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What gestures reveal about how semantic distinctions develop in Dutch children's placement verbs

MARIANNE GULLBERG and BHUVANA NARASIMHAN*

Abstract

Placement verbs describe every-day events like putting a toy in a box. Dutch uses two semi-obligatory caused posture verbs (leggen 'lay' and zetten 'set/stand') to distinguish between events based on whether the located object is placed horizontally or vertically. Although prevalent in the input, these verbs cause Dutch children difficulties even at age five (Narasimhan and Gullberg, accepted). Children overextend leggen to all placement events and underextend the use of zetten. This study examines what gestures can reveal about Dutch three- and five-year-olds' semantic representations of such verbs. The results show that children gesture differently from adults in this domain. Three-year-olds express only the path of the caused motion, whereas five-year-olds, like adults, also incorporate the located object. Crucially, gesture patterns are tied to verb use: those children who over-use leggen 'lay' for all placement events only gesture about path. Conversely, children who use the two verbs differentially for horizontal and vertical placement also incorporate objects in gestures like adults. We argue that children's gestures reflect their current knowledge of verb semantics, and indicate a developmental transition from a system with a single

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semantic component—(caused) movement—to an (adult-like) focus on two semantic components—(caused) movement-and-object.

Keywords: gesture, verb semantics, Dutch, language development, placement.

1. Introduction

How adult-like are children's verb meanings in the early stages of development? Prior work on how children tune in to semantic patterns in the input has investigated children's comprehension of verb meaning (e.g., Gentner 1978; Thomson and Chapman 1977) as well as their production of verbs in both elicited and spontaneous contexts (e.g., Choi and Bowerman 1991; Fisher et al. 1994; Gropen et al. 1991; Naigles and Hoff-Ginsberg 1998; Pye et al. 1996). However, with some notable exceptions (e.g., Anglin 1970; Bowerman 1978), surprisingly few studies have asked how adult-like children's semantic systems are once forms are in use in production. We therefore know remarkably little about the nature of the semantic representations children operate with, what changes take place in the system over the course of development, and when such changes occur. This study explores children's development of verb meaning and what semantic distinctions may underlie their extension patterns in the semantic domain of object placement by looking across modalities. More specifically, we ask what children's gestures about 'putting things in places' can tell us about their developing semantic systems.

1.1. *Placement, caused motion verbs, and their development*

Children and adults talk frequently about the placement of objects such as putting a toy in a box. Object placement can be defined as events of caused motion where an object (a 'located' or figure object) is moved to a location (a 'reference object' or ground) with (typically manual) control exerted over the located object until it reaches its end location (cf. Bowerman et al. 2002; Bowerman et al. 2004). Placement ('put') has long been a popular candidate for a cognitive and linguistically basic notion (Goldberg 1995; Pinker 1989), and children are assumed to acquire 'light' verbs such as 'put' early and easily (Clark 1978; Pinker 1989). But there is also crosslinguistic variation, for instance in the number of verbs that populate this domain and their level of semantic granularity (cf. papers in Ameka and Levinson 2007; Kopecka and Narasimhan to appear; Levinson and Wilkins 2006). Patterns range from single, light, all-purpose verbs like English 'put', via systems with a small number of (caused posture) verbs

with more specific semantics and constrained extensions like 'set', 'stand' and 'lay', to large inventories of very specific, classificatory placement verbs as in the Mayan languages. Moreover, languages sometimes have mixed systems with optionality between the use of light and more specific verbs, as in English where 'put' co-exists with the rarer 'set', 'stand', and 'lay' (cf. David 2003; Pauwels 2000).

The acquisition of verbs in this domain also displays variation cross-linguistically (e.g., Chenu and Jisa 2006; Hansson and Bruce 2002; Hickmann and Hendriks 2006; Slobin, et al. in press). But interestingly, neither number of semantic distinctions made in a given semantic domain, nor optionality of use in the input seem to significantly delay verb acquisition (e.g., Brown 1998; Narasimhan and Gullberg 2006). Based on a broad crosslinguistic comparison of the acquisition of placement verbs in languages that lexicalise path in verbs (verb-framed) vs. in satellites (satellite-framed, Talmy 1985), it has instead been suggested that acquisition is determined by many factors, including the interaction between semantic distinctions made in the verb and other non-verbal forms (e.g., case marking, adpositions) expressing relevant spatial information (Slobin et al. in press).

Dutch uses a small set of caused posture placement verbs, *zetten* 'set' and *leggen* 'lay'. In addition to caused change of location, these monomorphemic verbs encode information about figure objects and their end configuration in that location or ground. Among other factors, the choice of verb for a given event depends on the properties of the object being located: its shape, its orientation, and its disposition with respect to the ground. Specifically, the semantic distinctions concern the presence of a functional base and whether the figure object is resting on it, and whether the spatial extension or projected axis of the object is vertical or horizontal (Lemmens 2002, 2006; van Staden et al. 2006). For figure objects resting on their base, often extending vertically, *zetten* 'set' is typically used, as in example (1). For figure objects lacking a functional base and/or extending horizontally, *leggen*, 'lay', is preferred, as seen in (2).

(1) *zij zet de kop/de fles op tafel*
'she sets the cup/the bottle on the table'
(2) *zij legt de bal/de fles op tafel*
'she lays the ball/the bottle on the table'

Dutch caused posture verbs are semi-obligatory and frequent in adult usage, and they are also ubiquitous in the input to Dutch children (Narasimhan and Gullberg accepted). In line with claims that children tune in very early to the habitual patterns of encoding in their language (Choi and Bowerman 1991; Slobin et al. in press), Dutch children might

therefore be expected to acquire these verbs early, easily, and uniformly. However, these verbs cause unexpected difficulties for children as old as four and five leading to non-adult-like verb use (Narasimhan and Gullberg accepted). When Dutch children's verb use is compared to that of adults for the same set of scenes, children are found to over-extend *leggen* 'lay' and under-extend *zetten* 'set', seemingly picking one default verb to apply to all placement events. The question arises as to what semantic distinctions children who use *leggen* 'lay' for all placement events actually operate with. One novel way to examine this question is to consider other available vehicles of meaning, namely speech-associated gestures, along with speech.

1.2. *Gestures and language-specific meaning*

Speech-associated gestures are closely linked to speech and language. Generally, speech and gesture are semantically, temporally and pragmatically coordinated such that the most meaningful part of a gesture, the stroke, typically is temporally coordinated with a part of speech expressing closely related meaning (Kendon 1980; McNeill 1992). Although theories about the speech-gesture relationship differ in their views on the locus and nature of the connection, the connection itself is undisputed (for a review, see De Ruiter 2007).

Adults' gestural practices differ crosslinguistically for various reasons (cf. Kendon, 2004). Recent research suggests that the variation is partially related to linguistic variation. Although gestures convey information in a different format from speech, they reflect the linguistic choices speakers make: what information is considered newsworthy and when (McNeill 1992; McNeill, Levy and Pedelty 1990). Insofar as languages select different information for expression, gestural forms and their timing relative to speech thus differ crosslinguistically. For instance, gestures have been shown to be influenced by how semantic components like path and manner of motion are lexicalised and packaged syntactically in a given language (e.g., Duncan 1996, 2005; Gullberg et al. 2008; Kita and Özyürek 2003; McNeill and Duncan 2000; Özyürek et al. 2005). Languages like Turkish, which expresses path and manner of motion in separate spoken clauses (e.g., *descend* [path] *while rolling* [manner]), also tend to be accompanied by gestures which express each component separately: one separate gesture for the path and another for the manner (e.g., Kita and Özyürek 2003).

Gestures also appear to be influenced by verb semantics alone when information structure and syntactic packaging are kept constant. For instance, French and Dutch organise placement descriptions similarly

(agent-action-object-location) and the simple transitive placement verbs project similar structures. However, the semantics of the placement verbs differ. French has a general placement verb *mettre* 'put', which chiefly encodes the caused motion. French adults predominantly accompany placement descriptions by gestures expressing only the direction or path of the movement (Gullberg in press, submitted). This is in contrast to Dutch adults who instead chiefly accompany their caused posture verbs by gestures incorporating the figure object with the direction of the gestural movement in hand shapes that reflect the imagined object. These object-incorporating gestures are not restricted to a specific verb, but occur with both caused posture verbs (viz. *leggen* as well as *zetten*). Since the information structure and syntactic packaging of placement descriptions is similar across the two languages, the difference in gesture patterns arguably stems from the different semantic specificity of the placement verbs. The Dutch gestural focus on objects seems to be prompted by the semantic distinction based on the object and its properties, viz. *leggen* 'lay' for objects without a base extended horizontally, and *zetten* 'set' for objects resting on their base, extending vertically. Conversely, the absence of a French gestural interest in objects seems to be influenced by the relatively less specific verb semantics in French.

The observed coordination between speech and gesture, which includes crosslinguistic differences in semantic and syntactic distinctions, suggests that gestures can be seen as vehicles of language-specific meaning on a par with speech. They can therefore provide an additional window onto speakers' event-related, semantic representations.

1.3. *Gestures in language development*

A growing body of research indicates that gestures and speech develop in parallel in childhood (e.g., Bates and Dick 2002; Capirci and Volterra 2008; Nicoladis et al. 1999; Volterra et al. 2005). However, despite the integration of the modalities, a number of studies also show that gestures serve as precursors to speech (e.g., Bates and Dick 2002; Tomasello et al. 2007), carrying more communicative weight in younger children (e.g., Guidetti 2005; Stefanini et al. 2008). A particular research tradition focuses on how gestures foreshadow speech such that non-redundant meaning is expressed in gesture before it can be expressed in speech in so called 'mis-matches' (Church and Goldin-Meadow 1986). The presence of such gestures has been seen as an indication of transitional knowledge states and of a readiness to learn both language (e.g., Capirci et al. 1996; Goldin-Meadow 2007; Özcaliskan and Goldin-Meadow 2005), and learning more generally (e.g., Alibali and Goldin-Meadow 1993; Goldin-Meadow 2003; Pine et al. 2004) even beyond younger childhood.

There is also evidence that gestures can be informative about the development of semantic representations in general (Capone, 2007), and about the development of language-specific semantics in particular. This latter aspect has been examined in the domain of motion where the realisation of semantic components like path and manner has been explored in speech and gesture. A series of studies investigating descriptions of motion and causal events in English and Turkish have shown that children between three and nine learning these languages overall display general ('universal') patterns in younger childhood, and language-specific patterns later on (e.g., Allen et al. 2003; Özyürek and Özcaliskan 2000). At age three, the children examined often display similar patterns crosslinguistically, conflating elements of path and manner, or cause and path of motion, in gesture and in speech. Language-specific patterns emerge around age five or six, depending on the study and construction examined. Particularly interesting is the observation that speech and gesture often express the same meaning even if neither modality is adult-like. For instance, the youngest Turkish children's gestures differed from those of Turkish adults in that they conflated cause and path of motion more often than Turkish adults did, but they were consistent with their own spoken descriptions which also conflated these components more than adults (Furman et al. 2006). Similar findings come from a study of the expression of path and manner of motion in French. French children aged four and six were adult-like in their tendency to both talk and gesture predominantly about path (Gullberg et al. 2008).

In sum, these studies of children's speech and gesture generally suggest that children's gestures reflect the meanings that they express in speech. This in turn suggests that children's gestures can be informative about their semantic representations at a given point in time.

2. This study

The aim of the present study is to examine the nature of children's semantic knowledge of placement verbs in more detail. We do this by considering how Dutch three- ($N = 5$) and five-year-olds ($N = 7$) use gestures in parallel with Dutch caused posture verbs to describe object placement events compared to Dutch adults ($N = 10$). We ask the following two questions: (1) Do Dutch children gesture like adults in the domain of placement? (2) If not, do Dutch children's placement gestures differ depending on their patterns of use of placement verbs, and if so, how?

Previous research leads us to expect Dutch adults to produce the caused posture verbs *leggen* 'lay' and *zetten* 'set/stand' in the description

of placement events, and also to produce gestures that reflect the semantic importance of figure objects through a preference for object-incorporation with the direction or path of gestural motion. Our first analysis examines whether children's gestures accompanying placement descriptions look overall adult-like. Second, to determine whether children's use of placement verbs is adult-like, we investigate children's deployment of verbs to a set of target events, which systematically vary the orientation of figure objects, and compare them to adults. Finally, we examine whether gesture use differs between those children whose verb use is adult-like versus those whose verb use is not in order to explore whether the information expressed in gesture can shed light on the semantic representations underlying the usage of placement verbs.

3. Method

To elicit natural speech and gesture data while maintaining control over the extensions of placement verbs, we used a referential communication task (Yule, 1997) in the form of a Director-Matcher game. One participant, the Director, describes video clips depicting placement events to a confederate, the Matcher, who must then select the picture corresponding to the description from a set of possible options. The dyadic set-up as well as the information gap between the participants is conducive to gesture production despite the short, simple descriptions.

We first examine children and adults' overall gesture production and the frequencies of use of object-incorporating versus path-only gestures. We then compare children and adults' verb use to describe the same scenes in a subset of contrastive target placement events. Finally, we explore the connections between gesture production and verb use in individuals.

3.1. *Participants*

Participants were 29 children acquiring Dutch (aged 3;1 to 6;0) recruited through a Dutch preschool (Molenhoek, the Netherlands). For the purposes of this analysis, we excluded all children who produced fewer than three gestures during the task, leaving 12 children in total for analysis. The children fell naturally into two groups of children aged 3;1–4;5 (*M* 3;6, N = 5), and children aged 5;1–6;0 (*M* 5;4, N = 7). For ease of exposition, the child groups are referred to as 'three-year-olds' and 'five-year-olds'. Additionally, 29 adult native speakers of Dutch were tested as

controls, 10 of whom produced more than three gestures and were therefore retained for analysis.

3.2. *Materials*

The stimuli, developed for a crosslinguistic comparison of placement event descriptions (cf. Narasimhan and Gullberg 2006; accepted), consisted of a set of video clips showing a female actor manually placing figure objects (henceforth simply 'objects') on a shelf or a table top. Sixteen target events showed eight objects (a doll, a monkey, a bear, a dog, a can, a book, a flashlight, and a picture frame) being placed either in a vertical or horizontal position at a location (see the Appendix, target events listed in boldface). Twenty filler events and 3 warm-up items showed a range of other objects being dropped, squeezed, etc. These were not expected to elicit placement verbs. The stimulus clips were randomized and organized into two orders. The presentation of the stimulus order was counterbalanced. A set of still photos of the objects in their end location was also produced.

3.3. *Procedure*

Participants were tested individually and given oral instructions that they were going to play a game where they had to help one person (Experimenter2) put a set of pictures in the right order. Participants saw one video clip at a time on a laptop screen manipulated by Experimenter1. Experimenter2, who could not see the video screen, asked the participants "What did the woman do?". Based on the participants' descriptions, Experimenter2 chose the correct still image from the set of stills depicting the placement scenes. If participants gave a simple locative expression or an intransitive description (e.g., 'the book is/lies on the table'), then Experimenter2 asked 'What happened' or 'What did the woman do?' Adults controlled the computer themselves. The testing procedure was otherwise identical for adults and children. The session started with three warm-up items. The entire testing session was audio- and video taped.

3.4. *Data treatment*

3.4.1. *Speech.* Native speakers of Dutch transcribed the first spontaneous transitive description of each video clip (cf. Plumert et al. 1995). An (adult) example is given in (3), with the first transitive description in boldface.

(3) *ze pakt een dingetje … zo'n knuffelbeertje en* ***die zet ze op tafel***
'she takes a thingy … a little teddy bear and **that she sets on [the] table'**

The placement verbs were selected for further analysis. Where two utterances described the same scene with different object labels, the first one was selected. Finally, in cases of self-corrections, the first immediately following complete and/or interpretable description was retained. A similar procedure was applied to uninterpretable utterances.

3.4.2. *Gesture.* The narrow focus on the first descriptions is particularly important for the gesture analysis. Gestures are sensitive to information structure and tend to co-occur with the most newsworthy element. In the first description of the placement event, that information is the placement act itself in conjunction with the ground. In contrast, in elaborations prompted by questions, other spatial information is often targeted such as specific locations like 'at the right-hand corner on top'. Gestures accompanying such elaborations are often deliberately demonstrative, sometimes aligning with spoken deictic expressions referring to the gesture ('like this'). These gestures therefore target other information and are potentially driven by other mechanisms than gestures performed without any particular demonstrative intent. Also excluded from analysis, and for similar reasons, were gestures occurring with disfluencies or multiple hesitation phenomena (cf. Gullberg 1998).

Using frame-by-frame analysis of digital video in video annotation software (ELAN, http://www.lat-mpi.eu/tools/elan/), we identified gestures occurring with the spontaneous first descriptions of the placement events. Specifically, we identified gestural strokes, that is, the expressive part of the gestural movement where the spatial excursion of the limb reaches its apex, and post-stroke holds, or cases where the hands are temporarily immobile in gesture space before moving on (Kendon 1972, 2004: 111–112; Kita et al. 1998; Seyfeddinipur 2006). All gestures thus identified were then coded for whether they encoded (figure) object information, or only direction or path of movement. This coding was done with sound turned off and was based on the structural properties of the gestures alone to avoid circularity when gesture information was compared to speech information. Gestures were coded as expressing object information when they displayed a hand shape that reflected and incorporated the figure object into the movement. Gestures were coded as expressing only path of movement when they expressed a 'spatial excursion' (cf. Kendon 2004) laterally, vertically or sagittally from the speaker's body and displayed no particular hand shape, that is, a relaxed, floppy hand or a pointing hand shape. Examples of these categories are displayed in Figure 1a (Object-incorporation) and Figure 1b (Path-only).

Finally, in the same annotation software with sound turned back on, we also transcribed the speech that co-occurred exactly with the gesture

Figure 1a. *Example of gesture coded as Object-incorporating displaying a hand shape indicating the presence of a figure object.*

Figure 1b. *Example of gesture coded as Path-only displaying a flat hand with* no *hand shape indicating the presence of a figure object.*

stroke, although no detailed speech-gesture alignment analysis was performed for this study.

Interrater reliability of the gesture coding was established by having a second coder judge the data. The interrater reliability for gesture identification was .94 (N = 235) and for form coding (object-incorporation vs. path-only) .92. In cases of discrepancy, the judgement of the second coder was retained. Table 1 summarises the total number of gestures per age group.

Table 1. *Number of gestures per age group*

	# speakers	# gestures
3-year-olds	5	66
5-year-olds	7	70
Adults	10	99
Total	22	235

3.5. *Analyses*

The dependent variables are proportions of gestures per participant expressing object-incorporation vs. path-only, and proportion of verb types used per participant. Because the dependent variables are proportions, they were arcsine transformed for statistical analysis (Howell 2002); however, non-transformed values are reported in tables, figures and text. Analyses of gesture data draw on non-parametric statistical tests, specifically Kruskal-Wallis for comparisons of multiple independent samples and Mann-Whitney for comparisons of two independent samples. Speech

data are analysed with parametric one-way ANOVAs followed by Tukey HSD tests for post-hoc comparisons.

4. Results

4.1. *Overall gesture use*

We first examine whether Dutch children produce the same gestures and to the same extent as Dutch adults, excluding warm-up items but including both target and filler events. Figure 2 summarises the mean proportion of gestures that express object-incorporation in the form of object-related hand shapes or path-only as a function of age (3 years, 5 years, adults).

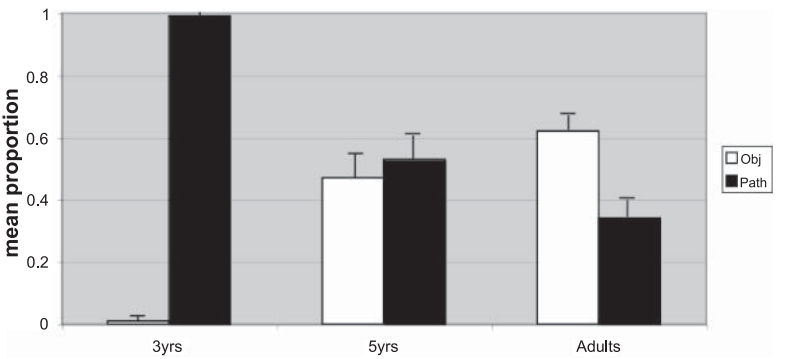

Figure 2. *Mean proportion of gestures expressing object-incorporation in hand shape (Obj) or path-only (Path) as a function of age. (Error bars = standard error).*

Adult Dutch speakers show a clear preference for incorporating object information in gestures that accompany placement descriptions. They produce gestures with hand shapes that incorporate objects in the gestural movement. Moreover, the occurrence of these object-incorporating gestures is not restricted to a specific verb, but they occur with both verbs across the board. These data replicate previous findings showing a robust adult Dutch gestural preference for object-incorporation with placement descriptions (Gullberg in press, submitted). The child data look strikingly different. The youngest children in particular almost exclusively produce gestures that express only path.

In order to investigate whether there was a difference in the overall pattern of gesture usage across the three age groups a Kruskal-Wallis test was run on the mean proportion of object-incorporating gestures

(Obj = 1) with age (3, 5, adults) as the between-subject factor. The groups differed significantly in the mean proportion of object-incorporating gestures (χ^2 (2, $N = 22$) = 11.46, $p < 0.01$). Specifically, 3-year-olds produced significantly fewer object-incorporating gestures (*M* 1%, *SD* 2%) than both 5-year-olds (*M* 47%, *SD* 27%; $z = -2.44$, $p = 0.02$) and adults (*M* 62%, *SD* 15%; $z = -3.09$, $p < 0.001$), who did not differ from each other ($z = -1.52$, $p = 0.13$). The youngest children clearly prefer to express only path in their gestures accompanying placement descriptions, and only very rarely do they express object information. 5-year-olds express considerably more object-incorporation, although their preferences do not numerically match those of adult speakers.

Children thus gesture differently from adults. They do not appear to imitate the adult gestural input, nor to imitate the practical placement actions by enacting a placement event with a symbolised, imagined object (cf. Capirci et al. 2005).

4.2. *Verb use*

We next investigate whether children use the same verbs to describe the same scenes as adults, that is, whether they have the same extension patterns as adults or convey the same meaning with the verbs as adults do. We focus on verb use for the 16 target items, which systematically vary object orientation. We group the target scenes by orientation into two groups of 8 scenes each: horizontal and vertical placement. All verb responses, including inappropriate forms for a given orientation, went into the analysis. For each age group, the mean proportion of responses per verb type (*leggen*, *zetten*, and OTHER) was computed (cf. Narasimhan and Gullberg accepted).[1] Figure 3 summarises the mean proportion of verbs used to describe horizontal (Figure 3a) and vertical items (Figure 3b), respectively, as a function of age.

For horizontal items the typical adult verb choice is *leggen* 'lay'. All age groups overwhelmingly used the verb *leggen* for items placed horizontally. The three-year-olds also used a sprinkling of OTHER verbs. One-way ANOVAs for each verb type with age group as the between-subject factor[2] revealed no difference between the groups in use of *leggen* 'lay' ($F(2,19) = 1.66$, $p = 0.22$), or *zetten* 'set/stand' ($F > 1$). However, the

1. This analysis is similar to the one performed in Narasimhan and Gullberg (accepted), but is performed here on a sub-set of those data, viz. only on speech data from those participants who also gesture.
2. Because an items analysis on as few items as 8 is difficult to interpret, no items analysis was performed.

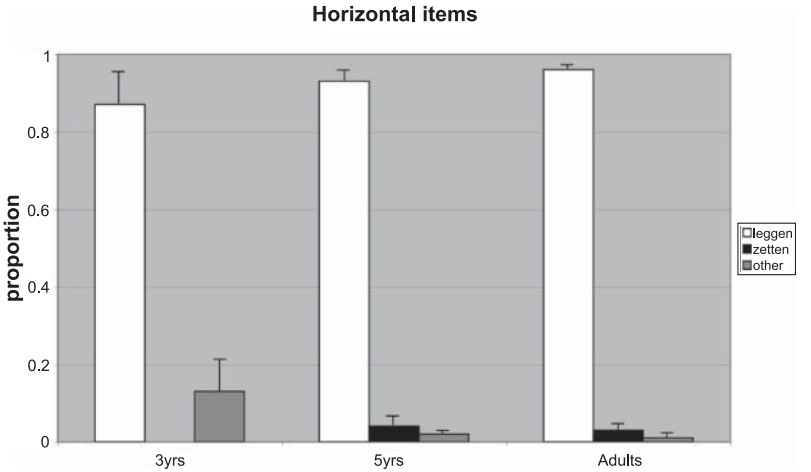

Figure 3a. *Mean use of* leggen, zetten, *and OTHER in Dutch for 8 horizontal target scenes across age groups (error bars = standard error).*

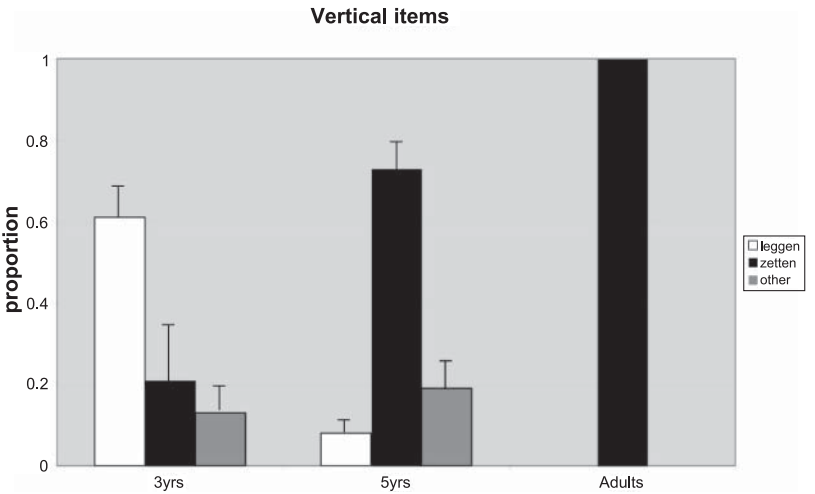

Figure 3b. *Mean use of* leggen, zetten, *and OTHER in Dutch for 8 vertical target scenes across age groups (error bars = standard error).*

groups did differ in their use of OTHER ($F(2,19) = 4.94$, $p = 0.02$), with three-year-olds using significantly more OTHER verbs (*M* 13%, *SD* 21%) than five-year-olds (*M* 2%, *SD* 6%; Tukey HSD $p = 0.04$) and adults

(*M* 1%, *SD* 4%; Tukey HSD $p = 0.02$), who did not differ.[3] Critically, the groups did not differ in the use of *leggen*. Dutch children thus use *leggen* for horizontal items as often as adults already by the age of three and half.

For vertical items, the standard verb choice should be the verb *zetten* 'set/stand'. This is the only verb used by adults, but children behave surprisingly differently. The youngest children use *leggen* 'lay' for more than half of the vertical items and only rarely use *zetten*. One-way ANOVAs for each verb type with age group as the between-subject factor revealed a difference between the age groups in the use of *zetten* 'set/stand' ($F(2,19) = 11.02$, $p < 0.001$), with three-year-olds using *zetten* significantly less (*M* 21%, *SD* 39%) than adults (*M* 100%; Tukey HSD $p < 0.001$), and five-year-olds also using *zetten* significantly less than adults (*M* 73%, *SD* 33%; Tukey HSD $p = 0.03$). Despite the numerical difference, the child groups did not differ statistically from each other. In contrast, the two child groups did differ in their use of *leggen* 'lay' for vertical items ($F(1,11) = 6.31$, $p = 0.03$), with the three-year-olds using significantly more *leggen* (*M* 61%, *SD* 31%) than five-year-olds (*M* 9%, *SD* 15%). The child groups did not differ in their use of OTHER, however ($F(1,11) = 3.19$, *p* 0.11).

The Dutch three- and five-year-olds in this sample thus differ from adults in their under-use of *zetten* 'set/stand' for vertical items, and both child groups differ from adults in that they use *leggen* 'lay' to describe vertical scenes, three-year-olds significantly more so than five-year-olds. Some children thus use *leggen* across the board for all placement scenes.

4.3. *Gesture use with **zetten** and **leggen***

We finally turn to the question whether gesture use differs between those children who use both *leggen* 'lay' and *zetten* 'set/stand' and those who over-extend *leggen* to all placement regardless of orientation of the object. Figure 4 summarises the mean proportion of gestures that express object-incorporation in the form of object-related hand shapes or path-only as a function of whether children over-extend *leggen* and chiefly use one verb (N = 6), or whether they use two verbs (N = 6) to describe the 16 target scenes. The adult data are included for ease of comparison.

When gestures are considered in parallel with speech, a binomial distribution is found such that children who mainly use only one verb, *leggen*

3. We could not perform an omnibus (repeated measures) ANOVA on all verb types across age groups since not all groups used all verbs. The same argument holds for the analysis of vertical items.

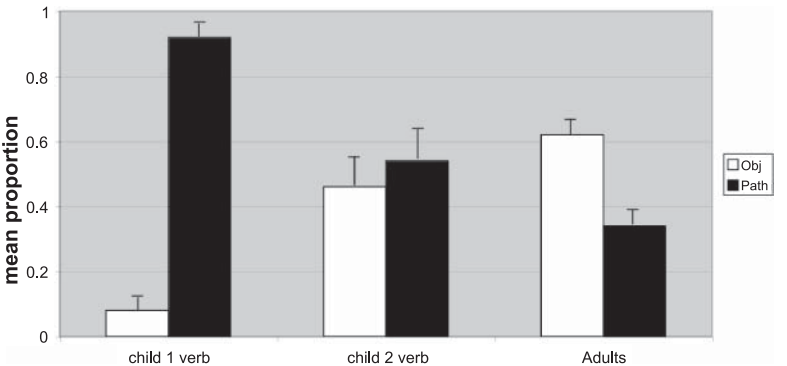

Figure 4. *Mean proportion of gestures expressing object incorporation in hand shape (Obj), or path-only (Path) as a function of whether children use one verb or two verbs to describe placement verbs. (Error bars = standard error).*

'lay', to describe all 16 target events also predominantly produce gestures that express path-only. In contrast, children who use two verbs, both *leggen* 'lay' and *zetten* 'set/stand', to describe horizontal and vertical placement, respectively, also produce object-incorporating gestures, even if their proportions do not quite match those of adults. Again, a Kruskal-Wallis test (Obj = 1) revealed that the groups differed significantly in the mean proportion of object-incorporating gestures (χ^2 (2, $N = 22$) = 12.15, $p < 0.01$). Specifically, children using mainly one verb produced significantly fewer object-incorporating gestures (M 8%, SD 16%) than both children using two verbs (M 46%, SD 26%; $z = -2.25$, $p = 0.03$) and adults (M 62%, SD 15%; $z = -3.28$, $p < 0.001$), who did not differ from each other ($z = -1.47$, $p = 0.15$).

Finally, a correlation analysis was run on the mean proportion of object-incorporating gestures and the mean proportion of *leggen* 'lay' used for vertical scenes across the age groups. The analysis revealed that with decreasing use of *leggen* for vertical placement, the proportion of gestures expressing object-incorporation increases significantly ($r(20) = -0.7475$, $t(20) = -5.03$, $p < 0.001$). This indicates that as children cease to label vertical scenes with *leggen* 'lay' and shift to using *zetten* 'set/stand', they are also more likely to produce object-incorporating gestures.

5. General discussion

This study examined how Dutch three- and five-year-olds use gestures in parallel with caused posture placement verbs to describe object placement events compared to Dutch adults. There are two main findings. First,

children in these age groups gesture differently from adults. Dutch adults show a robust preference for expressing objects and direction or path of movement simultaneously in placement gestures, a result replicating previous findings (Gullberg in press; submitted). In contrast, three-year-olds show a strong bias towards gestures that express only the path of the (caused) movement, and although five-year-olds are more likely to produce object-incorporating gestures, they are numerically still not adult-like in their preferences.

Second, children who use the placement verbs in non-adult-like ways in speech also gesture in non-adult-like ways. That is, children who over-extend *leggen* 'lay' to all placement scenes express only the path of the movement in gesture. In contrast, children who use both *leggen* 'lay' and *zetten* 'set/stand' differentially for horizontal and vertical placement respectively also incorporate objects in gestures like adults. They are adult-like in both speech and gesture, targeting information about objects and movement in both modalities.

What can these findings tell us about the semantic distinctions that underlie children's extension patterns in the semantic domain of object placement? The gesture data suggest that children who use *leggen* 'lay' to label all placement events are only targeting one semantic component, namely the movement or motion component of the caused motion verbs, as seen in their gestures expressing only path. These children do not seem to care about the object being moved and its properties. Recall that in the adult system some attention to the object is necessary for the choice of a specific placement verb to a given scene, which is arguably what prompts adults to also gesture about objects. There is no evidence in the children's gestures that the objects matter at this stage. Consequently, it is as if the verb *leggen* has an over-general meaning for children, 'cause to move' or 'put'. Similarly, the object-incorporating gestures produced by children who use both *leggen* and *zetten* differentially suggest that they have tuned their attention to encompass the object. Specifically, the gestural incorporation of the object suggests that these children have included the objects in their semantic representations of the caused posture verbs. We therefore argue that speech and gesture together indicate a developmental transition from a system with a single semantic component based on (caused) movement-only, reflected in the use of one single verb (*leggen*), to an (adult-like) focus on (caused) movement-and-object mirrored in adult-like use of two verbs (*leggen* and *zetten*).

Notice that the crucial issue is not whether children notice the objects more generally, but whether the object is included in the representations of the transitive caused posture verbs. Even children who use *leggen* for all transitive placement descriptions occasionally talk and gesture about

the objects. However, the objects are not included in the compact transitive caused posture verb descriptions, but appear elsewhere. In (4) a child comments on the object outside the transitive description for a scene where a monkey is placed in a standing position:

(4) *nou die [staat] hij legt hem op de tafel*
well it [stands] he lays him on the table (DuCh18 aged 4;5)

The child first describes the end state of the object using a correct *in*transitive posture verb, *staan* 'stand'. She immediately follows this by a description of the placement event itself using *leggen* 'lay'. Interestingly, the gesture accompanying the intransitive verb *staan*, indicated in square brackets, still expresses path-only, and more specifically, movement towards the ground. There is no hand shape indicating an object-incorporation. The example nevertheless highlights (a) that the child is not confused about the object's orientation (vertical, standing), and (b) that she attempts to express both information about the object in its end state in *staan* and the caused motion in *leggen*. This may be a precursor stage to bringing the two elements together in one single adult-like representation.

One might wonder why not all children gesture about objects. Given the nature of placement events, children could have been expected to imitate the practical action as perceived and enact the placing of an object with a symbolised, imagined object in hand (cf. Capirci et al. 2005; McNeill 2005). They might also have been expected to imitate the gestural input provided by Dutch adults as they talk and gesture about placement. Finally, children could even have been expected to gesture about objects on theoretical grounds, given the documented tendency for speakers to make more fine-grained distinctions at the goal of a path of motion (e.g., Lakuta and Landau 2005; Regier and Zheng 2007). The object in its end configuration is arguably a goal-related part of the caused motion. The fact that children do not, and that there is a developmental trend from gesturing about movement-only towards adult-like gesturing about movement-and-object simultaneously suggest that children's gestures in this domain are influenced by their linguistic activities, and, more specifically, by the semantic distinctions they operate with, even at young ages.

The converse question is why younger children so overwhelmingly target path or the direction of movement alone in their placement gestures. One possibility is that this is a reflection of communicative development, as suggested by Clark and Grossman (1998). The youngest children may interpret the communicative goal of the situation differently from older children, and focus on direction or path towards the goal ground. However, this does not explain the strong co-occurrence of such gestures with

children's overextension patterns with the verb *leggen* 'lay'. A compensatory account of gestures might suggest that children gesture about path because they do not talk about it.[4] Although they use caused motion verbs, it could be argued that the path element is not explicit in these verbs. However, the data contain examples of children using the frequent path-prefixed forms of the Dutch caused posture verbs, such as *neerleggen* 'down.lay' and *inleggen* 'in.lay'. There is no difference between gestures accompanying such explicitly path-prefixed verbs and the bare caused posture verbs. It therefore does not seem to be a matter of path-compensation in gesture. A third possibility is that the difference in gesturing has nothing to do with the semantics of Dutch specifically. Instead, the path component may be a more universally basic motion element, as suggested by Talmy (1985), which all children therefore target initially. More crosslinguistic data is needed in the placement domain to address that issue. An additional option is that children do not target path information per se but rather that the path gestures reflect a more basic focus on *change*.[5] Kamp (1980) has argued that change is the fundamental basis for any event structure. In the study at hand, both a focus on change in general or a more specific focus on path would yield path gestures. It remains an issue for future research to disentangle these options.

Finally, there is no evidence in the data that gestures foreshadow speech such that children who use *leggen* 'lay' for both vertical and horizontal placement produce object-incorporating gestures, using gesture to indicate an interest in objects that they are not yet able to express in speech. These results seem to run counter to findings in the literature on cognitive development where children are found to express aspects of mathematical reasoning in gesture not yet accessible to them in speech (e.g., Alibali and Goldin-Meadow 1993; Goldin-Meadow 2003; Pine et al. 2004). The absence of such mis-matches in the current data does not invalidate the basic observation that gestures reflect children's current knowledge of placement verb semantics. First, their absence can simply be a sampling accident. Given the small number of children in this study, we cannot exclude the possibility that some children may gesture about objects while still over-extending *leggen* to all placement events. However, an alternative explanation is that children engaged in reasoning tasks have more room to express alternative, additional, or different meanings in gesture than do children who talk and gesture about as mundane and

4. This was suggested by an anonymous reviewer.
5. We thank an anonymous reviewer for this suggestion.

simple things as putting toys on tables. The nature of the task and the age range examined here may both contribute to the patterns observed.

Moreover, support for non-compensatory gesture production in language development comes from other developmental studies in the domain of voluntary motion. Turkish three-year-olds have been shown to differ from Turkish adults in gesture *and* speech, with the children's gestures critically matching their own speech (Furman et al. 2006). Similarly, French children aged four and six talking about path and manner overwhelmingly gesture and talk about the same elements (Gullberg et al. 2008). This is despite the fact that the complex constructions for expressing manner in French might have led children wanting to express all aspects of motion to talk about path and instead gesture about manner. However, even the youngest children look adult-like and gesture about path when talking about path, and gesture about manner only when speaking about manner. Similar consistency is reported for bilingual French-English children (Nicoladis and Brisard 2002). The view of children's gestures as mainly compensatory at these ages thus receives little support here.

In conclusion, this study suggests that Dutch children's knowledge of placement verb semantics moves from a focus on (caused) movement-only to a focus on (caused) movement-and-object in conjunction. Part of children's difficulties with the Dutch caused posture placement verbs seem to be related to understanding the role of the object as a necessary semantic component in these monomorphemic, portmanteau verbs that conflate cause, motion, and properties of the object in one form (cf. Narasimhan and Gullberg accepted). The transition from a system based on one single semantic distinction to a system with an adult-like focus on movement-and-object is not necessarily complete by age five, but seems to continue to develop in later childhood. How and exactly when this transition takes place is an empirical question.

More generally, the study highlights the value of studying children's gestures as a means of examining semantic representations in development. Gestures, as vehicles of language-specific meaning, provide a window on the details of what semantic elements underpin non-adult-like use of forms in inappropriate contexts, as well as what elements undergo change in switches towards more adult-like speech. Gestures allow us to go beyond error analysis of speech, stating merely *that* children's verb meanings differ from those of adults, and allow us to explore *how* they differ.

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Appendix A: Materials (target items in bold)

Warmup item 1
Warmup item 2
Warmup item 3
Agent_put_bear_lying
Agent_put_flashlight_lying
Agent_put_book_lying

Agent_put_doll_standing
Agent_put_paper_envelope
Agent_squeeze_wet_cloth
Agent_put_book_standing
Agent_put_can_lying
Agent_put_flashlight_standing
Agent_put_monkey_lying
Agent_put_can_standing
Agent_spin_disc
Agent_put_picframe_standing
Agent_put_bear_standing
Agent_drop_can_accidentally
Agent_put_doll_lying
Agent_drop_pencils_table
Agent_put_mouse_vase
Agent_drop_book_lying
Agent_drop_can_lying
Agent_put_napkin_floor
Agent_drop_doll_lying
Agent_put_cookiebatter_tray_spoon
Agent_flick_coin
Agent_put_piece_puzzle
Agent_put_dog_standing
Agent_put_rice_table
Agent_put_picframe_lying
Agent_put_pillowcase_pillow
Agent_put_arm_frame
Agent_put_monkey_standing
Agent_put_ring_pole
Agent_put_dog_lying
Agent_put_tomato_bag
Agent_drop_matchsticks_table
Agent_drop_monkey_lying