the array (90°, 180°, or 270°), counter-clockwise from the child. After 2000 ms, four choices appeared at the bottom of the screen, depicting four different configurations of the blocks in a smaller version of the previous display. Children were asked to select the display option that corresponded to the owl's view by touching that choice. If the child made the right selection, he would get "1", otherwise the score would be "0". Four options were constructed to represent specific responses: correct response (i.e., the owl's view of the array), egocentric error (i.e., the child's view of the array), orientation error (i.e., correct front-back relationship of blocks but with a left-right reversal), and structured view (i.e, correct internal structure of blocks but incorrect orientation relative to the owl's position). The target array, the response options, and the owl remained visible during the entire trial.

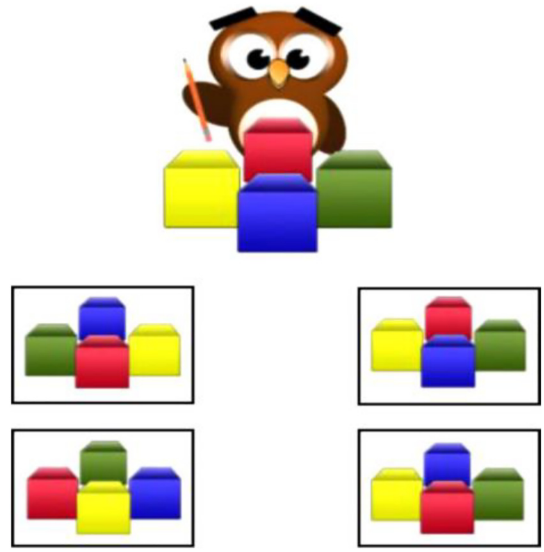


Fig. 1. Example of computerized four-block array with owl in 180° position. The target array and the owl appeared centered at the top of the screen and the four options appeared below. The options are: correct (top left), egocentric (top right), structured (bottom left), and oriented (bottom right).

Before the formal task, the child was introduced to the owl and was told that this character would move to different positions around another character, rabbit and that the child had to determine what the owl saw. Three to five trials with rabbit were presented to familiarize the child with the task. Next, the block array was presented, and the child was told that owl would move to various positions around this "toy (i.e., rabbit)" and that it was the child's job to figure out what the owl saw. There were three practice trials with a feedback of a happy (for correct trial) or sad (for incorrect trial) face. Following this practice, 16 experimental trials were presented in a random order, with no feedback. The task took approximately 10 min.

Each child received 16 trials, and the order of trials and the position of alternative responses were randomized across children. There were no time limits for children to respond and the options remained on the screen until a response was made, followed immediately by the next trial. If all the trials were correct, the child would get 16. If an error was made, one score would be subtracted.

2.1.3. Materials

In Chinese, active voice is expressed mainly in two ways. For example, to express "the chick eats the worm," we can say in Chinese "小鸡吃掉了虫子 (the chick\eat\the worm)" or "小鸡把虫子吃掉了 (the chick\ba\the worm\eat)". The two expressions differ in word order and the number of characters. For the former, the word order is SVO, and the number of characters is 7, while for the latter, the word order is

SOV, and the number of characters is 8. But the corresponding passive voice is expressed only in one way "虫子被小鸡吃掉了 (the worm\bei \the chick\eat)." Therefore, to exclude the interference of sentence length and word order, we adopt the second way to construct an active sentence, so that both active and passive sentences contain eight characters and both are verb-final sentences.

Materials were 24 sets of sentences as shown in (2). Each set included two types of sentence: active sentence (2a) and passive sentence (2b). The passive sentences were derived from the corresponding active sentences by exchanging agents and patients. Meanwhile, the word "ba (把)" was changed into the word "bei (被)". Here it should be noted that most passive sentences are produced by adding the word "bei" in Mandarin Chinese. Words were kept constant in the same set of sentence materials to exclude any confounding effect of word frequency, word meaning, and a number of strokes per character across conditions.

2a. Active sentence in Mandarin Chinese

小鸡\把\虫子\吃掉了。
Chick\ba\worm\eat
(The **chick** ate the **worm**.)

2b. Passive sentence in Mandarin Chinese

虫子\被\小鸡\吃掉了。
Worm\bei\chick\eat
(The **worm** was eaten by the **chick**.)

To ensure that the words were familiar to our participants, all the nouns and the verbs in experimental materials were selected from books compiled by People's Education Press for junior kindergarten. We first selected the nouns\verbs according to their distribution frequency (i.e., the times of the words used in the textbook) and then asked ten children who did not participate in the study to report orally whether they know the meaning of the words or not. Results showed that they all knew the words' meaning.

To ensure there were no differences in semantic plausibility across the two conditions, we recruited 20 college students to rate the plausibility of these sentences on a scale of 1 (more natural) to 5 (more unnatural). No significant differences in plausibility were found ($M_{active} = 1.13, M_{passive} = 1.25, t = -1, p = .33$).

The 24 sets of experimental sentences were divided into two lists, using a Latin square design, so that participants heard only one version of a set. The two lists contained 24 filler sentences of various grammatical types, among which some are simple statement sentence, and some are relative clauses, etc. All the filler sentences were matched in sentence length with experimental sentences. Pretests were done to ensure children of 5–6 years old could understand the materials easily. Thus, each participant heard 48 sentences which were pseudo-randomized so that at least one filler sentence intervened between target sentences.

After all the materials were selected, we invited a professional teacher to draw stick figures according to the sentences. The pictures were hand-sketched line drawings, which were scanned into the compute and colored, compiled and edited with a graphics converter. An example is shown in Fig. 2a.

2.1.4. Procedure

In this study, a sentence-picture matching task (Meyer, Mack, & Thompson, 2012) was used. In this task, subjects were presented with an auditory sentence that was prerecorded by a professional female broadcasting host and delivered through a loudspeaker connected to a portable computer. Immediately after that, two pictures were presented on the computer screen (see Fig. 2a.). Children were asked to select the picture that matched the sentence they just heard. The locations of the pictures on the computer screen were counterbalanced.

Children were tested individually in a quiet room, and the stimuli were presented via Powerpoint using a 14" screen Dell laptop at a resolution of 1026×768 pixels. Participants were instructed to listen to each sentence carefully, and then selected the matching picture. The correct selection was scored as "1", and the wrong as "0". Each participant needed to listen to 50 sentences, among which the first two were used to familiarize them with the procedure, and the other 48 sentences were actual materials. Experiment 1 lasted for about 30 min with a 5-min rest in the middle. The accuracy of sentence comprehension abilities for active and passive sentences was used to derive a percentage ranging from 0 to 100%.

2.2. Results

The percentage of correct answer for active and passive sentences in Experiment 1 was followed in Table 2.

The data were analyzed using mixed models logistic regression (Jaeger, 2008). The dependent measure in these models was accuracy (correct responses coded as 1, incorrect responses coded as 0). The odds of producing a correct response was predicted using Sentence Type (active sentences = −1, passive sentences = 1), Perspective Shifting (continuous measure of perspective shifting skill) and the interaction of these variables. The model also included RSPM and WM as covariates due to the significant correlation between these measures and sentence processing (see Table 1). Finally, participants and items were included as random factors in the analysis. The results of this analysis are presented in Table 3.

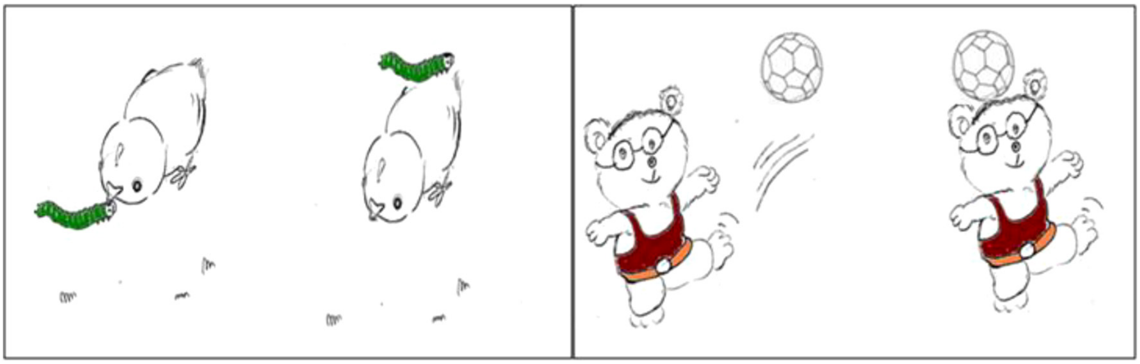
The main effect of sentence type was significant ($z = -2.28$, $p = .022$), passive sentences were more difficult to comprehend than active sentences (72.96% vs. 83.68%). And the main effect of perspective shifting was also significant ($z = -2.61$, $p = .009$), participants with higher perspective-shifting scores were more accurate than participants with low scores (80.5% vs. 76%).[1] The interaction between the ability of perspective-shifting and sentence type was significant ($z = -2.16$, $p = .049$). To follow up the significant interaction of Sentence Type and Perspective Shifting, we conducted separate regression analyses for the responses to the active and passive sentences. The dependent measure in these analyses was the participants' percent correct on the items, and the predictor was participants' Perspective Shifting score. The results showed that the contribution of perspective shifting to passive sentences processing was significant ($\beta = 0.462$, $t = 3.494$, $p = .001$), but not to active sentence ($\beta = 0.099$, $t = 0.659$, $p = .513$) (Fig. 3). The main effects of RSPM and WM were not significant.

2.3. Discussion

In Experiment 1, we explored the difficulties in active and passive sentences by manipulating the role of perspective-shifting. Compared with active sentences, passive sentences were more difficult to comprehend for all participants. The results were consistent with previous findings in English (Baldie, 1976; Lempert, 1990; Messenger, Branigan, McLean, & Sorace, 2012), Chinese (Huang et al., 2013), Japanese (Suzuki, 2002) and Korean (Lee et al., 2018).

Compared with active sentences, passive sentences have non-canonical word order because of there being an inversion between agents and patients. In passive sentences comprehension, it is very easy for readers to regard the sentence-initial animate entity as the agent. However, when encountering with the marker (被, *bei*) of passive voice, readers will realize that their initial-parsing is wrong, and hence they have to shift their perspectives from agent to patient, in order to

[1] For the convenience of description, the subjects were divided into high and low groups according to the mean value in Experiment 1. One mean is from the students in the upper half of the perspective shifting scale, and the other is from the lower half. The same division was used in Experiment 2.



a b

Fig. 2. Example of pictures used in Experiment 1 and Experiment 2.

Table 1
Correlation between individual difference variables ($N = 48$).

	Active sentence	Passive sentence	Vocabulary	PS	RSPM	WM	FEL	MEL
Active sentence	1							
Passive sentence	0.269*	1						
Vocabulary	0.251*	0.230*	1					
PS	0.227*	0.635**	−0.208	1				
RSPM	0.310**	0.369**	0.166	0.143	1			
WM	0.343**	0.497**	0.219	0.270*	0.205	1	.	
FEL	0.092	−0.030	−0.077	0.018	0.082	0.044	1	
MEL	0.024	−0.024	0.014	−0.039	−0.176	0.145	0.470**	1

PS: Perspective-shifting; RSPM: Raven standard progressive matrices; WM: Working memory; FEL: Father's educational level; MEL: Mother's educational level.
** $P < .01$.
* $P < .05$.

Table 2
Accuracy of percent in sentence comprehension (%) (SD).

Sentence type	Experiment 1	Experiment 2	
		Prototypical animacy	Non-prototypical animacy
Active sentence	83.68 (5.32)	88.58 (6.64)	86.46 (6.21)
Passive sentence	72.96 (9.12)	80.59 (6.22)	79.46 (6.58)

Table 3
General linear mixed regression model for accuracy of sentence comprehension in Experiment 1.

	Estimate	Standard Error	*Z*-value	*P*-value
Intercept	1.07	1.04	1.03	0.302
RSMP	0.01	0.01	0.79	0.429
WM	0.03	0.08	0.37	0.710
Sentence type (TP)	−1.48	0.65	−2.28	0.022*
Perspective-shifting (PS)	−0.04	0.05	−2.61	0.009**
TP × PS	0.09	0.07	2.16	0.049*

** $P < .01$.
* $P < .05$.

construct the right thematic relationship "*who-did-what-to-whom*". It is easier for children with higher perspective-shifting ability to reject the initial-parsing and shift their viewpoints because of their high cognitive flexibility, but it is difficult for children with poor cognitive flexibility. For active sentences, readers could assign thematic roles in line with sentence unfolding so that no difference is found between the two groups.

In Experiment 1, we found passives more difficult for the children with low ability of perspective-shifting. The difficulties in passives may be due to two aspects: one is the non-canonical word order or the mismatched mapping of thematic roles, and the other is the non-prototypical animacy characteristics of the agents and patients. Studies have shown that speakers tend to regard the sentence-initial NPs as subjects and agents if they are animate entities, but if the sentence-initial NPs are inanimate entities, speakers tend to regard them as patients and adopt the passive voices (Gennari & MacDonald, 2009). We could not disentangle such issues in Experiment 1, so Experiment 2 was conducted. In Experiment 2, we further investigated the difficulties in passive sentences with prototypical or non-prototypical animacy characteristics, as showed in (3). Among them, (3a) and (3b) are sentences with prototypical agents\patients, (3c) and (3d) with non-prototypical agents\patients. if it is just perspective shifting that explains children's difficulties with passives, then sentences like 3d (non-prototypical passive) would be no more difficult than sentences like 3b (prototypical passive) whereas if animacy does play a role then there may be an interaction with perspective shifting, whereby both groups might find sentences like 3d (non-prototypical passive) hard but only low-

Table 4
General linear mixed regression model for accuracy of sentence comprehension in Experiment 2.

	Estimate	Standard Error	Z-value	P-value
Intercept	0.25	1.26	0.20	0.840
RSMP	0.01	0.02	0.27	0.784
WM	0.06	0.07	0.89	0.376
Sentence type (TP)	−1.58	1.00	−1.88	0.051·
Perspective-shifting (PS)	−1.17	0.99	−2.19	0.029*
Animacy	0.11	0.10	1.12	0.261
TP × PS	0.11	0.11	2.14	0.031*
TP × Animacy	1.63	1.34	1.21	0.227
PS × Animacy	0.18	0.11	1.59	0.113
TP × PS × Animacy	−0.16	0.16	−1.02	0.310

* $P < .05$.

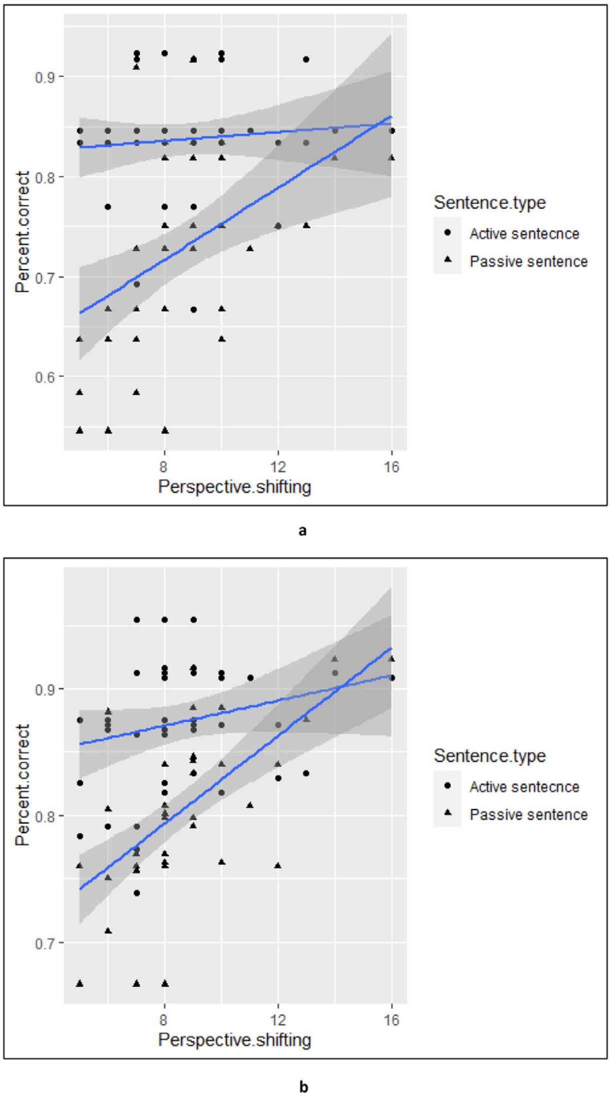


Fig. 3. a Scatterplot for Experiment 1.
b Scatterplot for Experiment 2.

perspective shifting would also find sentences like 3b (prototypical passive) hard, as in E1.

3. Experiment 2

3.1. Methods

Experiment 2 was carried out one month after Experiment 1, using the same participants. In Experiment 2, the procedure was same as in Experiment 1 except for the experiment materials (e.g., 3 and Fig. 2b). No difference was found in semantic plausibility across the materials (M_{3a} = 1.08, M_{3b} = 1.13, M_{3c} = 1.17, M_{3d} = 1.21, $F_{(3,\ 92)} < 1$).

3a. Active sentence in Chinese (prototypical agents\patients)

小熊把皮球踢飞了。
the bear\ba\ball\kick
(The **bear** kicked the **ball**.)

3b. Passive sentence in Chinese (prototypical patients\agents)

皮球被小熊踢飞了。
ball\bei\the bear\kick
(The **ball** was kicked by the **bear**.)

3c. Active sentence in Chinese (non-prototypical agents\patients)

皮球\把\小熊\砸到了。
Ball\ba\the bear\hit
(The ball hits the bear)

3d. Passive sentence in Chinese (non-prototypical patients\agents)

小熊\被\皮球\砸到了。
(The bear was hit by the ball)

3.2. Results

The data were analyzed using mixed models logistic regression as in Experiment 1. Results (see Table 4) showed that the main effect of type of sentence was significant (z = −1.88, p = .051), passive sentences were more difficult to comprehend than active sentences (80.25% & 87.52%). The main effect of perspective shifting was also significant (z = 2.44, p = .014), participants with higher perspective-shifting scores were more accurate than participants with low scores (87% vs. 81%). The main effect of animacy was not significant (z = 1.12, p = .26).The interaction between the ability of perspective-shifting and sentence type was significant (z = 2.14, p = .03). To follow up the significant interaction of Sentence Type and Perspective Shifting, we conducted separate regression analyses for the responses to the active and passive sentences. The dependent measure in these analyses was the participants' percent correct on the items, and the predictor was participants' Perspective Shifting score, and the results showed that the contribution of perspective shifting to passive sentences processing was significant (β = 0.629, t = 5.518, p = .000), but not to active sentence (β = 0.227, t = 1.544, p = .130) (Fig. 3b). The main effects of RSMP and WM were not significant. The main effect of animacy and the other interactions were not significant.

3.3. Discussion

By manipulating the animacy characteristics of the agents and patients, further investigation was done in Experiment 2. Results showed that passive sentences were still more difficult to comprehend than active sentences, especially for children with low perspective-shifting ability. Additionally, as found in E1, multiple regression results also showed that the ability of perspective-shifting could significantly predict the difficulties with passives. Given these findings, we argued that the difficulties with passives are indeed due to the non-canonical word order or the mis-matched mapping of thematic roles. In sum, findings from Experiment 2 are consistent with our predictions of the non-canonical word order or the mis-matched mapping of thematic roles, not with the predictions of animacy characteristics of the agents and patients.

4. General discussion

In the current study, we explored the factors associated with the difficulties in passives for 5–6 years old children using a sentence-picture matching task. Experiment 1 showed that passive sentences were more difficult to comprehend than active sentences. Similar results were also found in Experiment 2. Regression analysis from the two experiments also indicated that the ability of perspective-shifting could significantly predict the difficulties with passives, but the animacy characteristics of the agents and patients could not. On the other hand, the contributions of RSMP and WM in sentence processing were also not significant for rigid matching control for these variables were done.

Many studies on Indo-European languages (Armon-Lotem et al., 2016; Bastiaanse & Edwards, 2004; Burchert & De Bleser, 2004;

Luzzatti et al., 2001; Marshall, Marinis, & van der Lely, 2007; Yarbay et al., 2011) as well as Japanese (Suzuki, 2002), Korean (Lee et al., 2018) have shown that passive sentences are more difficult than active sentences for 5–6 years old children. Similar results are also found in our study. Although there are great differences in syntactic structure among Chinese, Korean, Japanese and Indo-European language, a common generative mechanism regarding the structure of a passive sentence is shared by these languages. Specifically, passives are formed by exchanging the location of agents and patients in active sentence. As the transformational theory of syntax argues, passives are derived from initial representations of their active counterparts, followed by a movement operation that raises sentence objects into subject position (Wexler, 2005). The transformation of syntax would bring some difficulties to the processing of passives. On one hand, it is impossible for children to assign thematic roles in line. They need to reposition the movements to its original location so as to construct the right argument relationship "*who-did-what-to-whom*" mentally, but such cognitive operations are very difficult for pre-school children. Borer and Wexler (1992) argued that the knowledge of this movement operation is absent in children's early grammar and does not mature until the early preschool period. On the other hand, as mentioned above, both English and Chinese have default subject-verb-object (SVO) word order. In sentence processing, children initially interpret sentences using a NOUN-VERB-NOUN = AGENT-VERB-PATIENT schema (Bever, 1970), especially when the sentence-initial words are animate entities. Abbotsmith et al. (2017) also found that young English-speaking children show a bias to incrementally designate an agent role to the first noun in a sentence. This strategy would work well in active sentences processing, but misinterpretations would occur when encountering with passive construction. So children need to revise their initial mis-parsing upon the appearance of the marker (e.g., "被, *bei*") of passive voice. However, it's difficult for children to revise an initial mis-parsing (Abbotsmith et al., 2017). Huang et al. (2013) also argued that children's difficulties in the comprehension of passives stem from a tendency to rapidly assign grammatical roles coupled with a subsequent failure to revise these interpretations.

One aim of the current study is to investigate the role of perspective-shifting in passive sentence processing and we found the main effect of perspective-shifting was significant, such that children with low perspective-shifting ability have more difficulties in passive sentence processing. The results are consistent with the findings of previous studies (MacWhinney, 1977; Suzuki, 2002). Altogether, these results suggest that perspective shifting indeed plays an important role in passive sentences processing. A similar result was also found in relative clauses processing. In Indo-European language, a well established finding is that subject relative clauses are easier than object relative clauses. According to the perspective-shifting account, syntactic subjects in English map onto the reader's perspective and that processing is easier when a consistent perspective is maintained (Macwhinney & Pléh, 1988). In sentences with subject-relative clauses, there is only one constituent serving as subject throughout the sentence, and no perspective-shifting is required. In sentences with object-relative clauses, the main clause subject is different from the relative clause subject. Readers must shift their perspective when they encounter the relative-clause subject and again when they return to processing the main clause. Perspective-shifts are presumed to be costly and time-consuming (Traxler, Morris, & Seely, 2002).

The structure of passive sentences involves NP-movement as in object relative clause, e.g. in a sentence such as *The girl$_i$ was pushed $\underline{\ }_i$ by the boy*, the patient NP (*the girl*) is moved from the post-verbal position to the subject position. Readers need to shift their perspective between patients and agents in order to maintain a consistent mapping between the syntactic subject and the reader's perspective, as well as assign thematic roles "*who-did-what-to-whom*" in line. Such cognitive operations are easier to accomplish for children with high perspective-shifting ability, but it is somewhat difficult for children with low perspective-shifting ability. The effect of personal traits on sentence processing has been found in other studies. A study about relative clause processing in Mandarin Chinese found that participants with low working memory span read the subject-relative structures more slowly than the object-relative structures, but there was no reading time difference for participants with high working memory span (Chen, Ning, Bi, & Dunlap, 2008).

To explore the role of perspective-shifting in passive sentence processing, we conducted multiple regression analyses with the score of perspective-shifting as the independent variable, and the comprehension accuracy as a predicted variable. The results showed that the perspective-shifting could significantly predict the difficulties with passives, but not for active sentences. Such findings were also obtained by the Pearson correlation matrix analysis, as showed in Table 1. Our findings give direct support to Suzuki's (2002) conjecture: "if children's capacity for perspective-taking is not fully developed, then they can be expected to perform poorly, even though they have mastered the structural properties of passives."

Animacy characteristics of agents and patients is another important factor in passive sentence processing, for evidences have shown that passives with prototypical animacy characteristics (e.g., inanimate patients and animate agents) are relatively easier to comprehend than passives with non-prototypical animacy characteristics. For instance, 2 year olds interpret active sentences more accurately when they contain animate agents and inanimate patients as opposed to inanimate agents and animate patients (Chan et al., 2009), and from around 3 years old, children are better able to produce passives with animate rather than inanimate patients (Vasilyeva & Waterfall, 2012). But in the present study, we did not find the interaction between sentence type and animacy characteristics. Specifically, actives with animate agents were not easier than actives with inanimate agents. Moreover, passives showed a similar pattern. Generally speaking, the animacy characteristics of agents and patients did not modulate active\passive comprehension in Chinese literature.

Additionally, language experience may be one of the factors underlying the difficulties in passives. In Mandarin Chinese, "被 (bei)" passive sentences occurred less frequently than "把 (ba)" active counterparts (Li, Bates, & MacWhinney, 1993; Xiao, McEnery, & Qian, 2006). An analysis of written text from the Lancaster Oslo Bergen Corpus (Johansson, Leech, & Goodluck, 1978) and the Lancaster Corpus of Mandarin Chinese (McEnery, Xiao, & Mo, 2003) revealed that passives occur at an estimated 1026 times per 100,000 sentences in English but only 110 times per 100,000 in Mandarin. While the statistics for spoken languages are likely to be somewhat different (Gordon & Chafetz, 1990; Stromswold, Eisenband, Norland, & Ratzan, 2002), the striking disparity between these languages suggests that "被 (bei)" may be quite rare in children's input.

5. Conclusion

Two experiments using a sentence-picture matching task were carried out in this study, with an aim to explore the role of perspective-shifting and the animacy characteristics of agents and patients in passives comprehension for 5–6 years old children. The results showed that passive sentences were more difficult than active sentences in Mandarin Chinese, which is consistent with other studies on English, German, Turkish, as well as Japanese, Korean. Most importantly, we found that perspective-shifting plays an important role in passive sentence processing, and this role is not modulated by the animacy characteristics of agents and patients although the animacy characteristics influences the difficulties in passives as well. Hence, we conclude that syntactic construction, i.e., non-canonical word order or syntax transformation, is the primary cause of difficulty in passives. Of course, syntactic transformation is a complex cognitive activity for young children, in which many factors, such as syntactic structure, lexical-semantic, language experience, and the ability of mental computation, should be given full consideration, as accounts of competition model (Bates & MacWhinney, 1989) argued that the children determine meaning of sentence by using linguistic and non-linguistic cues whose strength depend upon the degree to which they are associated with a particular interpretation (Huang et al., 2013).

Acknowledgment

This research was supported by the National Social Science Fund [18BYY092].

Compliance with ethical standards

This research involving Human Participants and was authorized by the center of experiment, Qufu Normal University.

Informed consent

We have informed the children and their parents that the aim of the study was only to investigate the inner mechanism of passive sentences processing in Mandarin, and which would not do any harm to them. If they consent to let their children to attend the study, they would signature before attending.

Funding

This research was funded by the National Social Science Fund under grant [number: 18BYY092] to the corresponding author Wenguang He.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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