

INFANTS OF 24–30 MONTHS UNDERSTAND VERB FRAMES

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1. INTRODUCTION

This chapter reports on a study designed to investigate young children's knowledge of three syntactic frames. The syntactic bootstrapping hypothesis, proposed by Landau & Gleitman (1985) and Gleitman (1990) suggests that children are able to use the syntactic frame in which a verb appears to determine something about the verb's meaning. However empirical support for this view relies on the fact that children can distinguish the syntactic frames in a language. Although it would be making too great an assumption to predict that a child can identify the semantic components that make up the meaning of an unknown verb just on the basis of knowledge of syntactic frames, the frame in which a verb appears may help the child identify some aspects of the verb's meaning, for example, whether it has a causative or contact meaning.

A novel verb in a transitive frame, on analogy with verbs such as "touch" or "turn", would be interpreted as a causative or contact verb. In example (1), Jane might be assumed to be in contact with Mark, or causing Mark to do something. However, neither of these interpretations would characterize the verb "chase" if it replaced "zork" in (1), unless Jane is causing Mark to move because she is running behind him. In contrast, a verb in an intransitive frame (as in (2) and (3)) is not likely to be interpreted as a causative or contact verb. Both of these can be understood as two participants are acting independently; this would be the interpretation for activity verbs in these contexts, activity verbs such as "run" and "skip". However, this generalization is not totally reliable because reciprocal verbs can involve contact between the two participants. If "kissing" was substituted for "sebbing" in (2), Mark and Jane would be in contact; they would be involved in a joint (reciprocal) activity.

- (1) Jane is zorking Mark.
- (2) Mark and Jane are sebbing.
- (3) Jane is zorking with Mark.

If children are able to attribute contact/causative interpretations or simultaneous activity interpretations to novel verbs just on the basis of the frames in which they appear, where does the knowledge of the frames come from? We would assume that children must have experienced them in the input language. That is, they must have been exposed to verbs in the frames and have acquired a lexical representation for each verb, based on a meaning assumed from the pragmatic context in which they are heard. Such a representation would include syntactic information as well as semantic. This position assumes that in the initial stages of learning new verbs a child acquires them item-by-item, along with the frames in which they are heard. This is Tomasello's (1992) position. He argues that children acquire verbs along with the syntactic structures in which they hear them, that is as units (the Verb Island Hypothesis). Clark (1996) argues for a similar position, that children learn new verbs as parts of constructions. She suggests that once children have identified some lexical content of a new verb and assigned a possible argument structure, they can use this knowledge as a template for other verbs which share meaning components.

At some stage a child must have acquired sufficient knowledge about syntactic constructions to be able to generalize. Children are productive in verb use, even overgeneralizing syntactic frames (e.g., see Bowerman, 1983). To identify different frames in the input language, children must know the distinguishing characteristics, which include word order and the grammatical markers which identify the relationships between the verb and nouns in a sentence. Note that the only difference between (1) and (3) is the preposition "with" after the verb; this marker changes the structure to intransitive.

If innate constraints guide children in the mapping of causative meaning to transitive (SVO) constructions, innate knowledge of the syntactic categories subject and object must be assumed, as well as knowledge of how they are realized in a particular language. However, if experience with language is required to determine the realization of subject and object for a particular language, then through exposure to the language the child must detect recurring meaning-form patterns in the input and contexts in which they are heard. Children use cues made available to them in the language being acquired, as discussed by Bates and MacWhinney in their discussions of the Competition Model (e.g., Bates & MacWhinney, 1987).

The age at which children show knowledge of syntactic frames in determining meanings for unknown verbs has been investigated, in particular, by Naigles (1990, 1996), Naigles and Kako (1993), and Hirsh-Pasek, Golinkoff, & Naigles (1996). Naigles and Kako questioned whether 23–29 month olds provide support for the syntactic bootstrapping hypothesis. They employed the Intermodal Preferential Looking Paradigm (IMPL) (Hirsh-Pasek & Golinkoff, 1991, 1996). The method enables visual dynamic stimuli to be used and thus provides a useful method for investigating verb knowledge, as opposed to static pictures. Participants are familiarized with two visual stimuli before being tested with an auditory stimulus which matches only one of these stimuli. The dependent variable is the child's looking time at each picture. The assumption is that if the child is able to interpret the structure heard, she will look longer at the matching stimulus. Novelty effects, found in intramodal preferential looking tasks, are eliminated because the visual stimuli are presented before the test trials, so the pictures are familiar by the time of testing.

Naigles & Kako (1993) introduced novel verbs for multiple action sequences in specific syntactic frames. The multiple actions were then separated into their two components and these events were shown individually. The test trials presented both components simultaneously as the children heard a sentence containing the novel verb. The

aim was to determine if the children preferred one of the actions as the referent for the novel verb, and whether their preference changed according to the frame in which the verb was presented. Naigles and Kako found that when a transitive frame was used to introduce a novel verb, the looking time to a causative action was significantly longer than when the verb was introduced alone, that is without a syntactic frame. The different response patterns, dependent upon the syntactic frame in which the verb was presented, provides some support for syntactic bootstrapping.

Hirsh-Pasek & Golinkoff (1991, 1996) report on a series of studies in which they tested infants on their emerging syntactic knowledge. They used transitive sentences and intransitive structures with a conjoined subject (e.g., “See Big Bird and Cookie Monster bending”). Two familiar and two unfamiliar real verbs were included. Three age groups were tested with mean ages of 19.28, 24.15, and 28.3 months. The youngest and oldest groups showed no preference for either visual stimuli when the verbs were presented without a syntactic frame. When the verbs were presented without a frame, the middle age group preferred to watch the synchronous actions, as was also found in the Naigles and Kako study. What is of interest is whether the children showed different looking patterns when the verb was presented in a syntactic context. The oldest group matched the transitive structures to the causative event. The youngest group did not. The middle age group watched the matching screen (that is, the causative event) significantly more than the non-matching screen for the known verbs; however, a later analysis showed this was only carried by the girls, not the boys. Thus the findings indicate that by 28 months children know that a transitive frame maps onto a causative interpretation. There were no significant findings in any groups tested with the intransitive conjoined subject structures.

A follow up study (Hirsh-Pasek, Golinkoff, & Naigles, 1996) used four novel verbs (“glorp”, “dax”, “blick” and “krad”) with 36 participants aged between 28 and 30 months. As with the older group in the earlier study, the children were found to match the transitive sentences, but not the intransitive, to the appropriate visual stimuli. Another study with 32 participants aged between 22–25 months and 26–30 months tested children on intransitive “with” structures (e.g., “Look Big Bird turning with Cookie Monster”), using the four real verbs from study 1. The younger boys treated the “with” structures as if they were transitive, that is matching them to the causative events, while the girls were successful in matching the sentence to the appropriate event. That is, the boys, but not the girls, ignored the preposition “with”. In the older age group, the children looked at the matching screen longer, although this was only significant for the boys.

Another study presented intransitive sentences with a conjoined subject and the auxiliary verb (e.g., “Big Bird and Cookie Monster are turning”). Two groups of children aged 23–25 months and 28–30 months were tested; only the younger group matched the auditory and visual stimuli. The older group looked in the predicted direction, but the results did not reach significance.

While some conclusions can be made about children’s knowledge of syntax on the basis of the studies discussed above, it is still not really clear at what age children are able to use a syntactic frame to interpret causative versus synchronous action when they are presented with two events showing two participants. While children under two-and-a-half years of age know something about syntactic frames, it is not clear how confident they are in identifying and contrasting the three frames illustrated in (1), (2) and (3). In order to investigate this area further, we designed a study with novel verbs.¹ Using

¹ The paper is based on data collected as part of a 1997 honours thesis by the second author plus some additional data.

novel verbs is a true test of how well children understand a syntactic frame since they can not have heard the verb before in a particular frame. Previous studies have generally used a between-subjects design with children tested on only one structure. In the current study, a within-subjects design was adopted to determine if the children could identify all three frames. We hypothesized that 24–30 month olds would look significantly longer at a causative action when hearing a transitive sentence, and significantly longer at a synchronous action with two participants when hearing an intransitive sentence with “with”, or an intransitive sentence with a conjoined subject.

2. METHOD

2.1. Participants

Thirty seven children aged between 24 and 31 months were tested. A total of 12 children were excluded, leaving data from 25 participants to be analyzed (with a mean age of 26.92 months). There were 14 boys and 11 girls in the final sample. The rejection criteria were based on those reported in other studies using the IMPL paradigm. We excluded subjects who failed to look at either screen during a test trial, for failure to look during familiarization, for failure to centre before a test trial, and for an obvious side bias. Children were recruited from local maternal health centres to sign up on the Child Development Registry at La Trobe University.

2.2. Materials

Six novel aerobics-type actions were videotaped in both causative and non causative scenarios. That is one person “caused” the other to perform the action by, for example, turning the person around in a four-point turn, or the two characters performed the same action individually, standing side-by-side. The novel verbs were “kazzing”, “sebbing”, “geaming”, “plunking”, “glorping” and “blicking”. The actions used are listed in Table 1. The actions were performed by the same participants, a young male and a young female. Each scene showed both participants. Two videos were prepared with counterbalancing for which participant caused the action in the causative scenes and for the side on which the characters stood in relationship to each other. One of the videos played on the right monitor and the other on the left.

Three auditory versions were prepared to allow for counterbalancing of the verbs to be tested in each frame. That is, a third of the children were tested with the transitive frame for two of the verbs, a third with the transitive frame for two other verbs, and a third with the transitive frame on the other two verbs. The two intransitive frames were

Table 1. Novel actions used

Action 1	Bending up and down repeatedly from the knees
Action 2	Right hand on chin, repeatedly moving head to right & left
Action 3	Repeatedly moving left hand onto right shoulder
Action 4	Side-on, repeatedly extending left leg back from standing position
Action 5	Repeatedly crossing lifted hands over and back across chest
Action 6	Exaggerated turning around in a 4-point turn

also counterbalanced across the verbs. All children were tested on two transitives, two intransitive “with” sentences, and two intransitive “and” frames. No verb was tested twice for any participant.

The two video tapes ran in synchrony, with each scene matched for length, frame by frame. Visual stimuli were on screen for seven seconds; a red light appeared between the monitors for three seconds to centre the children’s attention between trials. The auditory stimulus for each test trial finished as the pictures appeared on screen and the sentence was then repeated.

2.3. Procedure

Children sat on their caregiver’s lap in front of the two video monitors in a dimmed room. Caregivers were asked to close their eyes and listen to music played through headphones so as not to prompt the child. The children were video taped with a camera hidden between the two monitors. Looking times at each monitor were calculated off-line using a frame by frame analysis. Reliability checks on 20% of the data showed 97% agreement between two independent raters. The differences were resolved and a further reliability check showed 100% agreement. The high level of agreement between the raters shows that frame by frame coding is a preferable method of coding to push button, on-line coding (see Swingle, Pinto, & Fernald 1998 for a detailed discussion of coding biases). After coding, the matching screen for each trial for each participant was identified. The mean looking times for each frame by subject were calculated and an analysis of these times made by syntactic frame.

3. RESULTS

The mean looking times to matching and non-matching pictures for each syntactic frame are presented in Figure 1. To test the hypothesis that children would look longer at the matching screens for the three frames, we used a 3 (Transitive, Intransitive “with”, Intransitive “and”) \times 2 (Matching, Non-matching) repeated measures analysis of variance on these data. No significant interaction between frame and screen was found, $F(2, 48) = 1.09$, $p = 0.346$. Nor was there a significant effect of syntactic frame, $F(2, 48) = 0.90$, $p = 0.414$. However, there was a significant effect for screen, with longer looking at the matching than non-matching stimuli ($F(1, 24) = 13.03$, $p < 0.01$).

As can be seen from Figure 1, the looking times were in the predicted direction for all three frames. We compared the matching versus non-matching looking times for each frame using a one-tailed “ t ” test. Looking time at the matching picture was found to be significant for the transitive frame, $t(24) = 3.25$, $p < 0.01$ (Note that with a Bonferroni adjustment, this is also significant at the 0.05 level). For the intransitive “with” frame $t(24) = 1.93$, $p < 0.05$. With the Bonferroni adjustment, used because three comparisons were made, this is not statistically significant. However, given the small sample size, a 0.05 level is already conservative, so we can assume that the children did show knowledge of the frame. For the intransitive frame “and”, the differences were not statistically significant, $t(24) = 0.46$, $p = 0.65$.

The analysis reported above was by group. However, we were also interested in how many children seemed to be able to match an event to the structures. For this reason we counted how many children looked proportionally longer at the matching versus non-matching screen for each frame. Using the proportions of total looking time, 18 of the

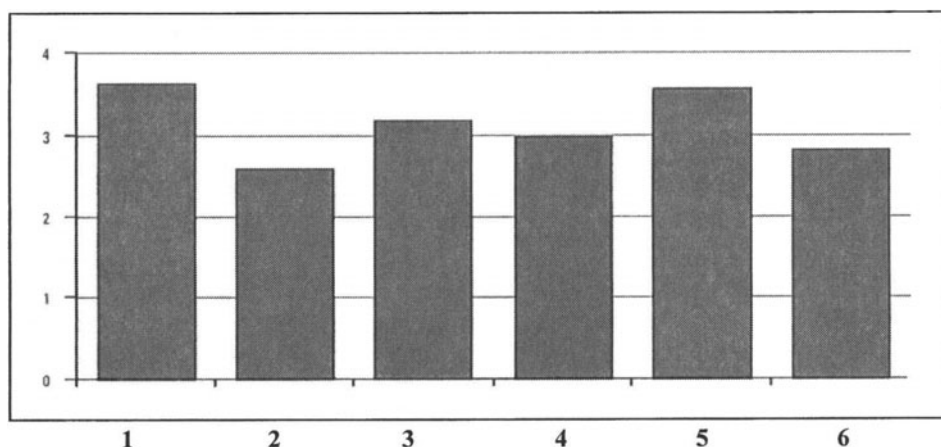


Figure 1. Mean looking times (in seconds) at matching and non-matching screens by frame. 1 = Transitive matching, 2 = Transitive non-matching, 3 = "And" matching, 4 = "And" non-matching, 5 = "With" matching, 6 = "With" non-matching.

25 children looked proportionally longer at the matching stimuli for the transitive frame, but for the intransitive "and" frame, only 11 children. For the intransitive "with" frame, 15 children looked proportionally longer at the matching stimuli. Boys and girls were fairly evenly represented.

4. DISCUSSION

The results confirm that children aged between two and two and-a-half can distinguish transitive and intransitive frames. When provided with one scene in which two people perform the same action and a second scene in which one person causes the other to perform, the children overall interpreted the frame X is v—ing Y as causative. In addition, they appeared to know that "with" changes the meaning, so that one participant does not cause another to act. While the direction of looking is in the predicted direction for the intransitive "and" frame, the difference is not significant. That is, the children assumed that the two participants were involved in a joint activity. There are two cues to a conjoined subject in these sentences, the conjunction "and", and the plural auxiliary "are", which reinforces the plural subject. In all our causative events the agent was in contact with the causee and it could be that this biased the children to think of the joint action as the referent for the "and" frame, even though the action was clearly only being performed by one of the two participants, caused by the other. Some "and" constructions do involve two participants in a joint activity. These include sentences with reciprocal verbs as well as others, such as "Mary and Jo fixed the car". However, given the different means in looking time at the matching screen for the transitive frame and the "and" frame, the children were clearly making a distinction between them. That is, the children showed awareness of "and", even if the looking times do not establish that the children were able to pick the correct referent for the event.

To investigate further the different looking patterns for each frame an additional analysis was made, using first looks. We calculated the looking times for the first look to each of the two visual stimuli during each test trial and compared these means using "t"

tests for each frame. For the “and” frame, children were found to look significantly longer at the non-matching screen ($M = 1.66$ to matching and $M = 2.21$ to non-matching), $t(24) = -1.98$, $p = <0.05$. That is, taking only the first looks at each screen, the children looked longer at the causative scene than at the non-causative when they heard a sentence such as “Mark and Jane are kazzing”. That is, initially they interpreted the conjoined subject construction as representing an event showing joint involvement of the two participants. However, given that the total looking times show slightly longer looking times at the matching picture, the children seem to have realized during the trial that there was a mis-match between the information in the sentence and the depicted causative event.

Recall that the first presentation of the auditory stimuli finished as the pictures appeared. The sentence was then repeated, allowing for an initial interpretation to be verified or not. (Note that it is important in IMPL tasks that the child hear the auditory stimuli before seeing the pictures in the test trial in that looking time is calculated for the test trial time period.) A change of mind would account for why the *total* looking time for the “and” frame showed a different pattern than the first look times. In contrast, first looking times were higher for the matching screen than the non-matching for the transitive frame ($M = 2.13$ seconds vs $M = 1.73$ seconds) and also for the “with” frame ($M = 2.24$ seconds vs $M = 1.77$), and this pattern was the same for the total looking times.

In discussing methodological issues when using children’s visual in response to an auditory stimulus, Swingle, Pinto, & Fernald (1998) discuss changes in the child’s looking. A pattern of interest they discuss is from the distracter to the target ($D \rightarrow T$) as it can be assumed that the child is processing the speech input. If the child looks to the target and then switches quickly to the distracter ($T \rightarrow D$) and stays there, we assume that the child is not able to match the visual stimuli to the auditory. However, once the child has matched, the question is how long she will remain fixated before losing interest. Thus one of the decisions to be made with IMPL tasks is whether to take total looking time as the measure in determining what children know. There are decisions to be made with other methods used for testing children’s language knowledge also. For example, with picture selection tasks the researcher must decide whether to record only the first picture pointed to, or whether to allow changes. Interpreting toy manipulation actions by young children may also be problematic.

IMPL tasks are particularly useful for testing language knowledge in children with language impairments. We have started using the method with SLI children aged from 3–6. Early results show that the children are more attentive to dynamic stimuli than static. Our tests of the children’s receptive language, on their understanding of different sentence structures, have taken less time than tests using picture pointing because the children have been more attentive and interested in the visual stimuli presented on screen than on paper. A clear advantage of the IMPL method is that it is possible to record the behaviour which reflects the child’s decision-making. Thus structures which are more difficult to map onto a visual stimulus can be investigated. The *number* of times a child switches from one screen to the other during the test trial may be indicative of uncertainty.

While in real situations the child may rely on pragmatic cues to interpret messages, the experimental set-up for IMPL offers a choice between two interpretations. The choice provided in the experimental set-up may affect how well the children are able to identify the matching scene. For example, in a study by Bavin, Wales, & Kelly (1998), it was found that children were better able to match a transitive sentence to the appropriate visual

stimulus if the choice was between two transitive (caused) events than if the choice was between one transitive (caused) and one intransitive (spontaneous). In order to determine which scene matched when the choice was between two caused events, the children only needed to use a word order strategy: first noun is agent. By manipulating the choices, it is possible to tease out how well children are responding to particular linguistic stimuli.

5. CONCLUSION

The results of the current study indicate that children of 24–31 months respond to three syntactic frames differently when novel verbs are presented in the three frames. The different patterns indicate that children pay attention to the linguistic stimuli rather than looking at a preferred picture; both Naigles & Kako (1993), and Hirsh-Pasek & Golinkoff (1996) report that a synchronous action is the preferred one when a verb is presented without a syntactic frame. The study has added to our understanding of children's syntactic knowledge. In a between-subjects design, as used in previous studies, it is not clear if the children can distinguish different syntactic frames, only that they can (or cannot) identify the patterns on which they are tested. The current study using a within-subjects design shows that children of 24–31 months (mean age 26.9 months) are able to distinguish all three.

Children must at some stage move beyond reproducing a verb in a memorized frame. Novel uses are evidence of this development. However in order to use verbs in novel ways, children must have generalized some meaning for particular syntactic frames. For example, if "give" was substituted for "push" in the novel utterance "Push her the mouse", the utterance would be appropriate. We assume the child producing this utterance intends "her" to be the recipient in this sentence and "the mouse" to be the thing which gets transferred. To find out how well children could generalize and to avoid the problem of particular frames being associated with particular verbs, the current study used novel verbs. While 25 month olds may not have a general category of verb (Olguin & Tomasello, 1993), the general findings from the current study support those from earlier studies using preferential looking: children between two and two-and-a-half years are able to interpret the referent for a novel verb if it is presented in a transitive frame. That is, the relationship between transitivity and causativity is strong. An intransitive frame is less likely to be matched with a spontaneous action. One influencing factor is that intransitive verbs are frequently followed by non-core arguments and these are attached with markers (prepositions) which identify their semantic role. In order to interpret the structures, the child must know the meanings of the grammatical markers. We used "with" in one of the intransitive frames to mark the second argument as comitative. Future research could investigate how well children are able to interpret intransitive frames which make use of other prepositions to link non-core arguments, markers including "to" (as in "Jane turned to Mark") and "from", as well as spatial and temporal words (e.g., "behind" and "after").

Results from a separate experiment in our laboratory suggest that two year old children may be more frame compliant with novel verbs than real verbs. In this study novel verbs and real verbs were included in a within-subjects design, testing three syntactic frames.² The real verbs (e.g., "bend", "turn" and "scratch") could be used in either a tran-

² Melissa Coutts, Evan Kidd, Shanyne Payne, Cathy Prowse, Belinda-Jayne Rhodes, and Briony Towers conducted the research.

sitive or intransitive frame. Looking times were in the predicted direction, but what is notable is that the proportion of looking times to the matching visual stimuli over the non-matching were greater for the novel verbs than for the real. Familiarity with verbs in particular frames may bias children's interpretations, as might be predicted by the Verb Island Hypothesis (Tomasello, 1992). However when a child hears a novel verb the frame in which it is used can assist the child in interpreting which of two interpretations is the intended one.

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