Children's understanding of the agent-patient relations in the transitive construction: Cross-linguistic comparisons between Cantonese, German, and English

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Abstract

Cantonese-, German-, and English-speaking children aged 2;6, 3,6, and 4,6 acted out transitive sentences containing novel verbs in three conditions: (1) agent and patient were cued redundantly by both word order and animacy; (2) agent and patient were marked only with word order; and (3) agent and patient were cued in conflicting ways with word order and animacy. All three age groups in all three languages comprehended the redundantly cued sentences. When word order was the only cue, English children showed the earliest comprehension at 2;6, then German, and then Cantonese children at 3;6. When the cues conflicted, none of the 2;6 children in any language comprehended in adult-like ways, whereas all of the children at 3;6 and 4;6 preferred word order over animacy (but with some cross-linguistic differences in performance as well). When animacy contrast changed across sentence types, Cantonese children comprehended the sentences differently at all three age levels, German children did so at the two younger ages, and English children only at the youngest age. The findings correspond well with the informativeness of word order in the three languages, suggesting that children's learning of the syntactic marking of agent-patient relations is strongly influenced by nature of the language they hear around them.

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1. Introduction

A central task in language acquisition is discovering how different participant roles in an event are indicated, the who-does-what-to-whom of the event. Languages indicate agent-patient relations in different ways, the major devices being word order (see Dryer 2005) and inflectional morphology which includes case marking (see Comrie 2005) and various forms of verb agreement (Siewierska 2005). How children weigh different cues to agent-patient relations has been studied most systematically in the context of the competition model (Bates and MacWhinney 1987; MacWhinney and Bates 1989). Cross-linguistic competition model experiments have indicated that children use cues differently when they acquire different languages (see MacWhinney and Bates 1989 for a review). In different languages learners can rely on such cues as the order of the participants (typically agent before patient in transitive sentences), morphological marking (e.g., case marking on the nouns indicating the participants), animacy (typically agents are animate), stress contrasts, and special markers like the passive agent-marker '*by*' in English.

In the current study, we investigated children's comprehension of the agent-patient relations in transitive sentences in three typologically distinct languages: Cantonese Chinese, German, and English. In particular, we focused on the word order cue and the animacy contrast cue that are available in all the three languages. We first characterized the two cues based on the typological properties of each language. Then, we looked at the availability and reliability (and hence validity) of the two cues in the child-directed speech (CDS) across the three languages. Following this, we made predictions for our cross-linguistic experiment based on ideas from the competition model and the CDS results. Lastly, we presented our cross-linguistic experimental findings.

1.1. *Word order*

Cantonese, German and English are similar in having the Subject-Verb-Object (SVO) order as the dominant order in active transitive main clauses lacking an auxiliary verb in pragmatically neutral situations (Dryer 2005: chapter 81). But in terms of how informative word order is as a cue to mark the agent-patient relations, the three languages differ along dimensions like cue availability, reliability, and hence validity.

English relies heavily on word order to express the basic semantic relations. Non-canonical word orders such as OSV and VOS are possible, but

even in these non-canonical orders, the subject still occurs in the preverbal position in O**S**V and the object in the postverbal position in V**O**S, as in the canonical SVO. There are some minor sentence types in English in which the subject does not occur in preverbal position: (1) locative inversion (e.g., Across the bridge lived an old man who ...), and negative inversion (e.g., Never in a million years would she do that), but they are rarely used in child-directed speech. Therefore, it is reasonable to predict that in general word order is a highly valid cue to mark the agent-patient relations in English, especially in child-directed speech.

German, on the other hand, has more word order patterns which deviate from the SVO order used in the main transitive clauses without an auxiliary. A crucial word order feature in German is that in subordinate clauses and clauses containing an auxiliary verb, the SOV order is used instead (cf. the *Satzklammer*). German also allows more word order variations for pragmatic functions. As a consequence, other non-canonical orders such as OVS, OSV, VOS and VSO are permitted in the language. One would therefore expect that word order as a cue to mark the agent-patient relations is not as reliable as in English, because the subject/agent or the object/patient is less strictly tied to a position.

Cantonese also permits a great deal of word order variations, mainly for pragmatic functions. Apart from the canonical SVO order (Matthews and Yip 1994), it also permits OVS, OSV, SOV and VOS orders, and so as in German, one would expect that the word order cue is not highly reliable in this language. In addition, Cantonese allows a high degree of argument noun ellipsis in natural discourse, and so the word order cue is not even always available.

1.2. *Animacy*

Unlike case marking or word order, animacy is not a device speakers can have control over to signal different semantic and pragmatic functions. Animacy by nature is an inherent semantic property of an entity. But since prototypically agents tend to be animate and patients tend to be inanimate (Comrie 1989; Dowty 1991; Hopper and Thompson 1980; Langacker 1991), when there is an animacy contrast between two entities in a transitive sentence it is prototypical that the animate one is the agent and the inanimate one is the patient. Since animacy contrasts correlate with the natural semantic contrast between the agent and the patient in prototypical transitive events, it is reasonable to predict that this cue is highly reliable across languages though certainly not always as sentences like *the ball hits John* demonstrate. Also, animacy is not always available, for example, in sentences like *the dog chases the cat*, animacy is simply not an available cue (MacWhinney 2005: 88).

1.3. *Other cues to agent-patient relations*

There are of course other cues in addition to word order and animacy contrast to help listeners identify the agent-patient relations in these three languages. For instance, one can make use of the English case-marked pronouns such as *I* (the subject pronoun) versus *me* (the object pronoun) to identify such a relation, although case-marking in English is minimal, restricted only to pronouns. In addition, subject-verb agreement is another cue to the agent-patient relations, because the verb has to agree in person and in number with the subject (but not the object) in English. And, in English full passives, the noun after *'by'* is always the agent, so '*by'* can be conceived as an agent-marker.

German, on the other hand, is a case-marking language. Especially in cases when word order deviates from the canonical ordering and the animacy contrast is not present, case marking can often clearly disambiguate the agent-patient relations. The exceptions are when both argument nouns are proper names (e.g., John and Mary), or when both are feminine or neuter in gender where their case-marked determiners (the feminine *die* and the neuter *das*) do not differ in form in the subject nominative and the object accusative positions. As in English, there is an agent-marker *von* in German full passives, and subject-verb agreement can be a potential cue to indicate the agent-patient relations.

Cantonese, in contrast, is characterized by a lack of verb conjugations, no case-marking, and no noun declension paradigms commonly attested in the Indo-European languages. Therefore, there are no morphological cues like subject-verb agreement and case markers available in the language as cues to the agent-patient relations. As in English and German, there are special markers such as the object-marker *zeong1* and the passive agent-marker *bei2*. For the sake of a more comprehensive characterization, Table 1 presents an overview of the cues to agent role identification in the three languages. In this study, we focused in particular on word order and animacy contrast.

1.4. *Child-directed speech (CDS) analyses*

Next, we calculated the availability, the reliability and the validity of the word order and the animacy contrast cues in each language input, based on the computational principles in the competition model literature. The availability of a cue was computed as the number of sentences in which a cue is present, divided by the total number of transitive sentences. Since the novel verbs used in our experiment were highly actional (see Table 4), the current CDS analyses were limited to utterances containing *actional* transitive verbs. As such, any utterance containing an *actional*

Table 1. *Cues to agent role identification in Cantonese, German and English*

	Cantonese	German	English
Word order (WO)	+ but weak (due to noun ellipsis and variable WO)	+	+ dominant cue
	Canonical SVO	Canonical SVO (in main clauses without an auxiliary)	Canonical SVO
	Variable WO for pragmatic functions	Variable WO for pragmatic functions and grammatical reasons	Relatively fixed WO, though other WOs possible e.g., OSV, VOS
Animacy contrast	+	+	+
Case marking	−	+ dominant cue	+ but minimal
Agreement	−	+	+
Special markers	Passive marker *bei2*	Passive marker *von*	Passive marker *by*

transitive verb would be counted as a transitive sentence. The reliability of a cue was computed as the number of sentences in which a cue correctly indicates the agent (or correctly indicates the patient in the case of the animacy contrast cue, see below), divided by the number of sentences in which the cue is present. The validity of a cue was computed by multiplying its respective cue availability and reliability. The following results were based on around 200 mother-to-child utterances containing actional transitive verbs from 6 children at age 2;5 for each language from the Manchester corpus for British English, the Szagun corpus for German, and the CANCORP corpus for Cantonese.[1]

1.4.1. *The word order cue* In English, the word order cue to agent identification is the preverbal position (Bates et al. 1982: 254). Competition model experiments typically showed that while native English adult

1. A larger sample size of the utterances yields a similar pattern of results (in Cantonese CDS by doubling the number of utterances; in German CDS, see Dittmar et al. 2008; in English CDS, see Scott and Fisher 2006). A cross-linguistic comparison of child-directed speech at ages 3;6 and 4;6 was not possible at the moment based on the available corpora, mainly because the Cantonese corpus CANCORP has only a few files going as old as age 3;6 and the other Cantonese corpus (HKU 70) contains only experimenter-to-child utterances (but not mother-to-child utterances) elicited in a controlled lab setting.

speakers chose nearly 100 *percent* of the time the first noun as the agent in the NVN frame, they would choose way *below* chance the first noun as the agent in NNV and VNN frames, reflecting their knowledge of the canonical SVO order and the non-canonical OSV and VOS orders that occur in the language.

In the case of Chinese, Li and his colleagues (1993: 173) pointed out that, in contrast to English, it is the postverbal cue to the identification of the object that is stronger in Chinese (likely because of massive subject ellipsis). Agent identification is therefore often *indirect* in Chinese. This is because since the subject is often omitted, the occurrence of the object can be interpreted as an indirect cue for the omitted agent. However, Li and his colleagues (1993) also noted that since OV order is possible due to object topicalization, the object does not have to follow immediately the verb. Thus, they concluded that "there seems to be no single positional cue that is strongly identified with the subject role in Chinese" (Li et al. 1993: 173).

As for German, the word order cue to agent identification also works differently from English. Kempe and MacWhinney (1998: 553) defined the word order cue in German as referring to "the particular configuration of the two nouns in a simple transitive sentence, regardless of the position of the verb". This is likely the more appropriate way to characterize the word order cue to agent identification in German based on the unique word order properties of the language. Bates and MacWhinney (1982) found that when animacy and agreement contrasts were neutralized, German native adult speakers chose above chance the first noun as the agent across all NVN, NNV and VNN frames, reflecting their knowledge of the SVO, SOV and VSO orders common in the language.

In view of the cross-linguistic differences, we therefore computed the word order cue based on the following two criteria across all the three languages: (a) the pre-verbal slot (following Bates et al. 1982: 254, appropriate for English); and (b) the relative ordering of the subject and the object regardless of the verb position (following Kempe and MacWhinney 1998: 553, appropriate for German).

In (a), the word order cue would be counted as present in a sentence when there is a noun argument (either the subject or the object) occupying the pre-verbal slot of the transitive verb. In the case of fragment sentences VO, VS and V, the word order cue would be counted as not present. Regarding cue reliability, the word order cue would be counted as reliable in a sentence when the noun argument occupying the pre-verbal slot is the subject (agent). Conversely, the word order cue would be counted as unreliable in a sentence when the noun argument occupying the pre-verbal slot is the object (patient).

Table 2a. *The word order cue in Cantonese, German and English child-directed speech (based on the pre-verbal slot)*

	Cantonese	German	English
Cue availability	47%	83%	87%
Cue reliability	95%	39%	96%
Cue validity	44%	33%	83%

Table 2b. *The word order cue in Cantonese, German and English child-directed speech (based on the relative ordering of the subject and the object regardless of the verb position)*

	Cantonese	German	English
Cue availability	33%	87%	85%
Cue reliability	92%	82%	95%
Cue validity	30%	72%	80%

In a similar fashion, in (b), the word order cue would be counted as present in a sentence when both the subject and the object are expressed. In the case of fragment sentences with only either the subject or the object expressed, or with both the subject and the object unexpressed, the word order cue would be counted as not present. Regarding cue reliability, the word order cue would be counted as reliable in a sentence when the first noun is the subject (agent). Conversely, the word order cue would be counted as unreliable in a sentence when the first noun is the object (patient). Cue validity was obtained by multiplying its respective availability and reliability. Tables 2a and 2b show the relevant figures across the three languages.

Results showed that the word order cue validity is consistently high across the two computation criteria in English (83% and 80%). The word order cue validity in Cantonese, in contrast, is consistently low across the two computation criteria (44% and 30%). This is due mainly to its low cue availability because of massive ellipsis of the subject or/and the object. When the word order cue is available, the current CDS results indicated that it is highly reliable (95% and 92%), that is, although adult Cantonese in principle allows word order variations, non-canonical word orders are actually infrequently attested in early Cantonese child directed speech. This finding is consistent with the adult input findings for the Cantonese dative constructions with the verb *bei2* 'give' reported in Chan (2003): frequent noun argument ellipsis but infrequent non-canonical word orders in early Cantonese child directed speech. The word order

cue validity in German appears to stand in the middle among the three languages: computation based on the relative ordering of the subject and the object regardless of the verb position would yield a relatively high word order cue validity (72%), which is slightly lower than that of English. On the other hand, cue reliability and thus cue validity would drop to as low as 39% and 33% respectively when the computation was based on the preverbal position, mainly because of frequent SOV orders in German.

The current CDS results thus captured the typological characteristics of the three languages: relatively fixed SVO order in English; SVO and SOV orders in German; and massive noun ellipsis in Cantonese discourse. Based on the current findings, it can be reasonably concluded that the word order cue validity is highest in English CDS, then German, and then Cantonese.

1.4.2. *The animacy contrast cue* In computing the availability, the reliability, and the validity of the animacy contrast cue, we followed the principles described in Kempe and MacWhinney (1998: 552). The animacy contrast cue would be counted as present in a sentence where there is a contrast in the animacy status of the two nouns. This included cases when one noun is animate and the other noun is inanimate; or one noun is animate or inanimate and the animacy status of the other one cannot be determined (either because the noun is unexpressed and therefore information regarding its animacy is not lexically coded, or because it is an ambiguous pronoun or demonstrative like *it, they, them*, *this(one)* and *that(one)* in English, *keoi5* and *keoi5dei6* in Cantonese, and *es* and *sie* in German which can refer to both an animate or an inanimate entity). The animacy contrast cue would be counted as not present in a sentence when both nouns are animate, or both are inanimate, or both cannot be determined (because of the above reasons).

Regarding cue reliability, the animacy contrast cue would be counted as reliable in a sentence when the animate noun is the agent or/and the inanimate noun is the patient. Conversely, the animacy contrast cue would be counted as unreliable in a sentence when the inanimate noun is the agent or/and the animate noun is the patient. Cue validity was obtained by multiplying its respective availability and reliability. Table 3 shows the relevant figures across the three languages.

Results showed that the animacy contrast cue is highly reliable across the three language inputs (above 90% in all cases), reflecting the tendency that prototypically agents tend to be animate and patients tend to be inanimate (Dowty 1991; Hopper and Thompson 1980). The animacy contrast cue availability is lower in Cantonese due to the combination of

Table 3. *The animacy contrast cue in Cantonese, German and English child-directed speech*

	Cantonese	German	English
Cue availability	65%	88%	84%
Cue reliability	94%	97%	98%
Cue validity	61%	86%	83%

massive ellipsis and ambiguous pronouns in the language, leading to a relatively lower cue validity.

1.5. *Previous studies*

We now turn to the relevant literature. Studies with adults have found that English speakers rely more on the word order cue than on animacy in interpreting transitive sentences, while Mandarin Chinese and German adults rely more on animacy than on word order. That is, when hearing a sentence like *the pencil is kicking the elephant*, English speakers choose the inanimate pencil as the agent much more often than the elephant (Bates et al. 1982; MacWhinney et al. 1984); Mandarin Chinese and German speakers show the opposite strategy, choosing the animate elephant as the agent much more often than the pencil (Li et al. 1993; MacWhinney et al. 1984; McDonald 1984; Miao 1981). There is no directly relevant research with Cantonese adults. But since Mandarin and Cantonese share grammatical features such as the presence of noun ellipsis and variable word order for pragmatic functions, the idea that word order is not as informative as animacy contrast in serving as a cue to agent-patient relation applies both to Mandarin and Cantonese. It is therefore reasonable to consider that the Mandarin adult results in the literature can be generalized to Cantonese adults.

As for child performance, Bates and her colleagues (1984) found that English-speaking children relied primarily on word order over animacy from as young as three years old. German-speaking children, in contrast, seem to begin by relying on animacy cues (Lindner 2003). Regarding child Cantonese, Wong and her colleagues (2004) described the influence of both word order and animacy as cues to Wh-question processing in Cantonese-speaking children. But as far as the relative reliance on word order and animacy cues for processing transitive sentences are concerned, there are no studies of Cantonese children. However, Miao (1986) tested older Mandarin children at 4-, 5-, 7-, 10- and 13-year-olds as well as adults, and found that when animacy and word order conflicted Mandarin-speaking children at 4-, 5-, 7-years of age relied more on word order; 10-year-olds preferred neither of the two cues, and 13-year-olds and adults

preferred animacy over word order. Across all studies involving English-, German- and Mandarin Chinese-speaking children, children displayed a strong and consistent preference in choosing the first animate noun as the agent when animacy and word order cues indicated redundantly the first noun as the agent.

A potential problem in comparing across languages is that all of these studies used highly familiar actional verbs such as *push*, *eat*, *bite* and *grab*. It is possible that the children in these previous studies determined the agent-patient relations based only on their verb-specific knowledge, e.g., the *push-er* typically occurs before the word *push* and the *push-ee* often occurs after the word *push*; and the *pusher* is always animate. We cannot tell from these results how productive children's understanding of the cues is at a more abstract verb-general level (see Tomasello 2003). In the current experiment, therefore, we looked at children's productive understanding of word order and animacy as cues to the agent-patient relations in the transitive construction using novel verbs. That is, children of three different ages learned the novel verbs before they came to the test trials without any word order marking of the agent and the patient roles, and with no animacy bias. The question then was whether the children could use their understanding of word order and animacy as cues to the agent-patient relations to interpret novel sentences containing the newly learned novel verbs.

Based on ideas from Bates and MacWhinney (1989), we made the overall cross-linguistic prediction that children should acquire a cue (conceived as a form-function mapping) earlier in a language where the mapping is stronger (i.e., higher in cue validity). Since the word order cue validity is highest in English CDS, then German, and then Cantonese, our prediction would be that children acquiring English would show the earliest general understanding of word order as a cue to the agent-patient relations among the three language groups, followed by children acquiring German, and then children acquiring Cantonese.

How the cues interact is also relevant in acquisition. Since cues are often in coalition in natural language, following Bates and MacWhinney (1987)'s idea of coalitions-as-prototypes, we predicted that children would find especially easy prototypical transitive sentences such as *the horse tams the telephone* in which both animacy and word order coalesce to cue redundantly the first mentioned animate *horse* as the agent. Moreover, these prototypical transitive sentences also reflect inherent causal asymmetries between the animate *horse* and the inanimate *telephone* along the force-dynamic causal chain of Croft (1991, 1998), Langacker (1987) and Talmy (1976), which are consistent with the natural transmission of force from the antecedent (the agent) to the other (the patient) in

the causal chain (see also Langacker 1990 on his energy flow hierarchy). On the other hand, following results from Matessa and Anderson (2000), McDonald (1986), and more recently from Dittmar and her colleagues (2008), we predicted that children would find especially difficult non-prototypical sentences such as *the present tams the chicken* which contain conflicting cues. Moreover, such an alignment of the two nouns (inanimate before animate) is also counter-iconic to the prototypical force-dynamics of the causal chain.

2. Method

2.1. *Participants*

Two hundred and eighteen children took part in this experiment. They consisted of 73 children in the 2;6 age group (Cantonese: mean age (M) = 2;6.17, $N = 24$; German: $M = 2;5.28$, $N = 24$; English: $M = 2;6.10$, $N = 25$); 72 children in the 3;6 age group (Cantonese: $M = 3;5.21$, $N = 24$; German: $M = 3;6.8$, $N = 24$; English: $M = 3;6.13$, $N = 24$); and 73 children in the 4;6 age group (Cantonese: $M = 4;6.10$, $N = 24$; German: $M = 4;6.14$, $N = 24$; English: $M = 4;5.26$, $N = 25$). There were approximately equal numbers of boys and girls at each age.

All children were born full-term and healthy, and were monolingual. Children were tested in their kindergartens in Hong Kong, China, Manchester, England and Leipzig, Germany.

An additional 21 children were tested but excluded because of the following reasons: child could not sit through the task ($N = 10$), experimenter error ($N = 9$), child later found to be bilingual ($N = 2$).

2.2. *Design*

This experiment was a $3 \times 3 \times 3$ mixed design. Between subject factors were (i) language group (Cantonese, German and English) and (ii) age level (2;6, 3;6 and 4;6). Within-subject factor was sentence type (Animate noun—Verb—Inanimate noun (AVI), Animate noun—Verb—Animate noun (AVA), and Inanimate noun—Verb—Animate noun (IVA)). That is, each child acted out [Noun-Verb-Noun] sentences involving novel causative verbs in three conditions: (i) prototypical AVI: *e.g., the horse tams the telephone*, where both animacy contrasts and word order coalesced to cue the first noun *the horse* as the agent; (ii) AVA: *e.g., the cow tams the giraffe*, where the animacy contrast was neutralized and word order favored the first noun *the cow* as the agent; and (iii) IVA: *e.g., the present tams the chicken*, where animacy and word order cues

conflicted—the animacy contrast favored the animate noun *the chicken* as the agent, while word order favored the first noun *the present* as the agent.

2.3. *Stimulus materials*

For noun stimuli, 11 animate objects and 8 inanimate objects were used to enact the actions (see Table 4). To ensure the vocabularies are age appropriate for two-year-olds across the three languages, these objects were chosen upon consulting (i) the Oxford Communicative Development Inventory (CDI) Database (Hamilton, Plunkett and Schafer 2000) for British English young children; (ii) the *Fragebogen zur fruehkindlichen Sprachentwicklung* (FRAKIS) (Szagun 2004)—a German adapted version of the MacArthur CDI (Fenson et al. 1993)—for German young children; and (iii) local kindergarten teachers in Hong Kong for Cantonese young children. In addition, we also administered an object identification task before the main act out task. All the children included in the current data analyses could identify all the objects used. Note also that case marking was neutralized in the present German stimuli. The German nouns listed in Table 4 were all either feminine or neuter in gender, where their case marked determiners (the feminine *die* and the neuter *das*) do not differ in form when the nouns occur in the subject nominative and the object accusative positions.

For verb stimuli, there were two novel verbs, chosen to meet the following criteria: monosyllabic as well as conforming to the phonotactic constraints of the respective language in form, easy to act out, and involving direct causation with change of location or motion in the patient. The actions corresponding to these two verbs together with the accompanying apparatuses, as well as some sample sentence stimuli are also listed in Table 4.

Each of the 3 sentence types (AVI, AVA, IVA) was combined with each of the 2 novel verbs to produce 6 different sentence stimuli. The 3 sentence types with a novel verb were presented in blocks because constant shifting of the apparatus would be extremely difficult for young children. The ordering of the three sentence types (AVI, AVA, IVA sentences) within a verb block was randomized. In order to have more test trials, we doubled the number of test trials by having 2 testing sessions, so each child received in total 12 sentence stimuli (6 in each session), with 4 trials (2 from each novel verb) for each sentence type. Across these 4 trials within a sentence type, the resting position of the agent was left or right an equal number of times, so any side bias would result in chance level performance. Across the 6 trials in a session, there was never a predictable sequence (e.g., Left—Right—Left—Right—Left—Right) of the

Table 4. *Object names, verbs and sample sentences*

Cantonese[2]	German	English
ANIMATE OBJECTS		
maa5zai2 馬仔	Pferd	Horse
ngau4zai2 牛仔	Kuh	Cow
coeng4geng2luk2 長頸鹿	Giraffe	Giraffe
gai1zai2 雞仔	Huhn	Chicken
ngaap3zai2 鴨仔	Ente	Duck
lou5syu2 老鼠	Maus	Mouse
zyu1zai2 豬仔	Schwein	Pig
joeng4zai2 羊仔	Schaf	Sheep
maau1zai2 貓仔	Katze	Cat
wu1gwai1 烏龜	Schildkroete	Turtle
mat6fung1 蜜蜂	Biene	Bee
VERBS		
tam1	tammen	tam
Resting position: Both objects stand on the protruded part of a spherical toy which can move up and down. Causative Action: Agent pushes patient down. Upright patient moves up and down.		
wung2	wiefen	meek
Resting position: Both objects stand on the circular platform of a rocking apparatus. Causative Action: Agent rocks patient back and forth.		
INANIMATE OBJECTS		
din6waa2 電話	Telephon	Telephone
lai5mat6 禮物	Geschenk	Present
nguk1zai2 屋仔	Haus	House
tou4waa2 圖畫	Bild	Picture
caa4bui1 茶杯	Tasse	Cup
syu1zai2 書仔	Buch	Book
zam2tau4 枕頭	Kissen	Pillow
laai5zeon1 奶樽	Flasche	Bottle
SAMPLE SENTENCES		
AVI:		
Maa5zai2 tam1 din6waa2	Das Pferd tammt das	The horse tams the
馬仔 tam1 電話	Telephon	telephone

2. The Cantonese stimuli are transcribed according to the JyutPing romanization system developed by the Linguistic Society of Hong Kong (see LSHK 2002). Tones are marked numerically (1: high level, 2: high rising, 3: mid level, 4: low falling, 5: low rising and 6: low level).

Table 4. *(continued)*

Cantonese[2]	German	English
AVA: Ngau4zai2 wung2 coeng4geng2luk2 牛仔 wung2 長頸鹿	Die Kuhn wieft die Giraffe	The cow meeks the giraffe
IVA: Lai5mat6 tam1 gai1zai2 禮物 tam1 雞仔	Das Geschenk tammt das Huhn	The present tams the chicken

agent resting position. The order of the two verb blocks was counterbalanced across the two sessions within a child as well as across children. For each child, each inanimate object was used only once, and each animate object functioned as the agent once and as the patient once (within a different pair in a different session). Which member of the pair was the agent of the action was also counterbalanced across children. Objects were paired up with the following considerations: (i) no significant asymmetry in power, size and color-brightness; (ii) no obvious semantic relation between the items in real world situation (e.g., cow was not paired up with milk bottle); and (iii) always yielding the feminine *die-die* or the neuter *das-das* combination in German. Appendix 1 shows an example of all the 12 sentence stimuli for a child across the two test sessions.

2.4. *Test procedures*

For most children, the two sessions were administered on the same day. Some children, especially the youngest two-and-a-half year olds, had the two sessions on two separate days with no more than one week apart.

The act out task consisted of three phases: (1) the demonstration phase in which the novel action was introduced with the accompanying description "*Look! This is VERB-ing!*"; (2) the training phase in which the child learned the verb-action mapping, with the accompanying description *"Yes, this is VERB-ing!"*; and (3) the test phase in which the child was tested for her interpretation of [Noun-Verb-Noun] sentences. In the demonstration and training phases, the novel verbs were presented without any word order marking of the agent and the patient roles of the causative events. In the test phase, the verbs were then used in a transitive SVO sentence frame. This would be the first time the child heard the novel verbs used in a transitive frame (see also Akhtar and Tomasello 1997: Study 3 for similar procedures).

For the Demonstration Phase, the experimenter (E) took out an apparatus and said *"Look! We are going to play a game. I'll show you first and then it's your turn. Watch carefully; you have to do it exactly like me"*. E positioned the apparatus in front of the child and demonstrated the action twice using the demonstration pair (dog and lion) with the accompanying description *"Look! This is VERB-ing!"*.

For the Training Phase, E then said *"Now it's your turn, can you do it?"*, placing the dog and the lion on the apparatus in resting position and pushing the apparatus forward toward the child. The child then performed the action with the demonstration pair, while E commented *"Yes, this is VERB-ing!"*. Demonstration and/or correction by physical manipulation were used when the child had difficulty in imitating the action properly.

E then reversed the agent-patient roles and demonstrated the action twice again with the appropriate description. A second training phase in which the child was again given a turn ensured that the child attempted to make one character act on the other in a causative manner on two consecutive trials involving role reversals.

After this, E repeated the demonstration and training phases as described above with another demonstration pair (rabbit and toothbrush) before proceeding to the test phase. The intention of using a second demonstration pair was to demonstrate to the child that the novel causative action expressed by the novel verb is possible not only between two animate participants (e.g., dog and lion) but also between an animate and an inanimate participant (e.g., rabbit and toothbrush). When there was an animacy contrast within the rabbit-toothbrush pair, each child saw and practiced the novel causative actions in both animate agent—inanimate patient and inanimate agent—animate patient directionalities roughly an equal number of times. Since children heard *no* noun arguments expressed in the demonstration and practice phases, the animacy contrast between the two nouns was never linguistically coded prior to the test phase.

In the Test Phase, E began by holding the apparatus back toward her side, and said *"Now you know how to VERB, so I have these two for you"*. E took out two new objects, placed them side by side on the apparatus in resting position, and said "*Show me: the X VERBs the Y!*". E then pushed the apparatus toward the child and repeated "*The X VERBs the Y*" and looked expectantly to the child (this would be the first time the child had heard the novel verb in a transitive frame). After the child's response, a second and then a third test trial each time with a new pair of objects were administered, before E proceeded to the other verb-apparatus (see Appendix 1).

All the experimenters were native speakers of the language. Apart from neutralizing case marking (no case marked masculine determiner *der* or *den* in German; no case marked pronouns *I* or *me* in English; and no case marking anyway in Cantonese grammar), the definiteness, the pace, the intonation and the stress pattern were also controlled across all the sentence stimuli. This was done by (i) ensuring that the two nouns in the NVN test sentences always had the same NP structure (see Appendix 1); (ii) having E undergone practice drills so as to ensure that prior to testing s/he could consistently say the sentence stimuli with equal stress on the first and the second nouns while maintaining natural pace and intonation perceptually to the ears of at least E and another native adult speaker; and (iii) having the first author present during all the testing sessions to double check perceptually whether two nouns received equal stress or not.

The first author coded all the children's responses- to ensure consistent coding by a single individual- either from videotapes or on-line (when video taping was not possible because of ethical concerns) into four categories: (i) a causative action with the first noun as the agent (e.g., the child would make the horse act on the telephone upon hearing "*Show me: the horse meeks the telephone"*); (ii) a causative action with the second noun as the agent (e.g., the child would make the telephone act on the horse upon hearing "*Show me: the horse meeks the telephone"*); (iii) an irrelevant non-causative action; and (iv) no attempt. The experimenter praised the child verbally for engaging with the task regardless of the correctness of response. One research assistant from each language coded at least 20 *percent* of the data (at least 15 children from each language) for inter-rater reliability. Inter-rater reliability was high: at least 95 *percent* agreement in all cases.

3. Results

The initial analysis was a $3 \times 3 \times 3$ ANOVA of Language group (Cantonese, German, English) $\times$ Age group (2;6, 3;6, 4;6) $\times$ Sentence type (AVI, AVA, IVA), with the conventional measure used in the competition model literature: the percentage of time picking the first noun as the agent (the number of such responses out of the total number of trials) as the dependent measure. A scattered plot of the residual against predicted values revealed no obvious deviation from the homogeneity of variance assumption.

There was a main effect of Language $F(2,\ 209) = 22.88,\ p < 0.001$, with the English children picking the first noun as the agent more often than their German peers ($p < 0.001$), who were in turn choosing the first

noun as the agent more often than their Cantonese peers ($p < 0.005$). There was also a main effect of Age $F(2, 209) = 113.01$, with the children at 4;6 (of all the three languages) choosing the first noun as the agent more often than the younger children at 3;6, who were in turn doing so more often than the youngest children at 2;6 ($p < 0.001$ in both cases). In addition, there was a main effect of Sentence type $F(2, 418) = 22.7$, $p < 0.001$, with the AVI sentences yielding more first-noun-as-agent responses than the AVA sentences ($p < 0.005$), which in turn yielded such responses more often than the IVA sentences ($p < 0.001$). There was also a significant interaction between Language, Age and Sentence type $F(8, 418) = 2.72$, $p < 0.01$. Such a three-way interaction meant that in addition to a two-way Language $\times$ Age interaction (which meant that the differences between languages were not the same across the age levels), the *pattern* of such a two-way Language $\times$ Age interaction was also not the same across the sentence types. For better understanding, please refer to Figures 1 to 6 reported later in the paper. No other interactions reached significance.

Analysis using as a dependent measure the total number of attempted trials (i.e., excluding those in which the child made no response) and the total number of attempted relevant trials (i.e., excluding those in which the child made no response or acted out an irrelevant non-causative action) yielded the same pattern of significant results, because in general there were very few "no response" and "irrelevant" responses. The number of "no response" and "irrelevant" trials accounted for only 1.34 *percent* of the total number of trials (35 out of 2616 trials).

The following post-hoc pairwise comparisons were also carried out using the Fischer's LSD procedure within the three-way ANOVA: (i) comparing the three language groups at each age level within each sentence type, which would give us information concerning in what ways children are similar or different when acquiring a different language for each sentence type at different ages; (ii) comparing the different age levels for each language group within each sentence type, which would give us information about developmental changes; and (iii) comparing the different sentence types for each language group within each age level, which would give us information regarding children's sensitivity to changes in the animacy contrast. In particular, we focused on comparing the prototypical AVI sentences (where the animacy contrast was introduced to coalesce with word order) and the AVA sentences (where the animacy contrast was neutralized); as well as comparing the AVA (where the animacy contrast was not present) and IVA sentences (where the animacy contrast was introduced to be in conflict with word order). The crucial findings were as follows.

3.1. *AVI sentences (prototype)*

3.1.1. *Two-year-olds* When animacy contrasts and word order coalesce, children as young as aged 2;6 acquiring Cantonese, German or English alike chose the first noun as the agent significantly more often than chance (Cantonese: 64.58%, $t(23) = 2.23$, $p < 0.05$; German: 70.83%, $t(23) = 3.4$, $p < 0.005$; English: 86.33%, $t(24) = 8.5$, $p < 0.001$; one sample *t*-tests). The benefit of having converging semantic and syntactic cues is especially large in English, with English children at this age displaying the highest first-noun-as-agent preference than their German age peers (English: 86.33% *vs* German: 70.83%, $p < 0.005$) and their Cantonese age peers (English: 86.33% *vs* Cantonese: 64.58%, $p < 0.001$), while Cantonese and German children at 2;6 behaved similarly in this condition (Cantonese: 64.58% *vs* German: 70.83%, $p = 0.249$, *n.s.*).

3.1.2. *Three-year-olds and four-year-olds* Later in development, children became equally good in comprehending the prototypical AVI sentences across language groups: there were no cross-linguistic differences registered at aged 3;6 and 4;6.

3.1.3. *Developmental changes* There was always a significant increase in the first-noun-as- agent responses between the two-year-olds and the three-year-olds for each language group ($p < 0.05$ in all cases), indicating an increase in children's ability to make use of these two converging cues to comprehend the transitive sentences of their target language during the third year of life. Figure 1 shows the relevant means and standard errors across age as a function of language group.

3.2. *IVA sentences (conflict)*

3.2.1. *Two-year-olds* With the IVA sentences where animacy contrasts and word order were in conflict, the same two-year-olds in contrast showed no group preference in either cue, picking neither above chance the first nor the second noun as the agent across language groups (Cantonese: 53.13%, $t(23) = 0.59$, $p = 0.56$, *n.s.*; German: 56.60%, $t(23) = 1.1$, $p = 0.29$, *n.s.*; English: 58.33%; $t(24) = 1.39$, $p = 0.18$, *n.s.*; one sample *t*-tests). There were no significant differences registered between language groups.

3.2.2. *Three-year-olds and four-year-olds* Later in development, children aged 3;6 and 4;6 across language groups, on the other hand, showed preference of word order over animacy contrasts when the two cues conflict, choosing above chance the first inanimate noun as the agent (at 3;6:

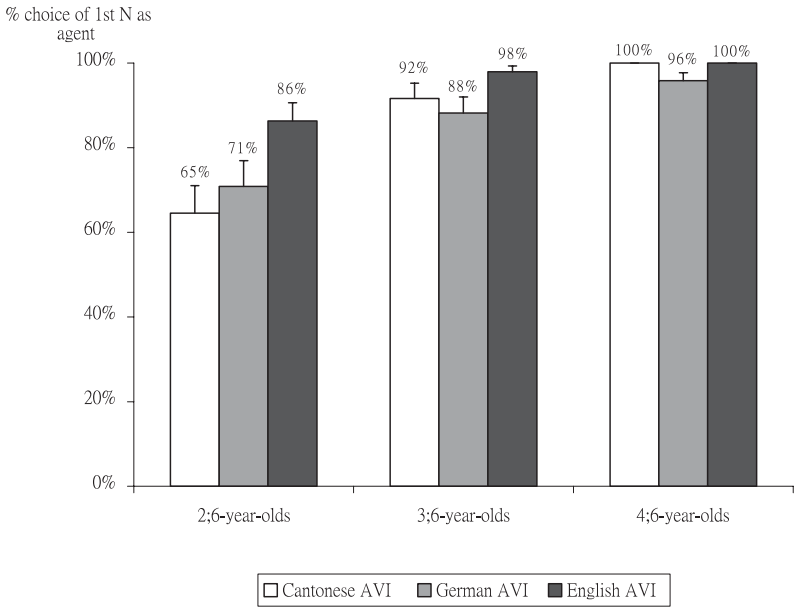

Figure 1. *Children's interpretation of the animate noun-verb-inanimate noun (AVI) sentences (prototype)*

Cantonese: 69.79%, $t(23) = 3.65$, $p < 0.001$; German: 79.17%, $t(23) = 4.75$, $p < 0.001$; English: 96.88%, $t(23) = 27.2$, $p < 0.001$, one sample *t*-tests). Children acquiring English did so more often than their age peers acquiring Cantonese or German at age 3;6 (English: 96.88% *vs* Cantonese: 69.79%, $p < 0.001$; English: 96.88% *vs* German: 79.17%, $p < 0.01$; Cantonese: 69.79% *vs* German: 79.17%, $p = 0.173$, *n.s.*). At age 4;6, children acquiring Cantonese did so less often than their age peers acquiring German or English (English: 97% *vs* Cantonese: 78.13%, $p < 0.01$; German: 94.79% *vs* Cantonese: 78.13%, $p < 0.05$; English: 97% *vs* German: 94.79%, $p = 0.75$, *n.s.*).

3.2.3. *Developmental changes* There was again always a significant increase in the first-noun-as-agent responses between children aged 2;6 and children aged 3;6 across all the three languages ($p < 0.05$ in all cases), suggesting an increased reliance on the word order cue during the third year of life among children acquiring these three languages. Between ages 3;6 and 4;6, there was no difference registered with the English children, because they were already close to ceiling at age 3;6. On the other hand, children acquiring German (but not those acquiring Cantonese)

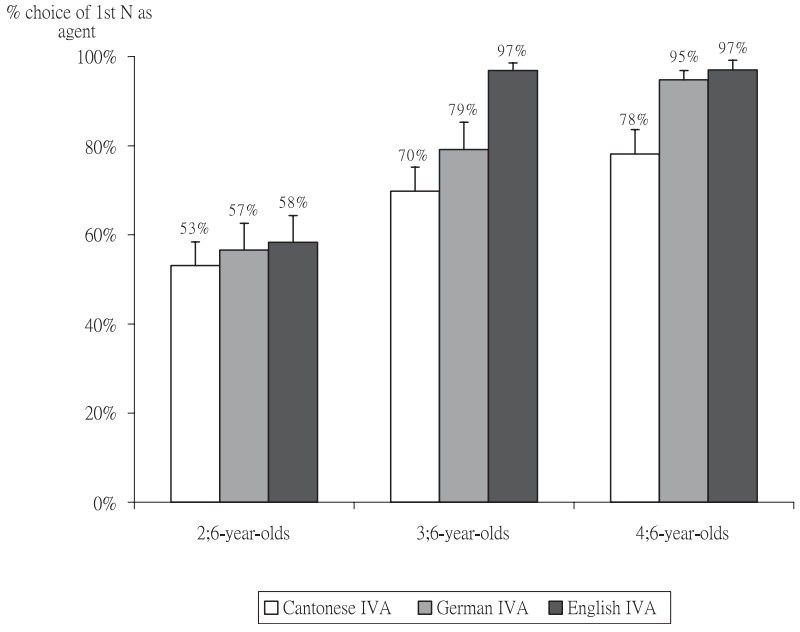

Figure 2. *Children's interpretation of the inanimate noun-verb-animate noun (IVA) sentences (conflict)*

displayed an increased reliance on the word order cue in processing the transitive IVA sentences, choosing the first inanimate noun as the agent more often at age 4;6 than at age 3;6 ($p < 0.05$). Figure 2 shows the relevant means and standard errors across age as a function of language group.

3.3. *AVA sentences (word order only)*

3.3.1. *Two-year-olds* With the AVA sentences where the animacy contrast was neutralized and word order was the only available cue to the agent-patient relations, children at 2;6 acquiring German or English were similar in terms of choosing the first noun as the agent significantly more often than chance (German: 67.02%, $t(23) = 3.16$, $p < 0.005$; English: 78.34%, $t(24) = 6.99$, $p < 0.001$; one sample t-tests), while their Cantonese age peers were at chance: 48.25%, $t(23) = -0.36$, $p = 0.73$, *n.s.*; one sample t-test). More detailed analyses using the median age split revealed that for German children it was the older-half of the two-year-old group who were above chance in their first-noun-as-agent choices, while the younger half was at chance (German older-half of the two-

year-old group: 72.23%, $t(11) = 2.97$, $p < 0.05$; young half: 61.81%, $t(11) = 1.52$, $p = 0.16$, *n.s.*; one sample *t*-tests). There was no sub-age-group difference among the Cantonese and the English children. These findings indicated that children acquiring English showed the earliest (from age 2;6 and up) general understanding of word order as a cue to the agent-patient relations in active reversible transitive sentences among the three language groups, followed by children acquiring German (from the older half of the two-year-old group and up), and then children acquiring Cantonese (not yet at age 2;6).

Children at this age also differed in magnitude in their reliance of the word order cue when acquiring different languages, with children acquiring English displaying the highest first-noun-as-agent preference, followed by their age peers acquiring German (English: 78.34% *vs* German: 67.02%, $p < 0.05$), followed by their age peers acquiring Cantonese who performed at chance as reported above (German: 67.02% *vs* Cantonese: 48.25%, $p < 0.001$).

3.3.2. *Three-year-olds and four-year-olds* Later in development, Cantonese three-year-olds could now make use of word order alone to interpret AVA sentences with novel verbs, choosing above chance the first noun as the agent (81.25%, $t(23) = 7.23$, $p < 0.001$; one sample *t*-test). Even though at age 3;6 when children acquiring either one of the three languages could all make use of word order to interpret the AVA sentence stimuli, children acquiring English did so to a greater extent than their age peers acquiring Cantonese ($p < 0.01$), with no differences between Cantonese and German children ($p = 0.157$, *n.s.*) nor between German and English children ($p = 0.225$, *n.s.*). At age 4;6, no cross-linguistic differences were registered with the AVA sentences, as with the AVI sentences.

3.3.3. *Developmental changes* There was again always a significant increase in the first-noun-as-agent responses between children aged 2;6 and children aged 3;6 across the three language groups ($p < 0.05$ in all cases), suggesting an increased reliance on word order to process the AVA transitive sentences during the third year of life. Between ages 3;6 and 4;6, English children showed no age difference because they were already close to ceiling when they reached 3;6. Children acquiring Cantonese or German, on the other hand, both chose the first noun as the agent more often when they were aged 4;6 than when they were aged 3;6, displaying an increasing use of the word order cue to comprehend AVA sentences during this period ($p < 0.05$ in both cases). Figure 3 shows the relevant means and standard errors across age as a function of language group.

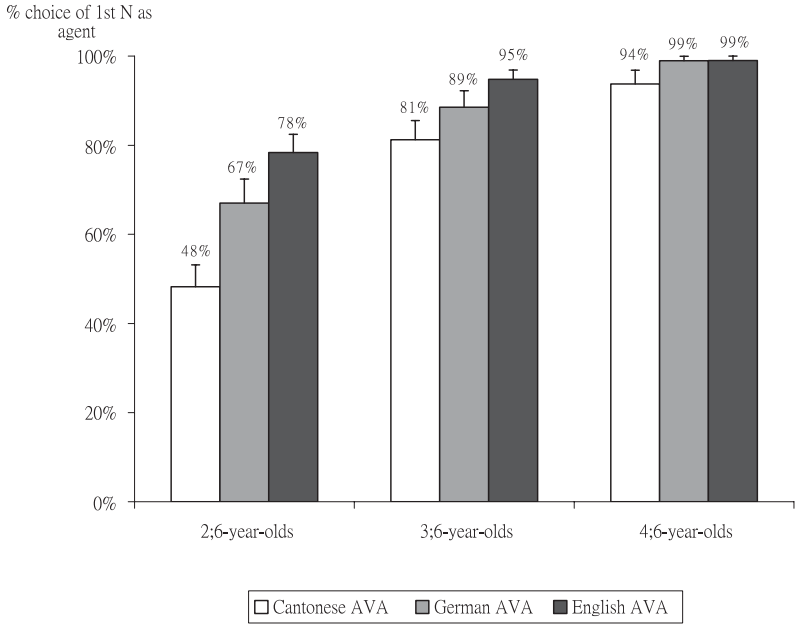

Figure 3. *Children's interpretation of the animate noun-verb-animate noun (AVA) sentences (word order only)*

3.4.1. *Two-year-olds* Results indicated that children as young as aged 2;6 displayed sensitivity to changes in the animacy contrast across all the three language groups. When the animacy contrast was neutralized in the AVA sentences, Cantonese children at 2;6 chose the first noun as the agent significantly less often, relative to their interpretation of the AVI sentences (AVI: 64.58% *vs* AVA: 48.25%, $p < 0.001$). Similarly, the German- and the English-children at 2;6 chose the first noun as the agent significantly less often when the first noun changed from being animate to inanimate (German AVA sentences: 67.02% *vs* IVA: 56.60%, $p < 0.05$; English AVA sentences: 78.34% *vs* IVA: 58.33%; $p < 0.001$). Figure 4 shows the relevant means and standard errors across language groups as a function of sentence type for the two-year-olds.

3.4.2. *Three-year-olds and four-year-olds* At age 3;6, animacy contrasts continued to play an influential role in Cantonese children's sentence interpretation and marginally so for children acquiring German (Cantonese AVI: 91.67% *vs* AVA: 81.25%, $p < 0.05$; Cantonese AVA: 81.25% *vs* IVA: 69.79%, $p < 0.05$; German AVA: 88.54% *vs* IVA: 79.17%, $p = 0.077$). Figure 5 shows the relevant means and standard deviations across

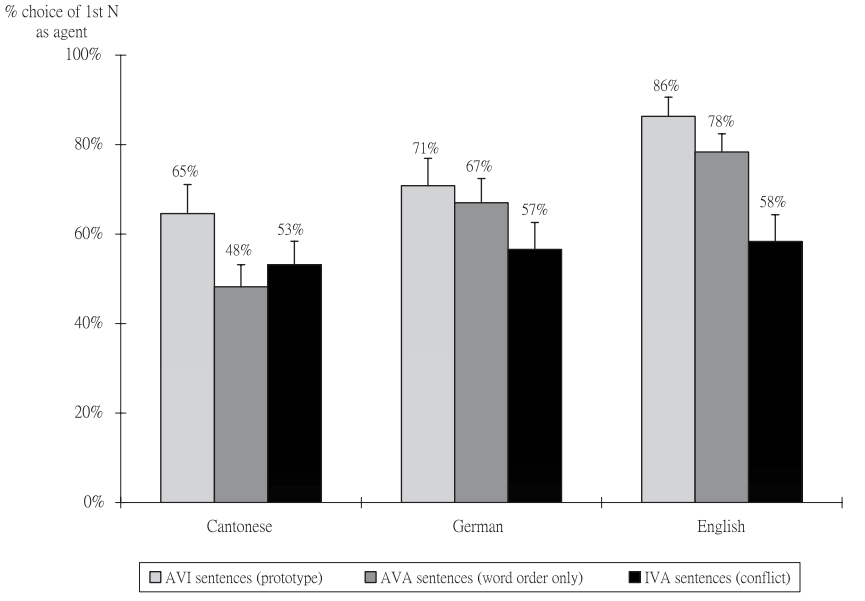

Figure 4. *Two-year-olds' interpretation of transitive sentences across sentence types*

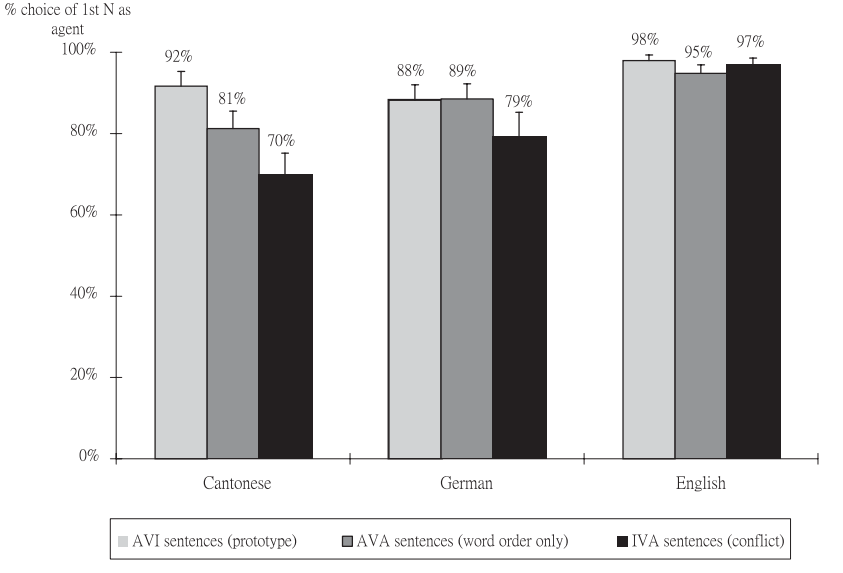

Figure 5. *Three-year-olds' interpretation of transitive sentences across sentence types*

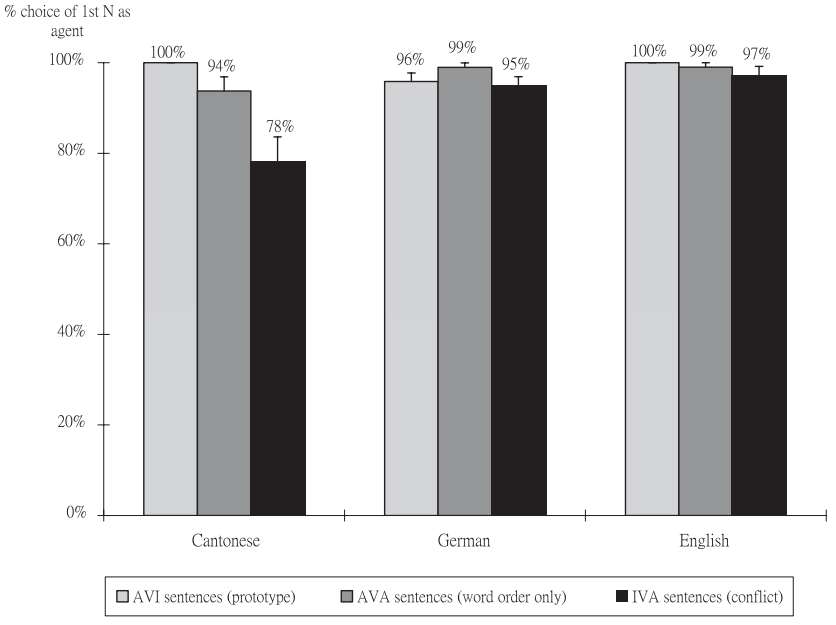

Figure 6. *Four-year-olds' interpretation of transitive sentences across sentence types*

language groups as a function of sentence type for the three-year-olds. At age 4;6, animacy contrasts persisted to have an influence on Cantonese children's sentence interpretation (AVA: 93.75% *vs* IVA: 78.13%, $p < 0.005$), but not for children acquiring German or English. Figure 6 shows the relevant means and standard errors across language groups as a function of sentence type for the four-year-olds.

4. Discussion

In the current study, we examined young children's general understanding of word order and animacy contrasts as cues to the agent-patient relations in the transitive construction. Using novel verbs allowed us to know exactly what each child had and had not heard (i.e., each child's experience). This control enabled us to have a cleaner test for evidence of productivity from young children (whether their knowledge could go beyond their experience). Standardizing the input conditions across language groups also offered a cleaner comparison between languages. Using essentially the same act-out paradigm with the same sentence, object and novel action stimuli, we tested children acquiring monolingually Cantonese Chinese, German or English at three age levels (2;6; 3;6 and 4;6).

Results revealed interesting cross-linguistic similarities and differences. With the prototypical AVI sentences where animacy contrasts and word order coalesce, across the three language groups, even the youngest two-year-olds were above chance in choosing the first animate noun as the agent, making the horse tam on the telephone upon hearing the sentence "*Show me: the horse tams the telephone*", for example. With the "counter-prototypical" IVA sentences where semantic and syntactic cues conflict, the same children aged 2;6- again across language groups- in contrast did not use either cue systematically, preferring neither the first inanimate nor the second animate noun as the agent on group performance. Later in development, children at 3;6 and 4;6 showed preference of word order over animacy, choosing above chance the first inanimate noun as the agent. With the AVA sentences where the animacy contrast was neutralized and only the word order cue was present, children acquiring English showed the earliest (from age 2;6 and up) and greatest reliance on word order among the three language groups, followed by children acquiring German (from the older half of the two-year-old group and up), and then children acquiring Cantonese (from age 3;6 and up). Across sentence types, children made significantly fewer first- noun-as-agent choices when the animacy contrast was neutralized (AVI v*s* AVA) or introduced to conflict with word order (AVA *vs* IVA), displaying sensitivity to changes in the animacy contrast. Cantonese children did this at all three ages; German children at ages 2;6 and 3;6; and English children at 2;6.

We interpret the findings in light of insights from the competition model (Bates and MacWhinney 1987; MacWhinney and Bates 1989) and the usage-based theory of language acquisition (Tomasello 2003). Children across the three language groups found it especially easy to comprehend prototypical AVI sentences with animacy and word order cues in coalition. This finding is consistent with our cross-linguistic prediction based on Bates and MacWhinney (1987)'s idea of coalitions-as-prototypes, especially when it is often the case that these prototypical sentences are also frequent in the input. In the current CDS analyses, transitive sentences with an animate agent and an inanimate patient are frequent in the input of the three languages, accounting for at least 80 *percent* of the sentences in which the animacy status of both the agent and the patient nouns can be determined. Another related perspective is that since these prototypical sentences also reflect inherent causal asymmetries that are consistent with the natural force dynamics or energy flow in the causal chain (from an animate agent to an inanimate patient; see Croft 1991, 1998; Langacker 1987, 1990; and Talmy 1976), it is possible that children find it especially easy to process sentence patterns which are iconic to the

natural energy flow of an event (see Cho et al. 2002 for more supportive evidence).

In contrast, with the IVA conflict sentences, the same two year olds were at chance across language groups. This finding is consistent with the idea that cue integration is incomplete at early stages of learning; especially conflicting cues (see also Matessa and Anderson 2000; McDonald 1986; and more recently Dittmar et al. 2008 for compatible findings). The finding therefore is in conflict with any model that assumes full cue integration throughout development. The point is that information processing restrictions of the type outlined by Matessa and Anderson (2000) point to the idea that children are using a few prototypical patterns (with natural coalition of cues) to organize early learning but they are not initially doing full cue integration, which involves at least being able to differentiate the cues and know the relative contribution (weighting) of each cue.

Then, later in development, the older three- and four year-olds preferred word order over animacy, making, for example, the first inanimate *present* meek onto the second animate *chicken* upon hearing "*Show me: the present meeks the chicken*", even though young children might have the expectation from their experience in the world that animate entities tend to be the agents and inanimate entities tend to be the patients (see Childers and Echols 2004; Corrigan 1988). Here the English three- and four- year olds in this study behaved like the English adults in the competition model literature (English adults would choose the first inanimate noun 82 *percent* of the time as the agent when interpreting the IVA sentences with familiar verbs, from Bates et. al. 1982: 282, Table 5). This phenomenon can be attributed to the dominant word order cue in English which overrides the animacy cue when they are in conflict (word order has higher conflict validity in English, see McDonald 1989). However, the Cantonese and the German three- and four- year- olds in this study performed differently from the Chinese and German adults reported in the literature: when interpreting the IVA sentences with familiar verbs, Chinese and German adults would prefer the OVS interpretation, choosing the first inanimate noun as the agent only 29 *percent* of the time and 37 *percent* of the time respectively (with case marking neutralized in the German sentence stimuli) (McDonald 1984; Miao 1981: 113, Table 3).

This phenomenon coincides with the developmental phenomenon observed by Bates and her colleagues (1984) from their Italian four year olds, which they interpreted those children as having overgeneralized the SVO word order to improbable IVA sentences, because they did not yet fully "understand the pragmatic/discourse function of word order variations in their language" (Bates et al. 1984: 352). This overgeneraliza-

tion phenomenon was reported also in French, Hungarian and Serbo-Croatian around four years of age (Bates and MacWhinney 1987: 175–178). Similar results could also be found in Miao (1986)'s study of Mandarin Chinese children, as reviewed in the introduction section. Here, the notion of 'functional readiness' proposed in Bates and MacWhinney (1987, 1989) applies also to the Cantonese and German children in this study: the other non-canonical word orders e.g., OVS permitted in adult Cantonese and German, express pragmatic/discourse functions which require more sophisticated pragmatic knowledge to master. Apart from considering children's functional readiness, input frequency is also relevant. IVA transitive sentences are rarely attested in the adult input, in fact, no such instance was attested in the current analyses of child directed speech of the three languages. So, there are, after all, not many tokens to learn the mapping between form and function there.

With the AVA sentences, children acquiring different languages showed differential sensitivity to word order as a cue to the agent-patient relations both in terms of timing and magnitude. Here, the notion of cue validity in the competition model (Bates and MacWhinney 1987, 1989) is useful. The current pattern of developmental findings corresponded with how informative the word order cue is in children's linguistic experience. As the current analyses of child directed speech indicated, the word order cue validity is highest in English child directed speech, then German-, and then Cantonese-child directed speech.

The current results with novel verbs also demonstrated that children's SVO word order productivity corresponds closely with how conducive the input properties are for the schematization of an abstract SVO schema, rather than being tied to a particular age. The English input properties would be considered the most conducive, since the functional constituents (the argument nouns) are often available and consistently aligned. The Cantonese input properties would be considered the least conducive among the three, since the functional constituents (the argument nouns) are often unavailable. German input properties would be in the middle between English and Cantonese—the functional constituents are not as consistently aligned as those in English, while they are available more often than in Cantonese (see Gentner and Medina 1998 and Tomasello 2003: 166 on the importance of a consistent alignment of the functional items for structure mapping and schematization).

Changes in the animacy contrast across sentence types always had an impact on Cantonese children's semantic role assignment: they made fewer first-noun-as-agent choices when the animacy contrast was neutralized or introduced to conflict with word order- at all ages; for German children changes in the animacy contrast only had an effect at the two

younger ages and for English children only at the youngest age. The cross-linguistic similarity noted at age 2;6 indicated that children as young as 2;6 display a more than verb-specific understanding of animacy contrasts as a cue to the agent-patient relations in the transitive sentences across the three languages. As for the cross-linguistic differences observed, what this study found is that Cantonese children's sentence interpretation was constantly influenced by the availability of and the changes in the pattern of animacy contrasts at all age levels, tempered with an increasing reliance on the SVO word order (to the extent that they even over-generalized it at certain developmental points). This finding is consistent with the idea that, when processing a language like Cantonese which has no morphological cues available to the agent-patient relations and where word order is not highly valid as a cue because of a high degree of noun ellipsis in the input, children- and adults alike have to constantly attend to cues like animacy contrasts when interpreting sentences (see Li et al. 1993 on their adult Chinese findings). On the other hand, German and English children's sentence interpretation becomes less influenced by changes in the animacy contrast as they grow older. This is not because they are no longer sensitive to changes in the animacy contrast, but possibly as the other more dominant cues (word order in English; and case marking, as well as word order in German) gain power, the animacy contrast becomes less important as a cue to the agent-patient relations in these languages, at least insofar as the NVN sentence stimuli are concerned. Possibly, animacy contrasts might become more important for the non-canonical NNV and VNN word orders. For a more complete characterization of the overall dynamics of cue competition and focusing in these languages, further research needs to look also at NNV and VNN patterns.

What does this cross-linguistic study tell us about the development of children's comprehension of transitive sentences? This study found that across languages, children aged 2;6 or probably even earlier comprehend prototypical transitive sentences with the coalition of word order and animacy, even with novel verbs. Since cues are often in coalitions in natural language, it is often the case that these coalitions-as-prototypes also occur frequently in the input. This does not mean, however, that children at this early stage of development are able to differentiate the cues and know the relative contribution (weighting) of each cue.

When the animacy contrast and the other cues such as case marking and stress contrasts are neutralized, and word order functions as the only cue to the agent-patient relations, a lot depends on how informative the word order cue is in the child's linguistic experience. In the case of acquiring English where the word order cue is highly available and reliable,

children comprehend SVO word order even with novel verbs as young as two-and-a-half. When acquiring a language like Cantonese where the word order cue is not as strong, children take longer to acquire a more abstract understanding of the SVO word order as a cue to the agent-patient relations. German children stand in the middle among the three language groups, as far as their general understanding of word order as a cue to the agent-patient roles is concerned, when they do not have support from case-marking.

It takes time for children to resolve transitive sentences with conflicting cues. In the current case where semantic and syntactic information conflict, children early on prefer neither animacy nor word order cue to interpret the sentences, unlike the adults who would rely on the cue which has higher conflict validity in the language. This phenomenon is attested in all the three languages. The two-year-olds' non-adult-like comprehension with the conflict sentences across all three language groups provides good evidence for incomplete cue integration early in development (see also Matessa and Anderson 2000; McDonald 1986; and more recently Dittmar et al. 2008 for compatible findings). Soon, word order dominates, especially when children have solidified the canonical SVO word order, even later to the extent that children acquiring variable word order languages like German and Cantonese overgeneralize the SVO order (relative to the adult convention). This is possibly because the alternative OVS interpretation is not yet in the 'pool' to compete, due to reasons such as the pre-requisite discourse-pragmatic skills not being ready, as well as children needing more exemplars to learn this form-pragmatic function mapping in their experience. The fact that the OVS interpretation would go counter-iconic to the natural energy flow of an active causative event might also pose extra processing difficulty for young children. But then, later, children understand the ideaof pragmatic variations in word order in their target language, and their understanding of pragmatic functions guides them to constrain their use of the SVO order to the adult convention. How this is achieved awaits future research.

To summarize, findings from the current cross-linguistic developmental study are consistent with the view that language acquisition is a process of first acquiring the frequently occurring coalitions of form-function mapping as prototypes *but* without complete cue integration, and then gradually adjusting the weight of each mapping until it provides an optimal fit to the processing environment like the adults (Bates and MacWhinney 1989: 59). Cue-driven distributional analyses and cue integration are actively involved during the acquisition process, and these psycho-computational processes receive more support when children become less constrained by information processing restrictions as well as

more "functionally ready" (Bates and MacWhinney 1987, 1989). These processing dynamics and developmental advancements eventually result in a body of adult-like knowledge, such as knowledge represented in the form of "adjusted weightings of each form-function mapping that provide an optimal fit to the processing environment" (Bates and MacWhinney 1989: 59) as well as the knowledge of a prototype as "the emergent property of a great many weightings between individual forms and functions" (Bates and MacWhinney 1989: 51).

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Appendix 1: A sample set of sentence stimuli for a child across the two test sessions

	Cantonese	German	English	Agent position
	Session 1: *zou6 bei2 ngo5 tai2* [Test Sentence] *hai6 dim2 gaa3? 'Do it for me to see: [Test Sentence] is how?'*	*Zeig mir 'Show me'...*	*Show me...*	
1	maa5zai2 tam1 din6waa2 馬仔 tam1 電話	Das Pferd tammt das Telephon	The horse tams the telephone	Right
2	ngau4zai2 tam1 coeng4geng2luk2 牛仔 tam1 長頸鹿	Die Kuh tammt die Giraffe	The cow tams the giraffe	Left
3	lai5mat6 tam1 gai1zai2 禮物 tam1 雞仔	Das Geschenk tammt das Huhn	The present tams the chicken	Right
4	ngaap3zai2 wung2 lou5syu2 鴨仔 wung2 老鼠	Die Ente wieft die Maus	The duck meeks the mouse	Right
5	nguk1zai2 wung2 zyu1zai2 屋仔 wung2 豬仔	Das Haus wieft das Schwein	The house meeks the pig	Left
6	joeng4zai2 wung2 tou4waa2 羊仔 wung2 圖畫	Das Schaf wieft das Bild	The sheep meeks the picture	Left
	Session 2: *zou6 bei2 ngo5 tai2* [Test Sentence] *hai6 dim2 gaa3? 'Do it for me to see: [Test Sentence] is how?'*	*Zeig mir 'Show me'...*	*Show me...*	
1	caa4bui1 wung2 maau1zai2 茶杯 wung2 貓仔	Die Tasse wieft die Katze	The cup meeks the cat	Left
2	gai1zai2 wung2 syu1zai2 雞仔 wung2 書仔	Das Huhn wieft das Buch	The chicken meeks the book	Right

	Cantonese	German	English	Agent position
3	wu1gwai1 wung2 mat6fung1 烏龜 wung2 蜜蜂	Die Schildkroete wieft die Biene	The turtle meeks the bee	Right
4	zyu1zai2 tam1 joeng4zai2 豬仔 tam1 羊仔	Das Schwein tammt das Schaf	The pig tams the sheep	Left
5	zam2tau4 tam1 maa5zai2 枕頭 tam1 馬仔	Das Kissen tammt das Pferd	The pillow tams the horse	Right
6	coeng4geng2luk2 tam1 laai5zeon1 長頸鹿 tam1 奶樽	Die Giraffe tammt die Flasche	The giraffe tams the bottle	Left

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