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Comprehension of Resultative Verbs in Normally Developing and Language Impaired German Children

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Between the ages of two and six, a normally developing (ND) child learns approximately 10 new words every day. The question of how children succeed in this task has long puzzled language acquisition researchers. Acquiring the labels for objects is already complex (Landau, 1994; Markman, 1994; Woodward & Markman, 1998), but learning the meaning of verbs poses even more challenges to the child. Unlike nouns, verbs do not refer to a concrete object but to events, which are typically fleeting.

Recently a number of studies have focused on verb acquisition strategies employing the distinction between manner and change-of-state components of verb meanings (for English cf. Behrend, 1990; Gentner, 1978, 1982; Gropen, Pinker, Hollander & Goldberg, 1991; Kelly & Rice, 1994; for German cf. Wittek, 1998, 1999). Findings from both comprehension and production tasks suggest that ND children up to 5 years of age and children with language impairment (LI) at an even later age prefer manner components of meaning to change-of-state components. This preference is referred to as the "manner bias" (Gentner, 1978).

In the present study, we investigate more closely children's verb comprehension in German. Our experimental evidence suggests that ND children correctly interpret resultative verbs as specifying the achieved endstate. Children with LI, however, are at chance in interpreting these verbs. Restating the notion of interpretation biases in event semantic terms, we argue that German speaking ND children possess a target-like event semantic representation of complex events, whereas LI children lack this representation.

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The first section of this chapter sketches the organisation of the verb lexicon and spells out how resultative interpetations of verbs are achieved in German. In the second section we summarize our findings from longitudinal studies with ND and LI children and outline the rationale of our experimental study. The third section presents the design of our comprehension study; the results are detailed in section 4. The last section discusses the findings in light of the "manner bias" proposed for young children and offers an outlook on future research.

ORGANIZATION OF THE VERB LEXICON

The Event Structure of Verbs

Unlike referential terms such as *Edinburgh* or *house*, verbs and most relational words including *play, eat, gone, more* and particles such as *up* refer to events or parts of events. Consequently, the lexical representation of a verb contains information not only about the core meaning and the argument structure but also about the type of event designated by the verb (i.e. aspectuality). Following Pustejovsky's (1995) model of event typology, we distinguish between states (*know, sleep*), processes (*play, eat, walk*) and transitions (i.e. complex events involving a transition from one subevent to another). Verbs such as *mix* and *build* and verbs such as *open* and *close* both designate a transition and are traditionally referred to as resultative verbs. However, there is a crucial difference between these two types of verbs regarding the hierarchy of the subevents. In *mix* and *build* the process subevent is more prominent, whereas in *open* and *close* the endstate subevent is more prominent. We will call verbs of the *mix*-type 'process-oriented' and verbs of the *open*-type 'endstate-oriented'.

Endstate-Oriented Verbs in German

Languages differ as to how event types are marked in syntax and word formation. Apart from verbs with an inherently endstate-oriented event type (e.g., *ankommen,* arrive), endstate-orientation of the predicate often depends on event-semantic properties of other elements in the sentence (cf. Hollebrandse & van Hout, 1998; van Hout, 1996). In German, endstate-orientation is often

marked by verb prefixation.[1] Prefixes such as *auf* or *zu* can mark the transitional events as endstate-oriented, as shown in (1):

(1) a. Er hat aufgegessen.
'he has AUF-eaten'
He ate up.
b. Er hat die Tür aufgemacht/ zugemacht.
'he has the door AUF-made/ ZU-made'
He opened/closed the door.

Event type marking via endstate-oriented prefixes is subject to considerable variation, however, depending not least on the semantic type of the verb and its arguments. In addition to endstate-oriented prefixes there are deictic prefixes such as *runter* or *rauf*, which express the speaker's perspective on an event and which are process-oriented (cf. Penner, Wymann & Dietz, 1998; Schulz, Wymann & Penner, in press). Thus, deictic prefixation can result in a process-oriented interpretation of the predicate, as shown in (2):

(2) Er ist den Turm raufgestiegen.
'he is the tower RAUF-climbed'
He climbed on the tower.

Given this intricate relation between a predicate's specific event type and its marking in a particular language, the question arises of how the child succeeds in learning the meaning of verbs.

VERB ACQUISITION IN NORMALLY DEVELOPING AND LANGUAGE-IMPAIRED CHILDREN

Words referring to events not only occur very early in children's speech (for English cf. Woodward & Markmann, 1998; for German cf. Behrens, 1999), but make up a significant proportion of a normally developing child's lexicon (Kauschke, 1999). Studies comparing verb inventories of LI and ND children suggest that children with LI have fewer verbs in their lexicons and make more frequent use of general purpose verbs than either their age-matched or their language-matched peers (Rice, 1991; Rice & Bode, 1993). To date, however, no study has examined in more detail how ND and LI children log into the verb lexicon. Put differently, in which order do these children produce which types of verbal prefixes and verbs?

This question is addressed in our longitudinal studies of 5 ND and 5 LI German children, who have been recorded from the onset of word production (Penner et al., 1998) The latter children were Late Talkers, defined as children

[1] Depending on the verb type, endstate orientation is also marked by determiners (cf. Krifka, 1989; Verkuyl, 1972, 1993; for acquisition cf. Van Hout, 1996, 1997).

who produce less than 50 lexical items at the age of 2;0. Later they were diagnosed as language-impaired. The main results are as follows. ND children log into the verb lexicon around their first birthday. All start out with the endstate-oriented prefixes *auf* or *zu*. Several weeks later, the first verbs occur in their speech. These are typically endstate-oriented verbs such as *aufmachen* (AUF-make, open). LI children exhibit a very different acquisition pattern. In addition to being delayed with regard to the emergence of verbal items, which are first produced around the age of 2;0, LI children start out with the deictic prefixes *runter* or *rauf*. Up to a year later, endstate-oriented prefixes and the first verbs occur in their speech.

A closer look at the usage of the first words referring to events confirms these qualitative differences between ND and LI children. In an analysis of how endstate-oriented events are expressed, we found that ND children lexicalized this endstate-orientation with an appropriate relational word in 82% of the cases. LI Children, on the other hand, correctly lexicalized the endstate-orientation in only 19% of the cases (Penner, Schulz & Wymann, in prep.).

In summary, our production data suggests that German ND children pay attention to the endstate of transitions from early on, whereas German LI children lack this endstate-orientation. An analysis of their usage of relational words moreover indicates that ND children possess a target-like event semantic representation of complex events that takes into account the hierarchy of subevents in transitions. LI children, by contrast, exhibit violations of the event semantic representation of complex events. This violation may be due to a lack of an explicit event semantic representation (cf. Penner et al., 1998; Penner, Wymann & Schulz, 1999; Schulz, Wymann & Penner, 1999, in press).

According to our account of the initial stages of ND and LI children's verb acquisition, analogous differences should arise at the level of comprehension. The experimental study was therefore designed to investigate whether and how the qualitative differences between ND and LI children with regard to event representations also affect their comprehension of event structures.[2] We hypothesized that ND children, adhering to an endstate-orientation, should recognize that the endstate is a necessary property of endstate-oriented verbs. LI children, on the other hand, due to a lack of the endstate-orientation should not recognize that the endstate is entailed by endstate-oriented verbs. This contrast should be especially clear when comparing the performance of children with LI and their age-matched peers, but it should also show up with very young ND children. To avoid ambiguous responses, we concentrated on clearly endstate-oriented transitions. The endstate-oriented verb *aufmachen* was chosen for two

[2] This experimental study is an extension of the experiment reported on in Schulz et al. (in press). Besides enlarging the data base by including a group of 16 ND children age-matched with the LI children, the statistical analyses have been modified and extended.

reasons. First, the hierarchy of subevents is optimally transparent, because the prefix *auf* unambiguously marks the endstate as the more prominent subevent, whereas the process subevent is lexically marked by the light verb *machen* (make, do) that carries little meaning on its own. Secondly, *aufmachen* has been documented in children's speech from very early on.

METHOD

Subjects

Forty-eight children participated in this experiment: 16 young normally developing children (10 girls, 6 boys, M = 2;10, *range* = 2;00 to 3;01), 16 language-impaired children (8 boys, 8 girls, M = 3;10, *range* = 2;11 to 4;10)[3], and 16 chronologically age-matched normally developing children (7 boys, 9 girls, M = 3;10, *range* = 2;11 to 4;10). Sixteen university educated adults served as a control group (6 men, 10 women, M = 37;08, *range* = 27 to 66). All of the subjects were native German speakers, with no known history of physical, socio-emotional, or mental impairments. The normally developing children exhibited age-appropriate speech, language, social, and cognitive functioning according to preschool teacher and parent reports. The children with language impairment met the following criteria: (a) they had been diagnosed by speech therapists as suffering from receptive and expressive language deficits, (b) the cognitive functioning was reported to be within normal limits for age, and (c) there was no report of hearing impairments. The chronologically age-matched children were matched so that for each child in the group of children with language impairment there was a child in the age-matched group within 1 month of age.

An additional seven children were tested, but had to be excluded from analysis. One young ND child and three LI children failed the pretest, and three young ND children did not complete the experiment.

Materials

Thirty-two picture sequences were created, each composed of two photographs depicting different instances of opening a container, e.g. a bottle or a cardboard-box. The first photograph always depicted the closed container and a hand moving towards it. The second photograph depicted the outcome of the action: The container was either opened or still closed, while the hand was being withdrawn. Using a variant of the truth-value judgment task (Crain & McKee,

[3] The higher age of the LI children is because, unlike ND children, they could not be subjected to tests involving yes/no questions until about their third birthday.

1985), we designed yes/no questions asking whether the person had opened the container. A subject who knows that the meaning of *aufmachen* entails the endstate [be open] should answer *yes* in the first case and *no* in the second case. In half of the picture sequences, the container was being manipulated by using just the hands, while in the other half it was being manipulated with the help of a tool (e.g., a wrench). Consequently, each picture-sequence varied with regard to the variables ENDSTATE [+/-] and INSTRUMENT [+/-]. There were 8 different instances of opening a container. Each subject thus saw a total of 8 test trials, two each in the four conditions. An example is given in (3):

(3) Sample item [-endstate, -instrument]

Diese Mutter wollte mit ihrem Kind spielen. Guck, da siehst du ihre Hand, und hier ist die Schachtel. Und dann. . .
This mother wanted to play with her child. Look, there you can see her hand, and here is the box. And then . . .

Test question:	*Hat siese aufgemacht?*	*Nein*
	'has she-her.CL AUF-made.PART'	
	Did she open it?	No

The perfect tense used in the questions is the standard form to refer to past events in colloquial (Southern) German, spoken by all participants. The four conditions were counterbalanced across the eight test items, yielding four different versions. Possible effects of order of test item were controlled for by designing two different orders, thus arriving at eight different lists to which subjects were assigned randomly.

Procedure

Each subject was tested individually. Preceding the actual experiment, a pretest was administered to ensure that both ND and LI children were able to respond to yes/no questions appropriately. While children were given the opportunity to manipulate the containers depicted in the picture sequences, they were asked simple yes/no questions about the objects (e.g., *Is that a suitcase?*). Only those children who answered all four pretest questions correctly participated in the main test. The encounters with the concrete objects moreover served the purpose of discouraging the child from basing her responses to the test trials merely on her previous world knowledge about the respective containers.

Following four practice trials, each subject was presented with the eight test items. As in the practice trials, the experimenter narrated the event. A hand

puppet then asked the yes/no question. Interspersed with the test items, there were four control items that contained verbs other than the test verb but were also phrased in the perfect tense. These were added to counteract processing strategies and moreover to ensure that children paid attention to each item until the end.

Predictions

We predicted that the ND children would perform better overall than the LI children. More specifically, both groups of ND children should correctly reject *aufmachen* for events in which the endstate is not reached, because they are aware that endstate-oriented verbs entail their endstate. Due to the age difference, we expected that performance of the three- and four-year-olds would be even better than performance of the 2-year-olds. LI children, on the other hand, should incorrectly accept *aufmachen* for events in which the endstate is not reached. With regard to the condition [+endstate], we expected that all groups would correctly accept the endstate verb *aufmachen* if the picture depicts an event in which the endstate is reached. Performance on the controls was predicted to be high for all subjects.

Scoring and Data Analysis

Responses to the test items were coded as correct or incorrect, as described in the materials section. A correct response received a score of 1, an incorrect response received a score of 0. Then, for each subject, the total number of correct responses for each of the four conditions and for the controls was calculated. In order to compare the mean of the controls to the mean of all test items, we introduced a meta-variable 'item' with the conditions [control] and [test item].

RESULTS

Group Responses to Controls and Test Items

All responses were first analyzed by a (4) group × (4) version × (2) order × (2) item ANOVA, with the last factor as a repeated measure ($\alpha = .05$). There were no significant effects of version ($F(3,32) = .45$, $p = .716$) nor of order ($F(1,3) = .17$, $p = .683$). Therefore, the between-subject factors version and order were neglected in the further analysis. All responses were then analyzed by a 4 (group) × 2 (item) ANOVA, with the last factor as a repeated measure. The proportion of correct responses for test items and controls is presented in Table 1.

TABLE 1
Proportion of correct responses (and standard deviation) by item type and subject group.

Item	*Young ND*	*Age-m. ND*	*LI*	*Adults*
Controls	87.50 (15.81)	98.44 (6.25)	95.31 (10.08)	100 (.0)
Test items	89.06 (13.59)	92.97 (11.15)	64.13 (11.06)	97.66 (6.80)

There was a significant effect of group, (F (3,60) = 19.83, $p < .001$) and a significant effect of item (F (1,60) = 13.59, $p < .001$). The interaction of group and item was also significant (F (3,60) = 13.59, $p < .001$). A *post hoc* analysis using the Scheffé procedure ($p < .05$) revealed that the means of the test items of the LI children differed significantly from the means of the test items of the young and the age-matched ND children and the adults, which formed a homogenous subset. A second *post hoc* comparison (Scheffé) indicated that the means of the controls of the LI children did not differ significantly from the three other groups.

Analysis of Test Items and Subgroup Comparisons

The responses to the four test conditions were analyzed by a 4 (group) × 2 (endstate) × 2 (instrument) ANOVA, with the last two factors as repeated measures (preserving α at .05). The analysis revealed a significant effect of group (F (3,60) = 30.14, $p < .001$) and of endstate (F (1,60) = 16.87, $p < .001$), but not of instrument (F (1,60) = .37, p = .547). With regard to the two-way interactions, the interaction between group and endstate process was significant (F (3,60) = 2.94, $p < .05$), as illustrated in FIG. 1.[4]

[4] The significant interaction between group and instrument (F (3,60) = 3.36, p = .024) was due to the low mean in the [-instrument] condition for the LI children and is neglected in the further analysis (cf. Schulz et al., in press, for an explanation of this result).

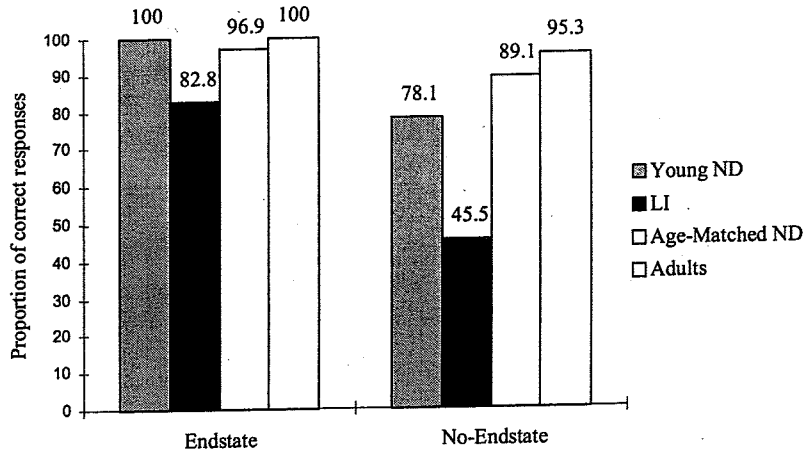

FIG. 1 Proportion of correct reponses to the test item by Endstate and subject group.

As can be inferred from Table 1 and FIG. 1, adults performed very well on all conditions. Hence only children's data was analyzed further. Weighted analyses of contrast were employed to examine possible distinctions between the three child groups. For the [-endstate] condition, there was a signifiant difference between the two groups of ND children and the LI children (T (45) = 4.256, $p < .001$), due to the low mean of the latter group (M = 45.5). To test whether performance of the LI children was different from chance, the means for the [-endstate] condition were compared to the proportion anticipated by chance (50.0) using the G test. It was found that if the endstate was not reached, performance was at chance level (p = .69). The contrast between the performance of the young and the age-matched ND children in the [-endstate] condition was not significant (T (45) = -1.053, p = .298). Regarding the [+endstate] condition, the contrast between ND children and LI children was significant (T (45) = 3.514, $p < .001$), whereas there was no contrast between the performance of the younger and the older ND children (T (45) = .609, p = .546). The G test revealed that in the [+endstate] condition, LI children performed significantly above chance ($p < .01$). Weighted analyses of contrast taking into account children's performance in both conditions revealed that the difference between LI children and ND children in the [-endstate] condition is significantly greater than in the [+endstate] condition (T (90) = -2.258, $p < .05$). A *post hoc* analysis (Scheffé) confirmed that the means of the LI children in the [-endstate]

condition differed significantly from all other means, which formed a homogeneous subset.

Finally, an ANOVA with the factor endstate as repeated measures was used to assess the responses of the LI children in isolation. There was a significant effect of endstate (F (1,15) = 6.43, $p < .05$), resulting from a lower mean in the [-endstate] condition (M = 45.31) than in the [+endstate] condition (M = 82.75).

Analysis of Individual Responses

Individual responses were examined to investigate whether the observed group differences between ND and LI children in the [-endstate] condition were also found in children's individual performances. Table 2 shows the percentage of correct answers to the [-endstate] condition for each child in the three subject groups.

TABLE 2
Percentage of correct responses in the [-endstate] condition distributed over subjects by subject group.

Percentage of correct responses (4 correct responses possible per subject)	*Young ND (N = 16)*	*Age-m. ND (N = 16)*	*LI (N = 16)*
100%	8	11	4
75%	4	4	0
50%	2	0	5
25%	2	1	3
0%	0	0	4

The endstate-orientation of the verb *aufmachen* was considered to be mastered by a child if she gave at least three correct responses in the [-endstate] condition. 12 out of 16 (75%) normally developing two-year-olds responded as though they had mastered the endstate-orientation of *aufmachen*. Among the three- and four-year-olds, 4 out of 16 (25%) LI children and 15 out of 16 (93.75%) ND children had mastered the endstate-orientation.

DISCUSSION

The high number of correct responses to the controls shows that both ND and LI children had in general no difficulty understanding yes/no questions containing a verb in the perfect tense. Thus, we can conclude that children's performance on the test items is not impeded by general problems with this question format. The analysis of the children's data confirmed that both groups of ND children performed much better on the test items than the children with LI. Both groups

of ND children correctly rejected *aufmachen* for events in which the endstate is not reached in 78% and 89% of the cases, respectively. Although not reaching significance, performance of the three- and four-year-olds was better in this condition than performance of the two-year-olds, as expected. LI children's rejection of *aufmachen* for events in which the endstate is not reached, on the other hand, was at chance level (46% correct). Analysis of the individual responses confirmed this difference between ND and LI children. The majority of the ND children but only 25% of the children with LI had mastered the endstate-orientation of *aufmachen*. All groups correctly accepted the endstate verb *aufmachen* if the picture depicted an event in which the endstate is reached. The children with LI performed significantly above chance but lower than all other groups (83% correct).

In summary, our experimental data revealed that ND children between the ages of two and four, but not three- and four-year old LI children, recognize that the endstate is a necessary property of endstate-oriented verbs such as *aufmachen*. Taken together with our data from spontaneous production, these findings corroborate our assumption that ND children possess a target-like event semantic representation of complex events, whereas LI children exhibit violations of the event semantic representation of complex events.

Both production and comprehension data are not compatible with the "manner bias" suggested to hold for English speaking children. Due to their preference for manner over change-of-state components, children up to the age of five have been found to misinterpret change-of-state verbs like *fill* or *mix* as specifiying the manner-of-motion instead of the achieved change-of-state (Behrend, 1990; Gentner, 1978, 1982; Gropen et al., 1991). Likewise, regarding German Wittek (1998, 1999) argues that four- and five-year-old children do not treat the endstate component as a necessary property of change-of-state verbs and thus misinterpret verbs such as *vollmachen* (fill), *aufwecken* (wake up) and *aufmachen* (open). However, many of the change-of-state verbs employed in these studies are process-oriented rather than endstate-oriented. *Fill* and *mix* as well as *wake up* refer to a gradual change, with the process subevent being the more prominent subevent. A verb-by-verb analysis of the German data confirms that the selection of the verbs considerably affected the results: Endstate-oriented verbs were in fact correctly interpreted as entailing their endstate in 80% to 100% of the cases, compared to 0% to 40% endstate-oriented interpretations for process-oriented verbs (cf. Wittek, 1999, p. 46).

Our results regarding LI children's verb interpretation are partially compatible with Kelly and Rice, (1994) findings regarding English speaking children with LI. They found that five-year-old LI children, unlike their age-matched peers, did not show any preference in applying a novel verb to either a motion or a change-of-state scene. As noted by Kelly and Rice (1994, p. 190), an account is needed of how children with LI differ from their age-matched peers in their strategies for verb acquisition and interpretation. Emphasizing the role of the verb's event structure, we advanced the hypothesis that LI children

lack a target-like event semantic representation of complex events. We hypothesized that this deficit results from a learning strategy for acquiring the event structure of verbs that does not consider the hierarchy of subevents (cf. Penner et al. 1998, 1999; Schulz et al., in press). The lack of a preference for a certain event type as observed by Kelly and Rice would follow then from a lack of an explicit event-semantic representation.

It remains for future research to evaluate this account, for example, by employing a wider range of resultative verbs. Moreover, studies with older LI children will have to show how persistent the observed deficits are. Preliminary results from a study with LI children between the ages of five and eight indicate that although their performance increases the deficits still exist (cf. Penner et al., in prep.).

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