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Developmental Patterns in Malay Shape-Based Numeral Classifier Comprehension

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ABSTRACT

Numeral classifier system is an instance of linguistic device for categorisation, a cognitive process that is indispensable in human cognition and language development. The current study investigated the acquisition of eight Malay shape-based numeral classifiers through a matching comprehension task in 140 6 to 9 year old children. The aim is to examine the developmental patterns observed in the comprehension of Malay shape-based numeral classifiers. Specifically, the study focused at examining if the complexity of the semantic features of individual numeral classifiers plays a role in numeral classifier comprehension order, and if the degree of typicality of numeral classifier exemplars has an effect on the comprehension order. Results indicated that semantic complexity and exemplar typicality play a significant role in Malay numeral classifier comprehension.This suggests that multiple factors interact with each other and contribute to the developmental pattern of numeral classifier.

Keywords: Acquisition order, categorisation, children, cognition, comprehension language development, Malay, numeral classifier

INTRODUCTION

Categorising and labelling is a fundamental process in human cognition and language development (Croft & Cruse, 2004). Categorisation is a complex task (Yuan *et al.*, 2010) as information can only be categorised, retrieved, labelled and evaluated when there is a satisfactory resemblance between new and stored information before an object is accepted into a respective category (Barsalou *et al.*, 1998). Objects that are perceived as belonging to the same category are then assigned to

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the same label (Mervis & Rosch, 1981). The current study is aimed at examining the developmental patterns observed in the comprehension of Malay shape-based numeral classifiers.

'Numeral classifiers' is a commonly recognised type of noun classifier system. They are used usually in counting objects and they occur contiguously to numerals and expressions of quantity in a noun phrase. Being a manifestation of a linguistic device of categorisation (Craig, 1986) (cf. "language-inherent classification", Zhang & Schmitt, 1998, p. 376), numeral classifiers classify nouns explicitly by signifying "some salient perceived or inputted characteristic" of the entity in question (Allan, 1977, p. 285). Syntactically, numeral classifiers form part of a noun phrase together with a noun and a numeral (Richards *et al.*, 1985).Semantically, they provide information about the physical, conceptual, functional and cognitive properties of objects in a particular culture (Zhang & Schmitt, 1998). Due to the fact that speakers of numeral classifier languages need to learn how to categorise objects in their environment and pair them with the appropriate numeral classifier using the language-specific classification system, numeral classifier systems offer researchers an ideal opportunity to examine how children learn to categorise and label objects in their environment using a constrained system.

The assignment of numeral classifiers in counting activities is primarily dependent upon semantic properties of the noun they categorise, usually based on "the parameters of animateness, shape, or function which are attributed to the head noun" (Adams & Conklin, 1973, p. 1). Allan's (1977) description of shape-based numeral classifiers illustrates how numeral classifier categorisation is, in general, a systematic, yet complex categorisation process. Typically, the categorisation of shape-based numeral classifiers is based on saliently one-dimensional (henceforth 1D to indicate 'long'), saliently two-dimensional (2D to indicate 'flat'), and saliently three-dimensional (3D to indicate 'round' or 'polyhedral') parameters. In addition, secondary parameters such as the rigidity and the size of the objects are also taken into consideration in determining which shape-based numeral classifier is to be assigned to the noun in question.

MALAY NUMERAL CLASSIFIERS

Malay, an Austronesian language spoken by 20 to 30 million native speakers, is said to be one of the languages that has an extensive numeral classifier system (Richards *et al*., 1985). The Malay numeral classifiers are described as 'coefficients' and 'numeral coefficients' because of their rigid collocation between nouns and numeral classifier names (Omar & Subbiah, 1995). In some cases, its absence in numeral phrases makes the structure of any formal Malay sentence ungrammatical (Omar & Subbiah, 1995).

Malay numeral classifiers may sometimes be homonymous to some Malay nouns (Salehuddin *et al.*, 2011). However, despite being homonymous, they do not, unlike Thai repeaters (Haas, 1942), collocate with each other. Thus, the noun phrase **tiga buah buah* and **tiga biji biji* never exist in Malay. The classification of Malay numeral classifiers is systematic, yet complex as it involves mixed semantic criteria between various inherent semantic features of the objects in question (Salehuddin & Winskel, 2008).

CROSS-LINGUISTIC STUDIES ON NUMERAL CLASSIFIER ACQUISITION

Quite a large number of cross-linguistic studies on numeral classifier acquisition have been conducted. Among the East and Southeast Asian numeral classifier languages, Japanese, Chinese and Thai are the most comprehensively investigated. In general, researchers agree that numeral classifier acquisition takes place at a later stage in language development in comparison with noun and verb acquisition (e.g., Carpenter, 1991; Gandour *et al.*, 1984; Mak, 1991; Ng, 1989; Uchida & Imai, 1999; Yamamoto, 2005). For example, Uchida and Imai (1999) found that 5-year-old Mandarin Chinese children gave only 45% of correct responses in a counting task, and in correcting errors. Even by the age of 12, Chinese children's numeral classifier repertoire is still not equivalent to an adults' (Ng, 1989).

Among the different types of numeral classifiers, shape-based numeral classifiers are considered as one of the most difficult types for children to acquire (Gandour *et al.*, 1984). This is due to the fact that for some languages, the classification of objects into the various shape-based numeral classifiers involves a combination of dimensionality and rigidity, or dimensionality and size of the objects in question.

Cross-linguistic studies conducted on the comprehension of numeral classifiers showed different results. For example, in a study conducted on the comprehension of Mandarin and Cantonese shape-based numeral classifiers on 34 4- to 6-year-olds, the majority of the 4-year-olds were not able to comprehend the numeral classifiers tested (Fang, 1985). Only by 6 years old could Mandarin and Cantonese speakers comprehend the inherent features of the Chinese shape-based numeral classifiers.

In a comprehension task on 12 Mandarin numeral classifiers with 24 Mandarin speaking children from the Greater Boston area, Hu (1993) found that the order of comprehension of Mandarin numeral classifiers is as follows: *zhang*(2D)>*tiao*(1D)>*ke/li* (0D)> and *pian*(3D). Chien *et al.* (2003) conducted another study on Mandarin numeral classifier comprehension on 80 3- to 8-year-olds. They found that by 7 years old, children showed an adult-like comprehension of the numeral classifiers tested.

Studies on numeral classifier comprehension have also been conducted on Japanese children. For example, 157 3- to 6-year-old Japanese children interpreted the 1D -*hon* and 2D -*mai* substantially more correctly than 3D –*ko* (Yamamoto, 2005).

Cross-linguistic studies reviewed above showed that children begin to comprehend shape-based numeral classifiers at different ages, and the order of numeral classifiers they comprehend differ between languages. Among the factors identified as playing a role in comprehension order are semantic complexity (e.g., Matsumoto, 1987; Yamamoto, 2005) and exemplar typicality (e.g., Carpenter, 1991; Matsumoto, 1985).

Semantic complexity or cognitive complexity refers to the cumulative number of semantic features in a particular semantic category. From the cognitive perspective, the degree of complexity is usually determined by "the number of criteria to be applied in order to arrive at the correct form" (Hulstijn & de Graff, 1994, p.103). According to the semantic complexity theory, the cumulative number of semantic features in a particular semantic category plays a role in children's categorisation patterns (Clark, 1973; Matsumoto, 1987). It has been argued that children first learn to categorise objects requiring less semantic features and then proceed to categories involving more complex categorisation processes (Clark, 1973). This also suggests that multiple-dimension categorisation rules are harder to acquire than single-dimension categorisation rules (Maddox, 1992). Such a complexity also affects the acquisition order of shape-based numeral classifiers (Yamamoto, 2005). With regard to Chinese and Japanese numeral classifiers, it has been found that Japanese numeral classifiers are acquired earlier than Chinese numeral classifiers because Japanese numeral classifiers have less semantic features attached to the category than the Chinese numeral classifiers (Uchida & Imai, 1999). Similarly, Thai *khûuu*is acquired earlier than Thai *phŷyn* as the latter is said to be more semantically heavy than the former (Gandour *et al*. 1994).

According to prototype theory (Rosch & Mervis, 1975), a member with more attributes in common with other members of the category, and with more dissimilarities with members of contrasting categories, is graded as a more prototypical or typical member (the best exemplar) of a particular category. Conversely, any members on the borderline (i.e., those having less features in common with other members within the same category, especially with the most typical member) are graded as atypical members of a category (Matsumoto, 1985). Initially, children appear to learn categorisation rules through typical exemplars and then gradually proceed to learning the rules associated with more atypical members of the particular category (Markman, 1989; Mervis & Pani, 1980; Rosch & Mervis, 1975). Cross-linguistic studies on numeral classifier acquisition also reveal that the acquisition of a numeral classifier begins with the prototype of the category and later proceeds to the less prototypical exemplars (e.g., Carpenter, 1991; Matsumoto, 1985; Uchida & Imai, 1999). For example, in a series of error-detection experiments on 4 to 7 year-olds acquiring Japanese and Mandarin, it was found that prototypical referents are learned earlier than less familiar items (Uchida & Imai, 1999).

This paper focuses on the comprehension of eight Malay shape-based numeral classifiers through a matching comprehension task. The aim was to explore the developmental patterns observed in the comprehension of Malay shape-based numeral classifiers. Specifically, it aimed at examining if the complexity of the semantic features of individual numeral classifiers plays a role in numeral classifier comprehension order. This experiment also aimed at investigating if the degree of typicality of numeral classifier exemplars has an effect on the comprehension order. This paper is written based on the following predictions:

1. Based on semantic complexity theory it was predicted that children's comprehension order of Malay shape-based numeral classifiers would begin with the two-form 1D and 2D numeral classifiers and progress to the four-form 3D numeral classifiers (1D, 2D > 3D).
2. Based on the prototype theory, it was predicted that more typical exemplars of a particular Malay shape-based numeral classifier would be comprehended earlier and classified with fewer errors than more marginal or peripheral (atypical) exemplars of the same Malay shape-based numeral classifier (Very Typical > Very Atypical).

METHOD

The objects used in this experiment were pictures of very typical, typical,moderate, atypical, and very atypical exemplars of the Malay shape-based numeral classifiers, which were the same exemplars used in Salehuddin & Winskel (2009, 2011). A picture of an exemplar of all Malay shape-based numeral classifiers from the same typicality type (e.g., pictures of very typical exemplar of *batang,* very typical exemplar of *utas,* very typical exemplar of *keping, helai, buah, ketul, biji,* and *butir*) were all printed on the same piece of A4 paper and were later simultaneously shown to the children. Children were asked to match the numeral classifier names, which were read to them, to the correct pictures. This task was chosen as matching labels to particular referents is a common activity in class for children in this age group (c.f. Scrimshaw, 1988).

Participants

One hundred and forty children attending a preschool and a primary school participated in the study. The children were 6 to 9-year-old native speakers of Malay and spoke Malay as their first language. 20 adults also participated in the experiment as a comparison group. The adults lived in the vicinity of the school and were from a mixed educational background. All participants were from middle SES. A description of the participants is given in Table 1.

Typicality ratings

Prior to the experiment, a survey of the typicality ratings of numeral classifier exemplars was conducted. Thirty adults were asked to rate pictures of familiar, everyday objects from most typical to most atypical exemplars for each of the eight numeral classifier categories. An object rated as very typical was given a score of

'5', whereas a very atypical exemplar was given a score of '1'. The responses given by the adults were averaged and subsequently very typical through very atypical objects were selected based on these rating scores.

Stimuli

Pictures of numeral classifier exemplars ranked as very typical, typical, moderate, atypical, and very atypical exemplars in the survey were grouped in five different sets of pictures so that each set had exemplars of all the eight numeral classifiers from the same typicality ranking (e.g., the first set had pictures of very typical exemplar of all eight numeral classifiers, the second set had pictures of typical exemplar of all eight numeral classifiers, etc.). In this matching comprehension task, all eight 25mm X 25mm pictures of shape-based numeral classifier exemplars from the same set were arranged randomly in vertical order and presented simultaneously in one column to the participants on a single A4-size paper (Fig.1). All the test stimuli for this task are as described in Table 2.

Procedure

Children were asked to match each numeral classifier name in the middle column of each

TABLE 1
Description of participants

Age group	Age range	Mean age	No. of participants	No. of males	No. of females
6-year-olds	5;8 – 6;7	6.18	31	14	17
7-year-olds	6;8 – 7;6	7.13	36	13	23
8-year-olds	7;9 – 8;8	8.25	41	19	22
9-year-olds	8;11 – 9;8	9.28	32	10	22
Adults	17;3 – 77;8	48.07	20	7	13
Total			160	63	97

TABLE 2
Description of Test Stimuli

Page 1			Page 2			Page 3		
Left column (Very typical)	Middle column (Classifier name)	Right column (Typical)	Left column (Atypical)	Middle column (Classifier name)	Right column (Very atypical)	Left column (Medium)	Middle column (Classifier name)	Right column
Paper	*Batang*	Photograph	Road	*Batang*	Watch	Biscuit	*Batang*	(Blank)
Rambutan	*Keping*	Ball	Robot	*Keping*	Cup	Thread	*Keping*	(Blank)
Chain	*Utas*	Box	Cake	*Utas*	River	Chicken Drumstick	*Utas*	(Blank)
Pencil	*Helai*	Star	Chain Links	*Helai*	Gold Ingot	Broom	*Helai*	(Blank)
Rice	*Buah*	Tree	Chocolate	*Buah*	CD	Leaf	*Buah*	(Blank)
Stone	*Ketul*	Shirt	Pants	*Ketul*	Planet	Family	*Ketul*	(Blank)
Plank	*Biji*	Rope	Sugar	*Biji*	Seed	Orange	*Biji*	(Blank)
Bus	*Butir*	Meat	Plate	*Butir*	Handkerchief	Precious Stone	*Butir*	(Blank)

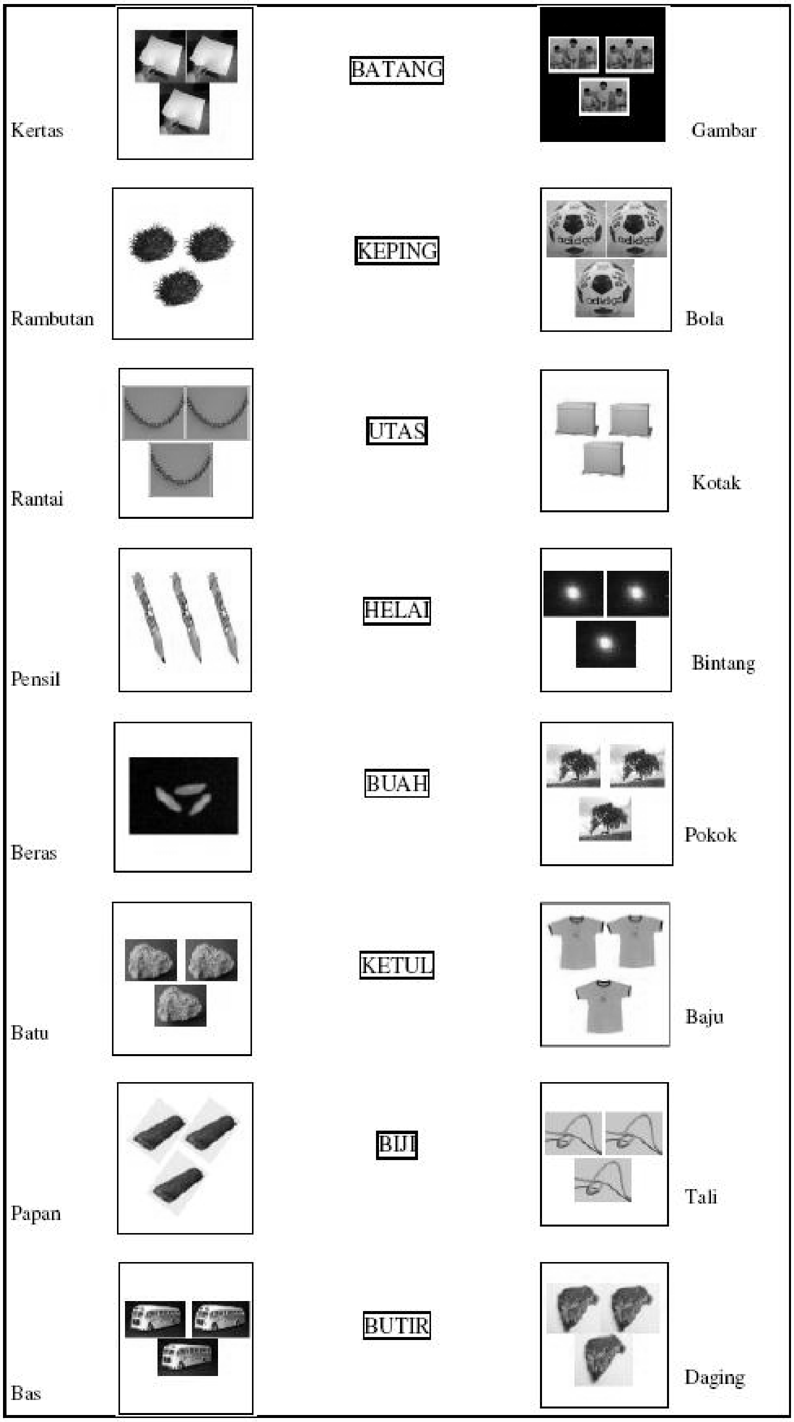

Fig.1: Matching comprehension task stimuli

page to the appropriate exemplars in both the left and right columns of the 3-page experimental test stimuli (e.g., Fig.1). They were each given a pencil to do the task.While matching the numeral classifier names to the pictures in the left column, pictures in the right column were covered with a blank sheet of paper so that the children could focus on one typicality type at a time. Each of the numeral classifier names was first read out aloud to the children before they matched the numeral classifier name to the picture of the exemplar.

Familiarisation Session

Prior to the experimental session, a slide display of all 44 pictures with an audio presentation of the names of the respective objects in the picture display were shown to the participants (Fig.2). Children were asked to repeat the names of the objects after the audio presentation of the respective objects before proceeding to the next slide. This was to ensure that the children were familiar with the items presented to them. Participants were encouraged to ask for clarification at this point.

Practice Trial

Eight pictures were used in the practice trial prior to the experimental session to familiarise the children with the experiment. The pictures included 2 exemplars of *orang* [animate: human], 2 exemplars of *ekor* [animate: animal], 2 exemplars of *bentuk* [specific: ring/hook], and 2 exemplars of *pasang*[pair] numeral classifiers. Children were asked to draw a line using a pencil from the numeral classifier name to the picture they selected to match the numeral classifier name to its respective exemplar.

The Experiment

The procedure was similar to the one described in the practice trial session, except that in the experimental session, each column had eight pictures – to accommodate all the eight shape-based numeral classifiers tested.Each session lasted for approximately 20 minutes for the younger children and 10 minutes for the older children and adults.

The children's correct responses were recorded. They were given 1 point for each correct match between the picture and the

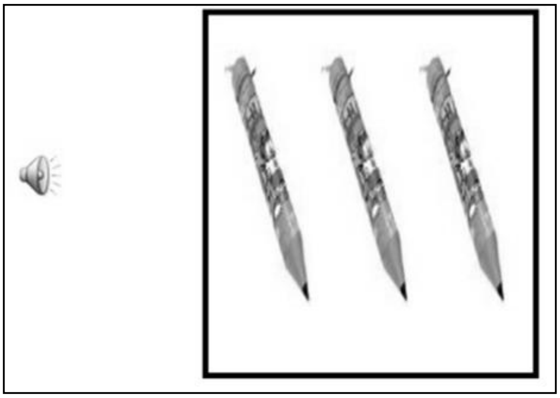

Fig.2: A slide from the picture-familiarisation session

numeral classifier name. Thus,children would get a maximum of 8 points for every typicality type if they matched all the numeral classifier names to the correct exemplars from one typicality type (e.g., very typical exemplars column). For each of the numeral classifiers tested, children got a maximum of 5 points per numeral classifier if they matched the tested numeral classifier name to all the exemplars (very typical, typical, moderate, atypical, and very atypical) correctly. The maximum score a child could get in this experiment was 40 points.

RESULTS

As expected, the percentage of correct responses increased with age; 6-year-olds, 22.1%; 7-year-olds, 37.9%; 8-year-olds, 61.3%; and 9-year-olds, 76.4% (see Fig.3). Despite showing the highest percentage of correct responses amongst the children, the responses given by the 9-year-olds were markedly different from the proportion of correct responses given by the adults (96.13%).

In order to compare the number of correct responses for the different numeral classifiers in the different age groups, an 8 (Numeral Classifier) X 5 (Typicality Type) X 4 (Age Group) X 2 (Gender) mixed repeated measures ANOVA, with numeral classifier and typicality type as within-subjects factors, and age group (6-year-olds, 7-year-olds, 8-year-olds, 9-year-olds) and gender as between-subjects factors was conducted. Mauchly's test indicated that the assumption of sphericity for numeral classifier, typicality, and Numeral Classifier X Typicality Type had been violated ($\chi^2(27) = 47.37$, $p < .01$; $\chi^2(9) = 26.01$, $p < .01$; $\chi^2(405) = 573.16$, $p < .001$ respectively). As a result, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .91$; $\varepsilon = .90$; $\varepsilon = .76$).

There was a significant main effect of numeral classifier, $F(6.36, 845.52) = 45.19$, $p < .001$, partial $\eta^2 = .254$; a significant effect

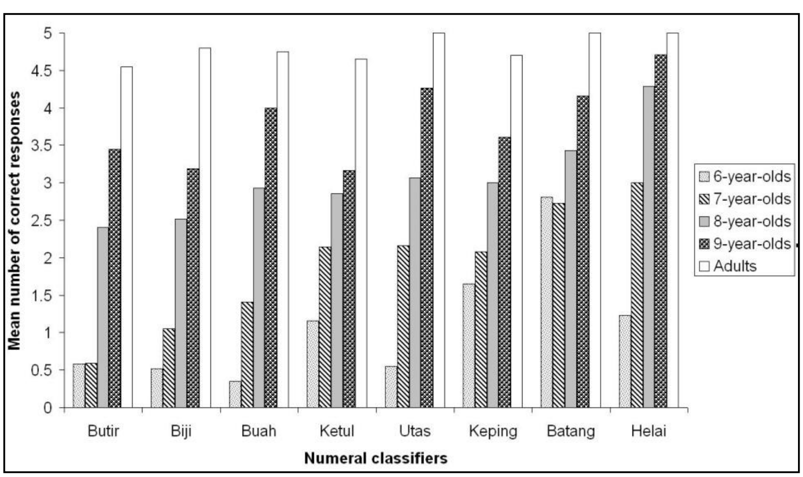

Fig.3: Mean number of correct responses by each age group for each numeral classifier

of typicality type, $F(3.61, 480.07) = 47.09$, $p < .001$, partial $\eta^2 = .261$; and a significant main effect of age group, $F(3, 133)=86.13$, $p < .001$, partial $\eta^2 = .660$. Gender, however, was not significant ($p = .75$). Tukey's post hoc analysis at $\alpha = .05$ revealed that correct responses of the different age groups were all significantly different from each other (i.e., correct responses by the 6-year-olds were significantly lower than the 7-year-olds which in turn were significantly lower than the 8-year-olds. Correct responses by the 8-year-olds were significantly lower than the 9-year-olds). The mean numbers of correct scores for the eight shape-based numeral classifiers across age groups are listed in Table 3. Pairwise comparisons based on estimated marginal means (LSD = .05) revealed correct responses between *helai* and *batang* were not significantly different from each other, *keping, utas,* and *ketul* were not significantly different, *ketul* and *buah* were not significantly different, and *biji* and *butir* were not significantly different from each other. On the basis of these results, the stage of Malay shape-based numeral classifier comprehension order is as illustrated in Table 3. In general the order of shape-based numeral classifier comprehension shows that the 3D numeral classifiers were comprehended after the comprehension of the 2D and 1D numeral classifiers (however, there is qualified support as *ketul* was not significantly different from *keping* and *utas*).

In addition, there was a significant interaction effect between numeral classifier and age group ($F(21, 931) = 6.64$, $p <.001$, partial $\eta^2 = .130$) (Fig.2). If we examine individual classifiers, there was a significant main effect of age group for *batang* [1D: +rigid] ($F(3, 137) = 14.01$, $p < .001$, partial $\eta^2 = .235$), for *utas* [1D: -rigid] ($F(3, 137) = 48.65$, $p < .001$, partial $\eta^2 = .516$), for *keping* [2D: +rigid] ($F(3, 137) = 21.48$, $p < .001$, partial $\eta^2 = .320$), for *helai* [2D: -rigid] ($F(3, 137) = 77.57$, $p < .001$, partial $\eta^2 = .629$), for *buah* [3D: +big] ($F(3, 137)$

TABLE 3
Stage of Malay Shape-based Numeral Classifier Acquisition Based on the Mean Number of Correct Matching Comprehension Responses across All Age Groups

Numeral classifier	Mean number of correct responses	*SD*
helai [2D: -rigid]	.66	.32
batang [1D: +rigid]	.65	.23
keping [2D: +rigid]	.51	.26
utas [1D: -rigid]	.51	.36
ketul [3D: medium]	.47	.28
ketul [3D: medium]	.47	.28
buah [3D: big]	.44	.35
biji [3D: small]	.37	.30
butir [3D: fine]	.36	.34

= 68.08, $p < .001$, partial $\eta^2 = .599$) for *ketul* [3D: medium] ($F(3, 137) = 18.26$, $p < .001$, partial $\eta^2 = .286$), for *biji* [3D: small] ($F(3, 137) = 42.53$, $p < .001$, partial $\eta^2 = .482$), and for *butir* [3D: fine] ($F(3, 137) = 48.40$, $p < .001$, partial $\eta^2 = .515$). Tukey's post hoc analysis at α=.05 revealed that the mean number of correct numeral classifier responses between the 6- and the 7-year-olds were significantly different for *utas* [1D: -rigid], *helai* [2D: -rigid], *buah* [3D: +big], and *ketul* [3D: medium], while the mean number of correct numeral classifier responses between the 8- and the 9-year-olds were significantly different for *utas* [1D: -rigid], *buah* [3D: big], and *butir* [3D: fine]. Tukey's post hoc analysis also shows that except for *batang* [1D: +rigid], *utas* [1D –rigid], and *ketul* [3D: medium], correct numeral classifier comprehension between the 7- and 8-year-olds were significantly different for all the other numeral classifiers.

Pairwise comparisons based on estimated marginal means (LSD = .01) indicated that in the overall results, correct responses for moderate, typical, and very typical exemplars were not significantly different from each other. Correct responses for moderate, typical, and very typical exemplars were significantly higher than atypical exemplars, which in turn were significantly higher than correct responses for very atypical exemplars. The overall pattern of exemplars was Moderate, Typical, Very Typical > Atypical > Very Atypical (Table 4).

TABLE 4
Mean Number of Correct Responses Based on Typicality Type

Typicality type	Mean number of correct responses	*SD*
Moderate	.59	.30
Typical	.56	.28
Very Typical	.56	.31
Atypical	.42	.25
Very Atypical	.34	.30

There was also a significant interaction between typicality type and age group ($F(12, 532) = 3.59$, $p < .001$, partial $\eta^2 = .075$). Pairwise comparisons (LSD = .01) for typicality type for each age group showed that correct responses for very typical exemplars were not significantly different from typical and moderate exemplars for the 7-, 8- and 9-year-olds; but for these age groups, correct responses for very typical, typical, and moderate exemplars were significantly higher than atypical and very atypical exemplars. Correct responses for atypical exemplars were significantly higher than very atypical exemplars in 6-, and 7-year-olds. Among the 8- and 9-year-olds, the difference between atypical and very atypical exemplars was not significant (Fig.4). In comparison, adults' correct responses for very typical and moderate exemplars were significantly higher than very atypical exemplars ($p<.05$).

There was also a significant interaction between typicality type and numeral classifier ($F(21.29, 2831.66) = 12.59$, $p < .001$, partial $\eta^2 = .086$). The interaction between typicality type, numeral classifier, and age group was also significant, $F(84, 3724) = 2.85$, $p < .001$, partial $\eta^2 = .060$.

The significantly higher correct responses for moderate exemplars in comparison to very atypical exemplars in the overall results were observed to be consistent in all numeral classifier (Fig.5). However, correct responses for very typical exemplars of *keping* (photograph), and very typical exemplars of *helai* (paper) were significantly different from the overall Numeral Classifier X Typicality Type results. This is because the mean number of correct responses for very typical exemplars of *keping* and *helai* were significantly lower than the correct responses for typical exemplars. The mean number of correct response for atypical exemplar of *helai* was significantly higher than very typical exemplar of *helai*.

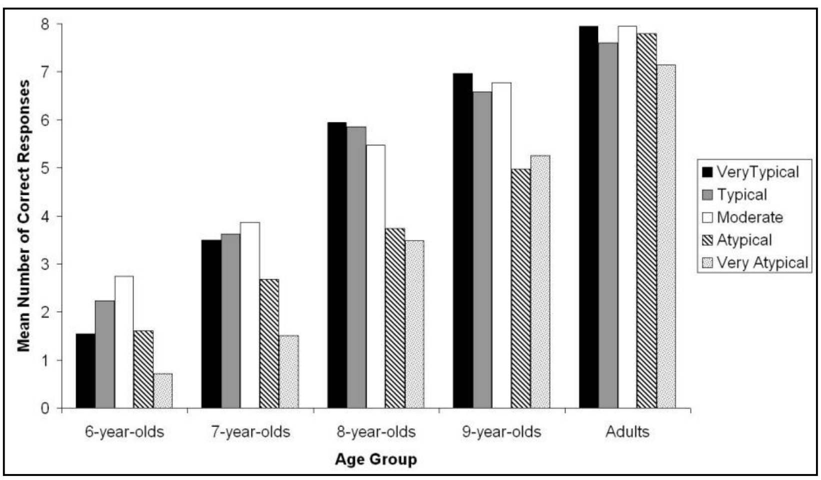

Fig.4: Mean number of correct responses by each age group based on typicality type.

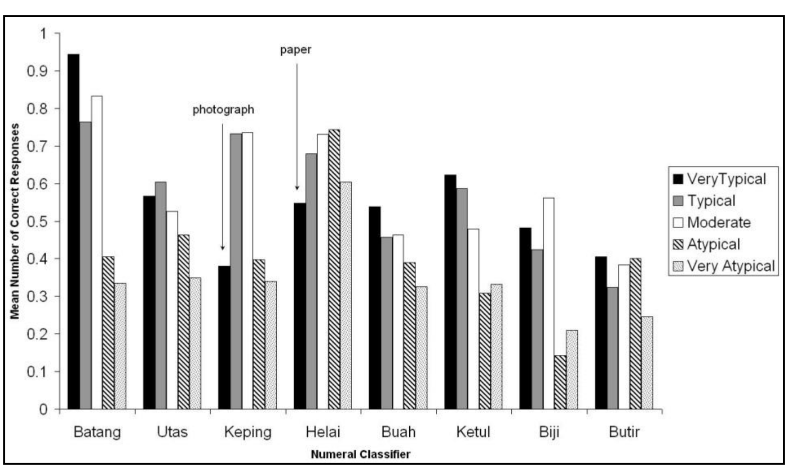

Fig.5: Mean number of correct responses for each numeral classifier based on typicality type.

DISCUSSION

Children's comprehension of Malay shape-based numeral classifiers appears to be a relatively delayed and prolonged process. Only one of the 6-year-olds comprehended all the numeral classifiers correctly; but not all the exemplars were correctly matched to the numeral classifiers. The 9-year-olds' percentage of correct responses (76%) was markedly different from the adults' (96%) and none of the 9-year-olds were able to match all the numeral classifier exemplars correctly. In contrast, numeral classifier comprehension studies conducted on other languages show a less delayed and less prolonged process. For example, Japanese children as young as 4 years old were already able to comprehend animate numeral classifiers, shape-based numeral classifiers, and numeral classifiers for machines (except aeroplanes) in a point-to-a-picture game (Yamamoto & Keil, 2000). By6 years old, Japanese children were able to comprehend numeral classifiers 60% correctly. Chinese children as young as 3 years old were able to comprehend both count- and mass-classifiers (Chien *et al*., 2003). The 7-year-old Chinese children were already showing adult-like comprehension with 81% correct responses. In sum the comprehension results indicate that Malay numeral classifier acquisition is relatively delayed in comparison with other Asian numeral classifier languages, and development of numeral classifiers continues throughout late childhood and adolescence.

Why are the Malay numeral classifiers comprehended at a relatively late stage in comparison to other languages despite Malay numeral classifiers being a syntactically important category in the Malay structure as it is to Chinese, Japanese, and Thai structure? One possible contributing factor could be the degree of obligatoriness of the numeral classifiers in these languages. In languages like Thai, Japanese, and Chinese, numeral classifier are more obligatory in usage. Unlike in Malay, numeral classifier usage in languages like Thai, Japanese, and Chinese does not only predominantly occur in counting processes. In Thai, for example, numeral classifiers are pervasively used in speech even if it is not for counting purposes, for example, *an niiriakwaamamuang* (CL-thing here call say mango, i.e., "This is called a mango.") (Carpenter, 1986, p. 21).

The lesser degree of obligatoriness of numeral classifiers may result in a frequently less usage of numeral classifiers in children's linguistic environment. Although input plays a minor role in acquisition to the cognitivists (Corder, 1967), input contributes, to a certain extent, to language development, especially when the input involves interaction (Ellis, 1984). Empirical studies show that language development is influenced by the frequency and usage of lexical terms in the children's linguistic environment (e.g., Goodman *et al*., 2008; Tare *et al*., 2008). Varied conversational input through a variety of linguistic and intentional contexts provides useful data for children to create early word-word mappings for non-object terms (Tare *et al*., 2008).

In later language development, both spoken and written forms of communication are significant sources of language stimulation as school children learn language both in informal settings (through indirect modelling and reinforcement) and formal instruction (Nippold, 1988). Thus, the numeral classifier comprehension pattern among children could depend on how much the children are exposed to usage of the numeral classifier in their environment.

Input frequency has been cited to be another important factor in the acquisition of Japanese numeral classifiers (Matsumoto, 1985; Yamamoto, 2005). Yamamoto (2005, p. 119), for example, found that higher frequency numeral classifiers in both speech and written texts such as *-tsu, -ko, -ri, -hiki,* and *-dai* "emerged maturationally" earlier than lower frequency numeral classifiers.

As numeral classifier acquisition takes place at a later stage in language development (e.g., Carpenter, 1991; Gandour *et al*., 1984; Mak, 1991; Ng, 1989; Yamamoto, 2005), input from various forms of discourse and not limited to only those concerning caretaker-child interactions is also more likely to play a role in the acquisition of Malay numeral classifiers in children. The Malay numeral classifiers usage is not pervasive in Malay caretaker-child interaction. In a total of 192-minute semi-structured elicitation procedure to stimulate caretaker-child interactions, only 44 numeral classifiers were observed, with *helai* as the frequently used numeral classifiers (12 times) (Salehuddin & Winskel, 2012).The lesser degree of obligatoriness of numeral classifier in Malay in comparison to other numeral classifier languages is probably a contributing factor to why the frequency of Malay numeral classifiers in interaction is low.

The relatively high frequency of *helai* (12) and *batang* (8) in the caretaker-child interactions in comparison to other numeral classifier could also explain why these two numeral classifiers are comprehended relatively earlier than other numeral classifiers. However, *biji* is comprehended at a much later stage even when its frequency in the caretaker-child interactions is the relatively high (11) (Salehuddin & Winskel, 2012).The relatively high frequency of *biji* now does not support our earlier proposition that high frequency may result in earlier comprehension. Clearly, input alone does not determine the acquisition of semantically complex item, like the Malay shape-based numeral classifiers.

We have so far explained why certain individual numeral classifiers are acquired earlier. We can clearly see that children comprehended 1D and 2D numeral classifiers earlier than they comprehended 3D numeral classifiers (Table 3). Malay 3D numeral classifiers (four forms) are semantically relatively more complex than the 1D and 2D numeral classifiers (two forms). According to semantic complexity theory, the cumulative number of semantic features in a particular semantic category plays a role in the development of children's categorisation ability (Matsumoto, 1987). Lexical categories which involve using less semantic features to categorise objects are acquired earlier than those which involve more semantic features. Our prediction that Malay numeral classifier acquisition order would follow the order that the two-form 1D and 2D numeral classifiers would be comprehended earlier than those with more complex features, (the four-form 3D numeral classifiers)is supported. When matching 1D or 2D exemplars, categorisation is based on whether objects are 'rigid' or 'flexible', whereas matching 3D objects is more complex as it involves deciding whether objects are 'big', 'medium', 'small', or 'fine'.

However, as shown in Fig.5, not all 1D and 2D exemplars are matched correctly more than 3D exemplars. In the current study, children matched objects more accurately when the exemplars were typical exemplars of the particular numeral classifier category. This concurs with previous research on numeral classifier acquisition (e.g., Carpenter, 1991; Matsumoto, 1985; Uchida & Imai, 1996, 1999) and previous categorisation studies (Gelman & Coley, 1990; Hampton, 1998).

According to Mervis and Rosch (1981), children tend to initially restrict category labels to only typical members. This results in "immature" categorisation, where atypical exemplars that do not share properties relative to adult category prototypes get excluded from the category whereas out-of-category instances that do share these properties are inappropriately included (Rogers & McClelland, 2004).

Objects that are least frequently encountered by children are poorly recognised (Lederman *et al.*, 1990, p. 58), and are categorised less accurately by younger children (Matsumoto, 1985; Uchida & Imai, 1999). Since the "redundancy structure of the category as a whole" (Rosch & Mervis, 1975, p. 602) is often not reflected in atypical members, atypical exemplars are more likely to be matched with greater difficulty by children than typical members. For example, younger children tended to match atypical exemplar of *buah* [3D: big] (planet) with the numeral classifier *biji* [3D: small]. This could be due to children basing their decision predominantly on perceptual features. A planet, although spherical and big, can be perceived as more like a small, spherical object, like a ball, when presented on paper. Children tend to match a planet with the numeral classifier *biji* probably due to the similarity between a planet and a ball (a typical example of *biji*) when the former is presented on paper. Children between 6 and 9 years old might also not have a true grasp of what planets are and how big they can be.Although in the familiarisation session children indicated that they knew what planets are, their limited knowledge with regard to the physical properties of planets may affect their judgement when the picture of a planet is presented on paper.

CONCLUSION

The categorisation of some objects into a particular numeral classifier category is not always clear-cut as there is a degree of flexibility or choice in how some objects are classified. Items can be paired with different numeral classifiers depending on their shape, appearance, or presentation, as categorisation is dependent on how the item is perceived by the speaker. Hence, it can be seen that there can be quite a high degree of variation between how some items are sorted into different categories by speakers. In sum, the developmental pattern in the Malay shape-based numeral classifier comprehension is not influenced by a single factor. Multiple factors namely semantic complexity, exemplar typicality, and numeral classifier frequency, all interact with each other and contribute to the developmental pattern observed in this study.

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