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The interaction of language and thought in children's language acquisition: a crosslinguistic study*

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ABSTRACT

The purpose of this research was to investigate the potential interaction of conceptual representations and linguistic systems in the process of language acquisition. Language–thought interactions were studied in 80 American, 48 Finnish and 48 Polish preschool children. The research focused on the conceptual and linguistic development of space and time. The spatial and temporal conceptual tasks were designed to measure the transition from experiential to inferential knowledge of space/time representations. In the linguistic domain, comprehension and production tests were used to evaluate the children's capacity to understand mono- and bi-referential location in space and time, where mono-referential location involves a single referent object/event with intrinsic

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properties (e.g. *in/on* or past/non-past), and bi-referential location requires two or more referent objects/events and relative perspective (e.g. deictic *front/back* or *before/after*). The conceptual and linguistic tests revealed significant changes during the period from two to five years of age, and measures of conceptual development were correlated with measures of linguistic development. As spatial and temporal representations became more structured, children were able to move from mono- to bi-referential location. In a comprehension test, we discovered an interaction of language by dimension. Finnish children found spatial distinctions relatively easy and Polish children found temporal distinctions relatively easy. This interaction was expected on the basis of the relative complexity of the morpho-syntactic coding in the spatial and temporal systems of the two languages. However, the argument relating the timing of acquisition to the transparency versus opacity of the linguistic systems was not supported by the English language comparison. Finally, the Finnish children were relatively better able to accomplish the spatial conceptual tasks as compared to the Polish children. This finding is consistent with a developmental concept of linguistic relativity. In general, the research indicates that spatial and temporal linguistic systems and representational knowledge interact during development with the influence occurring in both directions.

INTRODUCTION

Purpose

This research concerns the relationship between conceptual development and language acquisition within the domain of spatial and temporal location. The research was designed to explore the argument that changes in the nature of space/time representations provide the states of readiness required for changes in the form of linguistic expression, and that the relative transparency versus opacity of language specific morpho-syntactic coding accelerates or retards the acquisition process (see Slobin, 1973, 1985). Time and space are particularly interesting concepts because all languages have systems to express temporal and spatial relationships, these systems are integrated into the morpho-syntactic structure of the language, and there is considerable diversity across languages. Polish and Finnish, in particular, exhibit a salient contrast in their temporal and spatial systems. On the conceptual side of the argument, previous research has shown that the form of spatial and temporal representations changes from relatively egocentric (or experiential) to relatively coordinated (or inferential) during the preschool period of development. Research on child language reveals a change in the nature of spatial and temporal location which appears to be associated with the conceptual transition. This research was designed to evaluate the potential relationship between changes in conceptual and linguistic development. Previous research on language–thought interactions has detected a relationship between conceptual readiness and linguistic innovations (e.g. Gopnik & Meltzoff, 1984; Loveland, 1984; Trosborg, 1982).

Conceptual research: the spatial domain

In the spatial domain, three studies are particularly relevant to the argument and to the methodology of this research (see Mandler, 1983 for a complete review). Hazen, Lockman & Pick (1978) taught preschool children to navigate through a laboratory 'house' which had a set of uniquely marked rooms arranged in a four-quadrant design. Then, they tested the children to determine the properties of the spatial representations that the children had constructed. While all the children could retrace their steps, only 1 of the 24 children at age 3;7 could build an accurate model of the house in contrast to 15 of the 24 children at age 5;6. Thus, the five-year-old children demonstrated the potential to relate the components of their experience. Furthermore, Hazen *et al*. asked children to predict which room they would enter if they used a new door which was not part of the original route. A significantly superior capacity to make such inferences was detected only in a group of six-year-olds. Therefore, the older children demonstrated the capacity to construct a more integrated representation of space. Secondly, Acredolo (1977) investigated children's capacity to cope with a 180 degrees spatial transformation. The children learned a right-angular route turning right or left to reach the desired goal. The children were tested from a new starting point on the opposite side of the room which established a 180 degrees difference in their perspective on the situation. Without salient landmarks at the goals or the starting points, only 50 percent of the three-year-old children in contrast to 100 percent of the five-year-old children were able to consistently go to the original goal location. Landmarks at the goals or starting points improved performance. Acredolo (Bluestein & Acredolo, 1979) also found that the three-year-old (but not the five-year-old) child's map reading skills are adversely affected by a 180 degree map rotation. Finally, Lockman & Pick (1984) examined children's conceptual representations of their two-storey townhouses. The children were asked to shine a light in the direction of a specific room in their house. The youngest group ranged from four to six years of age which places them at the mature end of the preschool age range, i.e. post-transitional. Their performance was relatively good with less than a 20 degrees error in azimuth for locations on the same floor and 50 degrees error for different floors. We expect to find a significantly higher error rate for a group of three-year-old children. In general, children who are about five or six years of age have the capacity to construct spatial representations which are allocentric, integrated and able to support inferences and transformations (i.e. coordinated). Whether this change (or 'decentration' process) occurs as a function of a qualitative or quantitative difference in thinking remains at issue (e.g. Mandler, 1992).

Linguistic research: the spatial domain

If there is some link between the form of spatial representations and the nature of locative expression, we should expect to find some noteworthy change in child language during the preschool period. In an extensive cross-linguistic review of the acquisition of locative morphology, Johnston (1988) found that children comprehend and produce the *in/on* and inherent *front/back* contrasts during the period between about 2;0 and 3;6, whereas the *between* and deictic *front/back* contrasts emerge later between about 3;0 and 4;6. This trend supports an earlier argument by Johnston & Slobin (1979) that linked the acquisition of locatives to conceptual development as well as linguistic complexity.

In his analysis of how language structures space, Talmy (1983) distinguished between the primary-object and the referent-object. The primary object 'is a moving or conceptually moveable object whose site, path, or orientation is conceived as a variable the particular value of which is the salient issue' (p. 232). The referent object has properties such as 'more permanently located', 'larger', and 'greater geometric complexity' (pp. 230–1). Furthermore, Talmy discriminated between location which involves, 'one object's spatial disposition in terms of another' (p. 230) versus 'more than one referent object' (p. 245). Applying these ideas to child language, a locative relationship may be more complex: (1) as a function of the geometry of the referent object, e.g. the *across* geometry is more complex than the *into* geometry, and (2) as a function of the number of referent objects, e.g. inherent *front/back* involves a single referent object and deictic *front/back* requires two referent objects. Our focus is on the number of referent objects, and we will use the following distinction proposed by Weist (1991) so as to integrate spatial location with temporal location: (1) spatial/temporal location can be viewed as mono-referential when the place/time of the primary object/event is established with a single reference point, i.e. some featured object within the spatial dimension and the time of the speech act within the temporal dimension, and (2) location in space/time is considered bi-referential when the process of location requires two related reference points. We propose that the conceptual transition to coordinated spatial representations provides the necessary perspective for bi-referential spatial location.

Conceptual research: the temporal domain

In the temporal domain, there is only indirect evidence for a transition in representational structure, and the evidence comes from disparate areas of research often tied to language. Nelson & Gruendel (1986), Bauer & Mandler

(1989) and others have shown that young preschool children have the potential to construct event representations with chronological structure. Nelson and Gruendel used an interview procedure to investigate the nature of children's scripts and found that 'even the three-year-olds produced sequentially ordered accounts' (1986: 45). Bauer and Mandler employed a deferred imitation task containing a sequence of three events. Given three events, two links between events are possible. On the average, the children aged 1;8 could immediately reproduce slightly more than one link, and they could reproduce slightly less than one link after a two-week delay. Their capacity to recall the sequential properties of the episode were better when causal relationships were involved in the linkage. Bauer and Mandler concluded that children aged 1;8 can recall novel event sequences under both immediate and delayed conditions.

Given that young preschool children have the capacity for temporally organized representations, Fivush & Mandler (1985) proposed that preschool children develop the ability to understand and infer the logical relationships that link the event components of such representations. Fivush and Mandler asked preschool children to sequence familiar and unfamiliar events in forward and backward arrangements. They also demonstrated forward and backward sequences to the children and had the children duplicate or reverse the sequence. They argued that reversing an unfamiliar sequence 'requires both inferring the connections among actions and manipulating these relations in the absence of an already established representation to guide performance' (p. 1445). They found that this ability develops during the preschool period. We propose that children construct a higher order temporal structure on event representations which coordinates the event components allowing children to enter an event representation at superordinate locations such as the initiating event and to move forwards or backwards in the event structure, i.e. to demonstrate a sense of reversibility.

The evolution of temporal representations can also be inferred from research on the acquisition of narrative skills. Applebee (1978) found that there is a major shift during the preschool period from stories made up of unrelated events to stories having structure and focus. Berman & Slobin (1994) found a dramatic increase in the number of core story components (i.e. onset, unfolding and resolution) between three and five years of age. Furthermore, in reference to the narratives of five-year-olds, Trabasso & Rodkin (1994: 99) concluded that 'the episodes are, in turn, causally and temporally related and are organized hierarchally into an overall plan'. We interpret this structural development in narrative as reflecting the process of temporal decentration during the preschool period.

Linguistic research: the temporal domain

Within temporal systems, the placement of the primary event (or event time) is the salient issue, and the time of the primary event may be related to one or more referents. The most basic temporal referent is the time of the speech act (or speech time) which has the property of constituting the deictic centre. Given the sentence, *Hanna sneezed*, the speaker and the listener use tense to locate the primary event prior to speech time. Other referential time intervals are called reference times. Aspect and Aktionsart define the temporal 'geometry' of the primary and the referential events. Children exhibit an innovation in their temporal expression when they are about three years old shifting from an event time to a reference time system (see Weist, 1986, 1989). Location within the event time system is mono-referential as the time of the speech act is the sole point of reference. With the evolution of the initial reference time system, children demonstrate the capacity to establish reference points which are remote in time and space. The primary event can now be related to remote and non-deictic points of reference. Given the sentence, *While Marja was playing*, *Hanna sneezed*, the primary event is located within the temporal interval established by the adverbial clause, and tense locates the entire configuration prior to speech time. By integrating reference time, children add a bi-referential dimension to their linguistic time system. While the concept of reference time emerges relatively early, a number of studies have shown that children do not demonstrate a completely flexible integration of speech time, event time and reference time until they are about five years old. Hence, the transition to a bi-referential temporal system corresponds roughly to the transition found in the spatial system.

In summary, during the preschool phase of development, there is a major conceptual and linguistic change. Regarding the conceptual change, children become better able to build integrated representations which can be transformed by rotation or reversal and which provide the basis for inferences. Regarding the linguistic change, locative expression becomes relational. On the spatial dimension, children can relate the site/path of the primary object to two or more related objects, and on the temporal dimension, children can establish reference time prior/subsequent to speech time and then relate an event to the two referent intervals, i.e. speech time and reference time. One component of this research was designed to evaluate the idea that innovations in linguistic development are linked to conceptual development.

The temporal system in Polish and Finnish

In this research project, the most striking crosslinguistic contrast is between Polish (a Slavic language) and Finnish (a Finno-Ugric language). The spatial and temporal systems of Slavic and Finno-Ugric languages are quite different, and we expect to find that the structure of these languages interacts with the space and time dimensions during the acquisition process. This Slavic versus Finno-Ugric contrast has been the subject of theoretical interest in psycholinguistic research at least since Slobin's (1973) seminal paper introducing operating principles (see also Slobin, 1985). According to Slobin, matches between language specific coding and information processing strategies will facilitate acquisition. Slobin (1982) applied this argument at the morphological level to make predictions about such issues as the acquisition of the nominative versus accusative distinction and the acquisition of adpositions in Turkish, Serbo-Croatian, Italian and English. We are concerned with the acquisition process at the system level, and therefore, the structure of the system as well as the properties of the components are important. The temporal system involves tense, aspect, and modality. Values of these concepts interact, e.g. in Polish, the non-past form of perfective verbs has future meaning. For this reason, children cannot just learn about tense or about aspect. They have to discover the system.

In Polish, there are a number of reasons why the temporal system is transparent relative to Finnish. In Polish, there are distinct past, present and future forms in comparison to Finnish which has a past versus non-past contrast. In both languages, past tense is formed with a single, obligatory and relatively salient morpheme. Polish has only absolute tense relating event time to speech time, and there is only one past tense form. Furthermore, except for the imperfective future form, tense is always marked on the main verb in Polish. In contrast, Finnish has perfect tenses (i.e. absolute-relative tenses) as well as absolute tense (see Comrie, 1985), and for these and other forms, tense is marked on the auxiliary. The primary aspectual contrast is between imperfective and perfective, and the primary mechanism for aspectual coding in Polish is a set of affixes which do not overlap with tense morphology. Most Polish verbs have both aspectual forms. In contrast, the Finnish system codes aspect in a diffuse manner. A contrast resembling the Slavic imperfective versus perfective distinction is produced in the transitive context with a partitive versus accusative case contrast, and the concept of ongoing action can be specified with a periphrastic form involving the third infinitive plus the inessive case (see Heinämäki, 1983). The coding of temporal contour constitutes a secondary function for the partitive and the inessive case morphology. Furthermore, there are verbal suffixes referring to aspectual meanings like frequentitive or momentary, but these affixes cannot occur with all verbs. In short, the temporal system has the potential to be more accessible to the Polish child than to the Finnish child (see Appendix A). Appendix A was designed to show how the temporal and spatial systems are organized and to highlight by example the contrasts between Polish and Finnish. Furthermore, Appendix A shows how the concepts of perspective and direction are relevant to location in both time and space.

The spatial system in Finnish and Polish

Just the opposite is true for the spatial systems. The core of the Finnish system is organized around a dimension of perspective and of direction/place. The two perspectives are internal and external and the three directions are to, at and from. The six cases which are defined by this system are uniquely coded, and the coding is extended to adpositions. The system is not quite so clear cut since other cases get involved, e.g. some postpositions such as *alla* 'under' and *vieressä* 'next to' take the genitive which has other functions.

In contrast to Finnish, Polish has a relatively complicated system. The basic system involves a combination of a preposition and a case suffix. The cases which are used for location are taken from the overall case system where accusative marks the direct object, etc. Thus, the locative case is just one of a number of cases which are used to establish location, e.g. *w* 'in' and *na* 'on' sometimes govern the locative case; *do* 'to' and *od* 'from' take the genitive case; *przed* 'in front of' and *za* 'behind' govern the instrumental case, etc. Furthermore, the case required by prepositions can vary. In a stative situation, *na* 'on' takes the locative, but in dynamic location, *na* takes the accusative. While path is an integral part of the six local cases in Finnish, it is coded with a combination of verb prefixes and prepositions in Polish (see Smoczyńska, 1985 on Polish, and Toivainen, 1980 on Finnish).

In keeping with Slobin's argument, we expect to find that the level of linguistic complexity in the systems will influence language acquisition, but departing from (or perhaps elaborating on) Slobin's argument (see Slobin, 1990), we expect cognitive development to be facilitated by the precocity of entry into a system. Since the children in both languages will eventually be able to utilize the full extent of their own systems, the facilitation effect will be found in a formative phase of development, e.g. the transition period at issue in this project. More specifically, we expect that children who acquire a relatively transparent system will come to understand mono-referential contrasts at a relatively early phase of development, and the utilization of mono-referential contrasts should facilitate conceptual development establishing a readiness for bi-referential distinctions. Thus, we predict that the unique properties of the child's native language will shape the course of conceptual development. Whether or not language shapes the form of conceptual development is yet another issue (see Lucy's 1992 review of Whorfian issues, and Bowerman's 1991 comparative study of spatial systems).

Organization and predictions

This paper reports two very similar experiments. Both of the experiments contain an evaluation of conceptual and linguistic development during the preschool period with respect to time and space. Experiment 1 contains a replication of the comprehension test found in Weist (1991) and an extension of that procedure from a still to a motion picture format. This provides the opportunity to evaluate the reliability and validity of that test. Experiment 2 adds a Finnish versus Polish comparison. We have chosen to look at Finnish in comparison to Polish because these languages contain relatively extreme differences in their spatial and temporal systems. From the standpoint of experimental design, the Polish–Finnish comparison maximizes the likelihood of detecting a language × dimension interaction. We do not expect a major contrast with English, and we expect to find that children learning English will fall in the middle on both spatial and temporal evaluations. The project as a whole makes it possible to show how English fits into the overall crosslinguistic picture.

If the course of acquisition is influenced by cognitive factors, we expect this influence to be stable across languages. Therefore, mono-referential contrasts should be integrated into the spatial and temporal systems before bi-referential contrasts. We view the spatial and temporal systems as unique systems, i.e. one is not derived from the other. However, the experimental design will enable us to evaluate the idea that spatial distinctions are developmentally primitive with temporal contrasts being derived (e.g. Clark, 1973). The influence of linguistic factors depends on their universal versus language specific scope. Deictic relationships in time and space are universal. Children must acquire these distinctions in order to function in the context of a conversation. As far as time is concerned, the child must process the location of event time relative to the deictic centre (i.e. speech time) which is shared by the speaker and hearer. In space, the child must learn to shift perspective. During turn taking, the deictic centre changes its location, as the deictic centre always remains with the speaker. We expect to find that conceptual development will interact with linguistic development in the area of deixis. Since the deictic contrast of past versus non-past is mono-referential in nature, it should be acquired relatively early. However, the deictic *front/back* contrast is a bi-referential relationship, and it should be acquired at a later phase of development (see Kuczaj & Maratsos, 1975). In other words, the pragmatics of a conversation require that children monitor speaker/hearer, here/there and prior-to/subsequent-to contrasts. However, the relationship between the deictic centre and the place of the primary object is conceptually more complex than the relationship between the deictic centre and the time of the primary event. We expect that this conceptual difference will influence the course of acquisition. Regarding crosslinguistic comparisons, the structure of specific linguistic systems should influence the acquisition process in two ways. The acquisition of the spatial contrasts should be precocious in Finnish children, and the acquisition of the temporal contrasts should be precocious in Polish children. Finally, accelerated linguistic development should facilitate conceptual development.

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EXPERIMENT 1

METHOD

Participants

Twenty American children were tested at four age levels with the following average ages (and ranges): 2;8 (2;5–2;11), 3;7 (3;4–3;10), 4;6 (4;3–4;9) and 5;10 (5;5–6;1). The gender distribution was as follows: two years = 10 female and 10 male, three years = 12 female and 8 male, four years = 9 female and 11 male, five years = 11 female and 9 male. The children were from middle class families in the Fredonia–Dunkirk area of Western New York. Their parents were contacted through preschools, kindergarten and the local newspaper. For the typical child, the testing took about three weeks with meetings twice a week lasting about 30 minutes. The two-year-old children required at least two additional meetings. The testing was preceded by an acquaintance period which varied with the age of the child.

Design

The overall research design included the following components: (1) domain of cognition = conceptual (or representational) versus linguistic, (2) dimension of cognition = spatial versus temporal, (3) complexity = mono- versus bi-referential, and (4) age of the children in groups (2, 3, 4 and 5). It was not possible to counterbalance the complete design. The tests were presented in the following order: (1) conceptual with either space or time first, (2) linguistic comprehension, static before dynamic (dimension and complexity are counterbalanced within the test), and (3) linguistic production. A slide-tape programme covering all of the tests was used to train the experimenters in all three cultures.

Spatial–conceptual procedure

The test of spatial–conceptual development had three phases: first, observing, second, searching, and third, pointing. In the observing phase, the children were presented with a photograph of a model (see Fig. 1 *a*). On each trial, a different primary object was identified with one of four small stickers, e.g. a snowflake sticker. The children learned that the sticker identified an object in the photograph, e.g. a desk or a bucket. (DeLoache (1987) has shown that two-year-old children can use a photograph to guide a successful search in a model.)

In the searching phase, the experimenter showed a child the actual model which had been depicted in the photograph, and the child was asked to find the primary object and to point to it (see Fig. 1 *b*). Regardless of the child's accuracy, the experimenter turned over the correct (i.e. primary) object and

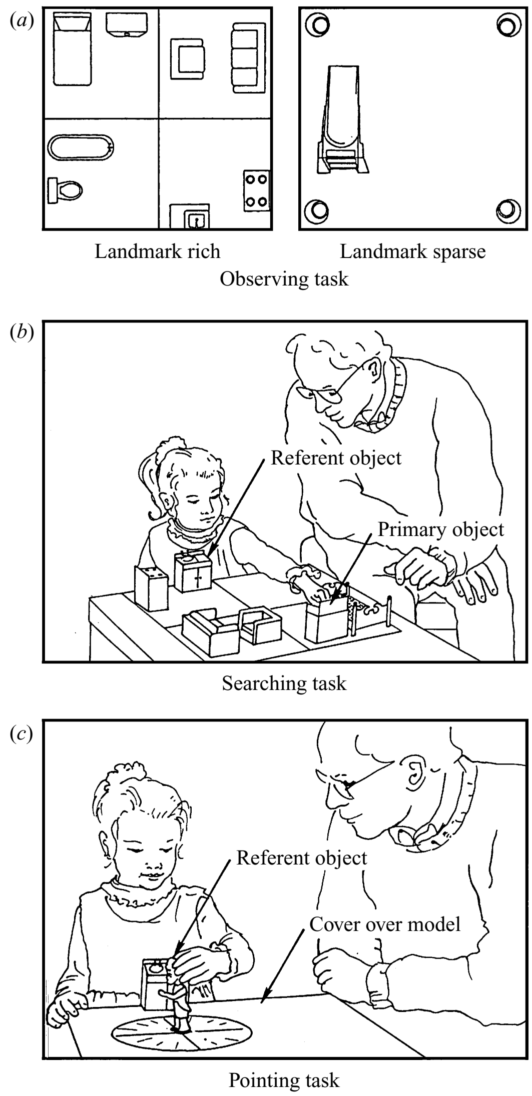

Fig. 1. The observing (*a*), searching (*b*), and pointing (*c*) phases of the spatial-conceptual task

showed her/him a matching sticker. This experience should be adequate for the child to build some kind of representation of the model (DeLoache, 1987).

In the pointing phase, the model was covered with a box, and a referent object was placed on the top of the box in the same location that it had in the model (see Fig. 1 *c*). The referent object was the sink in the dollhouse model, and it was the slide in the playground model. A 'compass' marked 0 to 360 degrees was placed next to the referent object, and a doll was placed in the centre of the 'compass' with one arm pointing at the referent object. The child was asked to rotate the doll so that it was pointing in the direction (or azimuth) of the primary object and the azimuth was recorded (cf. Lockman & Pick, 1984). We propose that the pointing phase of the procedure requires an integrated representation of the model whereby the location of the primary object is coordinated with the location of referent objects (cf. Hazen, *et al*., 1978).

The procedure always contained three phases, but conditions varied. Three models were used, a practice situation, a dollhouse with four rooms and two objects per room, and a playground containing a slide and four identical buckets in each corner (see Figure 1 *a*). The model was either landmark rich, i.e. the dollhouse, or landmark sparse, i.e. the playground, and the photograph was presented in an aligned or 180 degree rotated position (cf. Bluestein & Acredolo, 1979). The pictures of the photographs are in aligned perspective in Fig. 1 *a*. The child's experience began with four practice trials which were used to teach the children about the procedure. There were eight experimental trials in all with four landmark rich followed by four landmark sparse trials and with aligned versus rotated trials alternating.

Temporal–conceptual procedure

This component of the design contains an imitation and a picture-card arrangement task. In the imitation task, the experimenter acted out a sequence of three arbitrarily related events in which the agent remained constant. As the experimenter acted out the episode, she/he described the action, e.g. 'First, the boy walks through the playhouse, and then he draws on the board, and then he hugs his teacher.' Finally, the child was asked to imitate the experimenter's actions (cf. Bauer & Mandler, 1989). There were eight trials. Given three events, there were two potential sequences of two events (i.e. links) per trial or a maximum of 16 links. In order to complete this task, the child only needs to be able to build an event representation which has sequential information.

In the picture card arrangement task, the children were presented with a set of three pictures which portrayed a sequence of events linked by enablement relations, e.g. the boy brings some wood, he builds a structure, and then he admires a completed doghouse. The pictures were presented in a triangular display, and the child was asked to place the cards along a three-place board from left to right while telling a story about the events. The request for a story was included to encourage the children to concentrate on the placement task, and any responses were accepted. This task requires a level of integration not found in the imitation task. There were four practice trials and eight experimental trials. Like the imitation task, there were two potential links on each of eight trials or a maximum of 16 links making a direct comparison to the imitation task possible.

After completing the card sequencing component of the task, the 12 problems were repeated with a related procedure. In the related procedure, the experimenter initiated the trial by placing the picture-card representing the middle of the story on the left or right side of a two place board. The children were then asked to choose the picture which made the story go 'forward' (also, which showed what happened 'after' this happened) or to choose the picture which made the story go 'backward' (also, which showed what happened 'before' this happened) (cf. Brown & French, 1976 and Fivush & Mandler, 1985). This procedure requires children to construct a three-part event representation, to enter that event representation in a central location, and to move toward the antecedent or consequent conditions. We argue that this task requires at least an elementary level of coordination. In fact, the temporal–conceptual procedures were not independent of language. In particular, in the forward–backward arrangement task, we could not avoid including the terms *after* and *before* in order to make the procedure clear to the children. Therefore, to some extent these 'conceptual' tasks are already correlated with linguistic development.

Linguistic-comprehension procedure

In contrast to the conceptual procedures, our evaluation of the dimensions of space and time were integrated into each test and there were three different tests. There were two comprehension tests, i.e. static and dynamic, and one production test. In the static comprehension test, we used the same sentence-picture matching task that was used previously by Weist (1991). To summarize the procedure, the experimenter described two pictures, and then she/he read two complete sentences. One of the sentences was then repeated, and the child was asked to point to the matching picture. The following example demonstrates how the sentences were introduced: first, 'One of the pictures shows *The man jumped into the water*, and one of the pictures shows *The man will jump into the water*', and second, 'Which one shows *The man will jump into the water*?' The test contained four major categories of problems with each main category having two subordinate categories as follows: (1) space and mono-referential, *in/on* and inherent *front/back*, (2) space and bi-referential, *between* and deictic *front/back*, (3) time and mono-referential, past/future and internal/external viewpoint aspect, and (4) time and bi-referential, remote/immediate adverbs and *before/after* (see Appendix B). The test began with a set of practice problems. The experimental problems were organized into six sets of four problems. The four main categories were represented in each set. A more detailed discussion of the temporal and spatial problems can be found in Weist, Wysocka & Lyytinen, 1991 and Weist & Lyytinen, 1991 respectively.

Secondly, we created a sentence–video matching task which was somewhat similar. The scenes were acted out by young girls. The programme was presented on two monitors (see Golinkoff, Hirsh-Pasek, Cauley & Gordon, 1987). First, the left monitor came on showing one scene while the right monitor was black, and then the right monitor came on with the contrasting scene while the left monitor was black. During the presentation of the individual programmes, the experimenter read a sentence which called attention to some aspect of the picture, e.g. 'Look at the girl and the basket!' for a deictic *front/back* problem. In the next phase of the programme, the contrasting left and right programmes were presented simultaneously, and the experimenter asked 'Which one shows...?' followed by a test sentence, e.g. *The girl is throwing paper in front of the basket*. The child was required to point to the matching monitor. The video test also had four major categories of problems as follows: (1) space and mono-referential, *in/on* (or *on/under*), e.g. *The girl is putting the toys on the basket*, and *The girls are playing in the playhouse*, (2) space and bi-referential, deictic *front/back*, e.g. *The girl is putting the cookies in back of the glass*, and *The girl is throwing the paper in front of the basket*, (3) time and mono-referential, past/future, e.g. *The tower of blocks will fall down*, and *The girl blew out the candles*, and (4) time and bi-referential, *before/after*, e.g. *The girl put on her hat before she put on her mittens*, and *The girl sneezed after she blew her nose*. In the *in/on* problems, the girls either placed an object *in* versus *on* a referent object or they played *in* versus *on* the referent object. In the deictic *front/back* problems, the experimental subject had a side view of the action, and therefore, he/she had to take the perspective of the actress in order to solve the *front/back* problems. In the past/future problems, the action was either completed or anticipated. In the *before/after* problems, the two events were arranged in the opposite orders. There were six problems of each type which were mixed together in the programme with the correct answer randomly distributed across the left and right monitors.

Linguistic-production procedure

In this part of the project, we employed two elicitation procedures, a *where* and *when* test. The responses of the children were audio-tape recorded. In the *where* test, the experimenter sat across from and opposite to the child at a table. The experimenter held a hand puppet which was blindfolded. The experimenter placed a coin in some location relative to a set of referent objects and asked the children to tell the puppet where the coin was. If the child pointed and said, 'here' as younger children were apt to do, the experimenter explained that the puppet could not see where they were pointing and that they needed to provide more information. The following eight problems were used: (1) *in* a toy box, (2) *between* a desk and a box within a desk, box and chair arrangement, (3) *behind* a man who is facing right from the child's perspective, (4) *in front of* a ball from the child's perspective, (5) *between* a play-box and a drawing-board within a box, board, boy arrangement, (6) *in front of* a car which is facing right from the child's perspective, (7) *on* a desk, and (8) *in back of* a cup from the child's perspective. On trials 4 and 8, the puppet was initially next to the experimenter. After the child made his/her first response, the puppet was moved to the child's location and the trial was repeated. In the first phase of trials 4 and 8, the child must take the non-egocentric perspective, and in the second phase, we evaluated the child's ability to shift perspective. In summary, half of the problems were mono-referential in character (i.e. 1, 3, 6 and 7) and half were bi-referential (i.e. 2, 4, 5 and 8).

In the *when* test, the experimenter acted out two events which either occurred simultaneously or in a sequence. On every trial a boy doll broke a toothpick either before, during, or after some other event. While acting out the two events, the experimenter said, '*X* does this, and *X*/ *Y* does that'. The child, was first asked 'What happened?' and then depending on the response, 'When did it happen?' In other words, the experimenter tried to persuade the child to express the temporal relationships between the two events. The following episodes exemplify the set of events in a simultaneous (SIM) and a sequential (SEQ) problem: SIM = the boy broke a toothpick while his father was driving a car, and SEQ = the boy broke a toothpick, and then he put the parts in a desk. There were four problems of each type which were presented in a series alternating between SIM and SEQ problems. The children were given a bi-referential score when they coded the contrast between simultaneous and sequential action. In other words, we required that the children demonstrate flexibility in their integration of speech time, event time and reference time.

RESULTS AND DISCUSSION

Conceptual results: spatial and temporal

Concerning the spatial dimension, the most interesting results were found with the pointing task. According to our argument, this task requires the children to construct a representation during the searching phase in which the primary object is related to referent objects. The dependent measure is the number of degrees of error in azimuth. Thus, the most accurate judgement would yield a zero degree error, and the least accurate judgement would be 180 degrees of error in azimuth. Figure 2*a* shows these data for the landmark rich and sparse conditions. The children became more accurate with age ($F(3,76) = 7{\cdot}83$, $p < 0{\cdot}001$), and there was a major transition

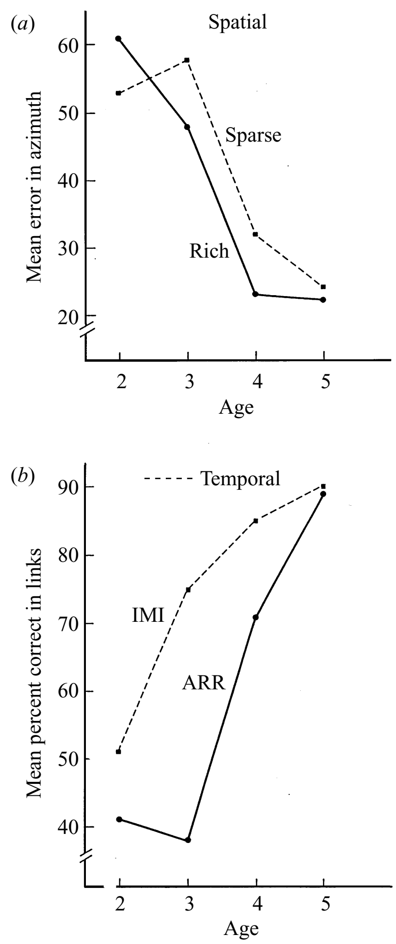

Fig. 2. The mean degrees of error in azimuth as a function of age and level of landmarks in the pointing phase of the spatial test (*a*), and the mean percentage of correct links as a function of age and type of task (imitation, IMI versus arrangement, ARR) in the temporal test (*b*)

between three and four years of age. Because of the implications for correlations which will be discussed later, we want to emphasize that there was an inverse relationship between the pointing scores and age. Our findings are consistent with the considerable prior research which has revealed the emergence of coordinated representations during the preschool (or so called preoperational) period of development (see Gelman & Baillargeon's 1983 review). The difference between the layouts was not significant ($F(1, 76) = 0{\cdot}68$, $p < 1$). The potential difficulty in the landmark sparse condition could have been masked by the consistent rich to sparse order of presentation.

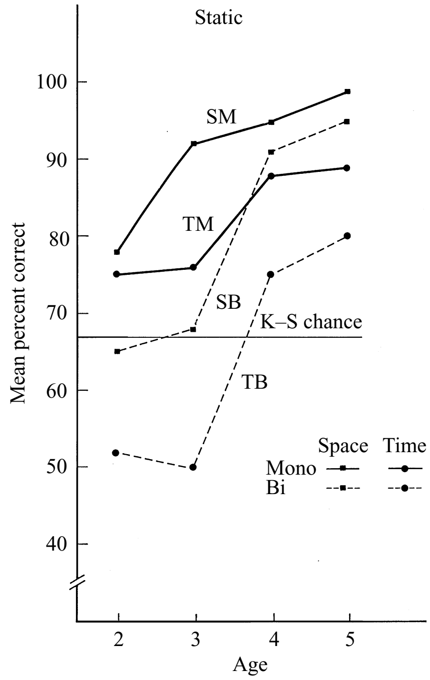

Fig. 3. The mean percent correct as a function of age, level of complexity (Mono- and Bi-referential), and dimension in the static comprehension test

The analysis of the search task data revealed a number of significant findings, but they are all due to a relatively simple effect. In general, the children had considerable difficulty with the rotated and landmark sparse condition which is consistent with prior research (e.g. Acredolo, 1977). If we look at the mean number of correct searches in the four conditions (summing over age), the following pattern can be seen: (1) rich and aligned = 1·62, (2) rich and rotated = 1·51, (3) sparse and aligned = 1·50, and (4) sparse and rotated = 0·88 (where 2 = maximum). As a result, all the main effects were significant, and the most salient finding was the interaction of layout × orientation, $F(1, 76) = 17{\cdot}83$, $p < 0{\cdot}001$.

Regarding the temporal dimension, the results of the imitation task and the sequencing phase of the card arrangement task are shown in Fig. 2*b*. The dependent measure is the number of links, where a link is defined as a correct sequence of two components of the episode. The maximum number of links was 16 for both tasks. The children improved with age on these temporal conceptual tasks, and the main effect of age was significant ($F(3, 76) = 67{\cdot}49$, $p < 0{\cdot}001$). The imitation task was easier than the card arrangement task ($F(1, 76) = 31{\cdot}17$, $p < 0{\cdot}001$). In the imitation task, the two-year-old children

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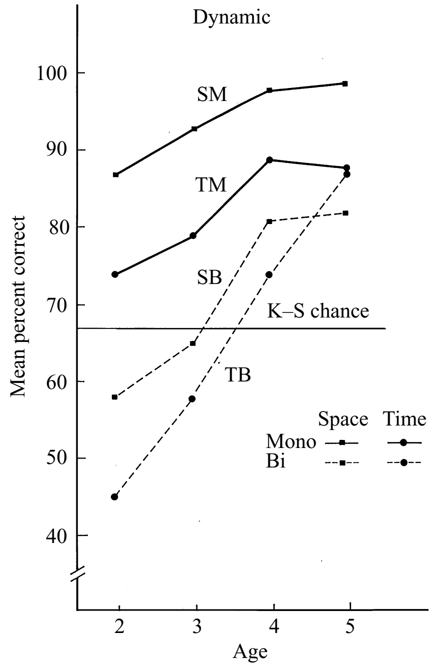

Fig. 4. The mean percent correct as a function of age, level of complexity (Mono- and Bi-referential), and dimension in the dynamic comprehension test

were about 50 percent correct which is quite similar to the comparable condition in Bauer & Mandler's (1989) research. As can be seen in Fig. 2, the performance on these two tasks converges creating a significant interaction of age × task ($F(3, 76) = 7{\cdot}38$, $p < 0{\cdot}001$). In other words, the greatest change was found in the task which required the capacity to coordinate the antecedent and consequent conditions of an event representation, and the major change occurred between three and four years of age as was the case for the spatial results. The forward–backward phase of the card arrangement task will be discussed below in the section comparing conceptual and linguistic development.

Linguistic results: comprehension and production

The comprehension data are shown in Figs 3 and 4. The minimal contrasts were presented to the children in a static format with the picture book and in a dynamic format with our television programme. The pattern of results is so similar that we will report them together. The older children were more accurate than the younger children ($F(3, 76) = 35{\cdot}7$ for static [23·35 for dynamic], $p < 0{\cdot}001$), bi-referential problems were more difficult than mono-referential problems ($F(1, 76) = 62{\cdot}36$ for static [105·2 for dynamic], $p < 0{\cdot}001$), and spatial problems were easier than temporal problems ($F(1, 76) = 38{\cdot}99$ for static [16·83 for dynamic], $p < 0{\cdot}003$). There was an age × level of complexity interaction which was more evident with the dynamic test ($F(3, 76) = 5{\cdot}04$, $p < 0{\cdot}003$). The organization of the two comprehension tests is somewhat different. Each of the four major categories of the static test (but not the dynamic test) contained two subordinate categories. An item analysis was done to evaluate the subordinate categories. The subcategories and the probability of an error on a problem of the subcategory were as follows: (1) space and mono-referential = *in/on* (0·04) and inherent *front/back* (0·10), (2) space and bi-referential = *between* (0·22) and deictic *front/back* (0·19), (3) time and mono-referential = progressive/non-progressive (0·22) and past/future (0·13), and (4) time and bi-referential = adverbial (0·37) and *before/after* (0·32). Considering these subcategories for each age level, with one exception, the subcategories of bi-referential problems were more difficult than the subcategories of mono-referential problems. The exception was that the four-year-old children made two fewer errors on the three deictic *front/back* problems than on the three inherent *front/back* problems. These data show that the static test has a relatively high level of internal consistency.

The Kolmogorov–Smirnov (K–S) test was used to compare the obtained with the theoretical distribution, i.e. a binomial with $p = 1/2$ and $N = 6$. The K–S test provides information about the transition from an early to a later phase of preschool development (see Figs 3, 4). The 'K–S chance' demarcation lines shown in Figs 3 and 4 summarize the entire set of tests given $N = 20$, and these values fluctuate with sample size as can be seen in Experiment 2. With one exception, the two- and three-year-old children failed to deviate from chance expectations on the bi-referential problems given both presentation formats. The exception is that the three-year-old children passed the bi-referential space problems with the static format. All of the children passed (i.e. $p < 0{\cdot}01$) all of the mono-referential problems. Hence, the transition period was between three and four years of age which is consistent with a large body of previous research (see Johnston, 1988 on space, and Weist, 1986 on time). Furthermore, the reliability of the static test was demonstrated by replicating Weist (1991), and the validity of the argument was supported by extending the pattern of results to the dynamic presentation.

There were two production tests, i.e. the spatial *where* test and the temporal *when* test. We evaluated the production data in two ways: first, the number of children to meet a criterion, and second, the number of correct bi-referential problems. Since there were different opportunities to demonstrate the bi-referential locative ability on the *when* and *where* tests, and since the children across cultures varied in how responsive they were, we used a measure based on the number of children to reach a comparable bi-referential criterion as the dependent measure for crossdimensional and crosslinguistic comparisons. Given the *where* test and the spatial dimension, we determined the number of children who were able to express one of the four bi-referential locations. On the deictic front/back problems, the children were given credit if they could take the puppet's perspective which they did not share. We did not require them to make the deictic shift under this dependent measure. The results were as follows (where 20 = maximum): 2 yr = 4, 3 yr = 14, 4 yr = 18 and 5 yr = 20. The *where* test had subcategories like the spatial component of the Static comprehension test. The sub-categories and the probability of a correct response on a subcategory problem was as follows: mono-referential = *in/on* (0·81) and inherent *front/back* (0·64), and bi-referential = *between* (0·49) and deictic *front/back* (0·44). There were no subcategory reversals. According to Johnston's (1988) review, previous investigators found it more difficult to elicit *between* than inherent *front/back*. Relatively speaking, we found that inherent *front/back* was as easy to produce as it was to comprehend. About 75 percent of the three-year-old children produced a correct response on at least one of the two inherent *front/back* problems, and all of the three-year-old children comprehended at least one of the inherent *front/back* problems. Hence, Johnston's review estimate of 2;0 to 3;6 for comprehension is supported, but the estimate of 4;0 to 4;6 for elicitation underestimates the rate of development. It is possible that the mono- versus bi-referential (i.e. inherent vs. deictic) distinction between the two types of *front/back* problems was not properly controlled in previous research.

Given the *when* test and the temporal dimension, we wanted to identify the point at which children could express the SIM versus SEQ contrast (i.e. two different relationships between event time and reference time). We used the following measure: (1) For SIM, the lexical component was satisfied by *when*, *while*, *at the same time*, *etc*., and the aspectual component was fulfilled with progressive aspect in the adverbial clause and non-progressive in the main clause, and (2) For SEQ, the lexical component was satisfied by *and then* or *before/after*, and the aspectual component was fulfilled with non-progressive in both clauses. The children needed to produce two correct responses out of eight opportunities (as compared to one of four opportunities in the spatial dimension). The following are a four-year-old's prototypical responses to the question, 'What happened?': SIM = *When they were doing that*, *the boy broke the stick*, and SEQ = *The boy slided down the slide*, *and then he broke the stick*. The number of children who were able to make the SIM versus SEQ contrast was as follows (where 20 = maximum): 2 yr = 2, 3 yr = 9, 4 yr = 15 and 5 yr = 19. The trend in both space and time on the production test was similar to the comprehension test, i.e. the transition period was between three and four years of age.

Language–thought comparison

Before proceeding into this section, a few more remarks on scoring are required. In this analysis, we developed composite scores which were designed to give the best overall estimate of the individual child's phase of development. Within the linguistic domain, we combined production with comprehension scores. These scores were entered into correlations involving either the spatial or the temporal domains. On the production side, we measured the relative level of bi-referential development. Scoring on the spatial dimension was transparent, i.e. the children did or did not produce a bi-referential lexical or inflectional form. In solving a *between* type problem, the child might locate the primary object *between X and Y* or *in the middle of X and Y* but not *next to X* or *in the vicinity of Y* as the latter are mono-referential in nature.

On the temporal dimension, we counted the number of sentences with bi-referential coding given that the child could demonstrate a simultaneous versus sequential contrast. The following sentences will illustrate the scoring problem (where SEQ and SIM refer to the nature of the action and not necessarily the scoring).

1. (2;6) SEQ He broke the stick.
2. (2;6) SIM He is kicking like that.
3. (3;7) SEQ He broke the stick and kicked the ball.
4. (3;7) SIM He broke the stick, and she kicked the ball.
5. (4;7) SIM The boy broke the stick just when his Dad was driving.
6. (4;7) SEQ The boy broke the stick and then kicked the ball.

In this analysis, we used a relatively sensitive measure to determine the number of bi-referential productions. The children were given credit for a bi-referential response if they used either lexical, aspectual or a combination of means to contrast SIM with SEQ. The youngest children typically produced a single clause with the verb in the past tense, e.g. sentences 1 and 2, and the older children were likely to use both lexical and aspectual means, e.g. sentences 5 and 6. The former is obviously mono-referential and the latter bi-referential. We did not give children bi-referential credit for producing compound sentences with no indication of an SIM versus SEQ contrast such as the child who produced sentences 3 and 4.

In order to evaluate the relationship between language and thought, we correlated composite measures of linguistic and conceptual development in time and space. In the temporal domain, the linguistic composite score was the sum of the bi-referential contrasts comprehended and produced, and the conceptual composite score was the sum of the number of links in the card arrangement task plus the number of correct consequences and antecedents in the forward–backward task. In the spatial domain, the linguistic composite

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score was also the sum of the bi-referential contrasts comprehended and produced, and the conceptual composite score was the sum of the two pointing scores in the landmark rich and sparse conditions. The spatial correlation should be negative since the pointing scores decreased as the children became more accurate. The Pearson correlation coefficient was $r = +0.70$ for time and $r = -0.64$ for space. These values are clearly significant with $p < 0.001$. Since age is an obvious (but also necessary) third variable, it might be argued that partial correlations are somehow more meaningful. The partial correlations were as follows: time, $r = +0.25$, $p < 0.014$, and space, $r = -0.47$, $p < 0.001$. While the absolute value of the correlations was diminished, the level of significance remained relatively high. The results support the argument that conceptual decentration is related to bi-referential location in time and space. In the temporal domain, the strength of our argument in this domain is diminished by the fact that the conceptual evaluation procedures were not independent of language.

Since correlation only yields covariance, one cannot specify the direction of the language–thought influence, and both alternatives are viable. From the conceptual side, it is possible that the process of decentration provides a necessary condition for bi-referential location. From the linguistic side, spatial deixis requires allocentric perspective (see Kuczaj & Maratsos, 1975). As we have pointed out above, the spatial deictic centre is at the location of the speaker creating a perspective on the situation which may or may not be shared by the listener. In order to acquire the deictic *front/back* contrast, the child is required to shift perspective which could facilitate the development of coordinated representations. There was a direct test of perspective shifting with the deictic *front/back* problems of the *where* test. The percentage of children who were able to take the doll's perspective and then shift perspective was as follows: 2 yr = 5, 3 yr = 15, 4 yr = 40 and 5 yr = 67. In the temporal domain, the deictic centre is shared by the speaker and the hearer. However, reference time is established by the speaker, and the listener has to discover the speaker's perspective in order to understand the location of the primary event. This requirement could also contribute to the development of coordinated representations.

EXPERIMENT 2

METHOD

Participants and procedure

The research design includes the following components: (1) language = Polish and Finnish, (2) dimensions of experience = space versus time, (3) level of complexity = mono- versus bi-referential, (4) domain of cognition = conceptual (or representational) versus linguistic, and (5) age = 12 Polish and

12 Finnish children at the levels 2;6, 3;6, 4;6 and 5;6. The Polish children had the following characteristics (average age (range)): 2;7 (2;4–2;9), 3;7 (3;4–3;9), 4;7 (4;3–4;9) and 5;7 (5;4–5;9), and the Finnish children: 2;6 (2;4–2;9), 3;7 (3;4–3;7), 4;6 (4;4–4;9) and 5;7 (5;3–5;10). The gender distribution was as follows: for Polish, 2 yr = 7 male and 5 female, 3 yr = 6 male and 6 female, 4 yr = 5 male and 7 female, and 5 yr = 3 male and 9 female, and for Finnish, 2 yr = 8 male and 4 female, 3 yr = 2 male and 10 female, 4 yr = 5 male and 7 female, and 5 yr = 8 male and 4 female. The children were from middle class homes, and they were contacted through their day-care centres in Jyväskylä, Finland and Poznań, Poland. The methodology in Experiment 2 was the same as in Experiment 1 except for the fact that there were two languages in the design and the dynamic comprehension test was omitted due to television requirements. There was one additional difference in the procedure, and that occurred during the presentation of the events in the *when* test component of the elicitation tests. The investigators in Poland said the target verbs, e.g. 'break, drive, slide, etc.'. They did not limit their remarks to the form, 'X *does* this, and X/Y *does* that', and this might have decreased the motivation for complete answers. In retrospect, it would have been better to just draw the child's attention to the events, e.g. 'Watch this/that!', and not to have said anything else.

RESULTS AND DISCUSSION

Conceptual results: spatial and temporal

The spatial conceptual task had three components, i.e. observing, searching and pointing. We argued above that this task requires children to construct a coordinated spatial representation, and we judged that the pointing phase of the procedure gave the best estimate of the level of integration. Fig. 5 shows the results of the pointing task for Finnish and Polish children on landmark rich (i.e. the dollhouse) and the landmark sparse (i.e. the playground) layouts. The Finnish children did better on this task than the Polish children ($F(1, 88) = 64.31$, $p < 0.001$). The children became more accurate with age ($F(3,88) = 13.17$, $p < 0.003$). There was a slight tendency for the older children to do better on the landmark sparse (not rich) layout. This tendency was reflected in a marginal main effect of layouts ($F(1, 88) = 4.78$, $p < 0.05$) and an interaction of age × layouts ($F(3, 88) = 4.63$, $p < 0.01$).

In the search task (or second phase), where the children were required to find some primary object in a model, the Finnish children were superior ($F(1, 88) = 18.66$, $p < 0.001$). The condition which combined sparse landmarks with a rotated photograph caused the most difficulty resulting in a main effect of landmarks ($F(1, 88) = 16.01$, $p < 0.001$), and a small interaction of orientation × landmarks ($F(1, 88) = 6.93$, $p < 0.01$). Finally, the children improved with age ($F(3, 88) = 21.32$, $p < 0.001$). Hence, we found

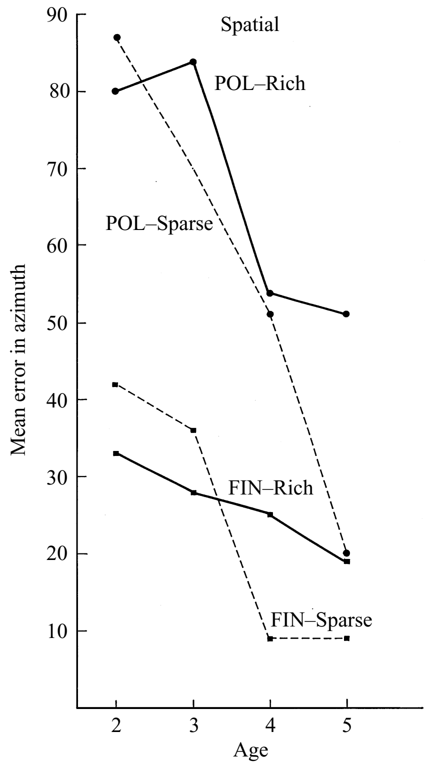

Fig. 5. The mean error in azimuth as a function of age, language (Polish, POL; Finnish, FIN), and landmark condition

that in general Finnish children do better on tests of spatial development than Polish children.

Regarding the temporal component of the study, the results of the imitation task and the card arrangement task are shown in Fig. 6. The dependent measure is the number of links. There was no main effect of language ($F(1, 88) < 1$). The children improved with age on these temporal conceptual tasks, and the main effect of age was significant ($F(3, 88) = 57{\cdot}06$, $p < 0{\cdot}001$). The imitation task was easier than the card arrangement task ($F(1, 88) = 54{\cdot}61$, $p < 0{\cdot}001$). There was a tendency for the performance on these two tasks to converge creating a significant interaction of age $\times$ task ($F(3, 88) = 5{\cdot}73$, $p < 0{\cdot}001$). The results of the forward–backward test were analysed separately and the data are included in a language–thought comparison below. The pattern of statistical outcomes was the same as it was for the American children, but the magnitude of the improvement between three and four years old was greater for the American children.

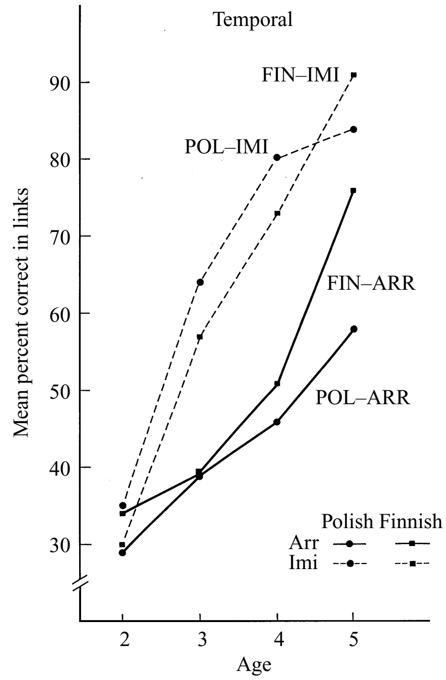

Fig. 6. The mean percent correct on the temporal problems as a function of age, language (Finnish, FIN; Polish, POL), and type of task (imitation, IMI versus card arrangement, ARR)

We expected the Finnish children to demonstrate precocious development within the spatial dimension and Polish children to excel within the temporal dimension. Therefore, it is important to evaluate the interaction of language × dimension in the conceptual domain. This requires a transformation of the data to standard scores (or z scores) because the dependent measures used to evaluate time and space were quite different. In this analysis, we were only interested in measures of coordinated representation. In space, we focused on the pointing task, and in time, we combined the two components of the card arrangement task, i.e. the sequencing and the forward–backward task. The spatial score was based on an error score where the maximum error equals 180 degrees. By taking 180 minus the child's error score, we obtain a score which gets larger as the children become more accurate. This transformation is needed so as not to create a spurious interaction. The time and space scores were then converted to z scores and compared. First of all, the main effects of age ($F(3, 88) = 31{\cdot}85$, $p < 0{\cdot}001$) and language ($F(1, 88) = 52{\cdot}21$, $p < 0{\cdot}001$) were significant. The comparison of temporal versus spatial dimensions across languages produced a significant interaction of language × dimension ($F(1, 88) = 11{\cdot}82$, $p < 0{\cdot}009$). In short,

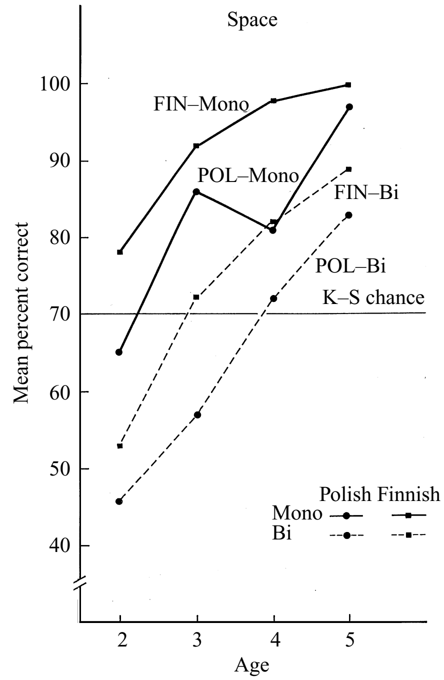

Fig. 7. The mean percent correct on the spatial problems as a function of age, language (Finnish, FIN, Polish, POL) and level of complexity (Mono- and Bi-referential)

the Finnish children did better than the Polish children on both tasks, and their relative advantage was greater in the spatial domain. While there was a language × dimension interaction, it did not involve a crossover as expected.

Linguistic results: Comprehension and production

The results of the comprehension test are shown in Figs 7 and 8. There are four very important findings here. In the first place, there was no overall difference due to language ($F(1, 88) < 1$). Secondly, mono-referential location was much easier to comprehend than bi-referential location ($F(1, 88) = 149.56$, $p < 0.001$). Thus, distinctions which are linked to conceptual development were found consistently across languages supporting the claim that these differences are conceptually driven. Thirdly, there was a significant interaction of language × dimension ($F(1, 88) = 26.15$, $p < 0.001$). The Finnish children did relatively better on spatial problems, and Polish children were more proficient on temporal problems. Hence, the general transparency of the Finnish locative system and of the Polish temporal system appears to have facilitated the children's capacity to discern minimal morphological contrasts. Regarding the dimensions of time and space, there

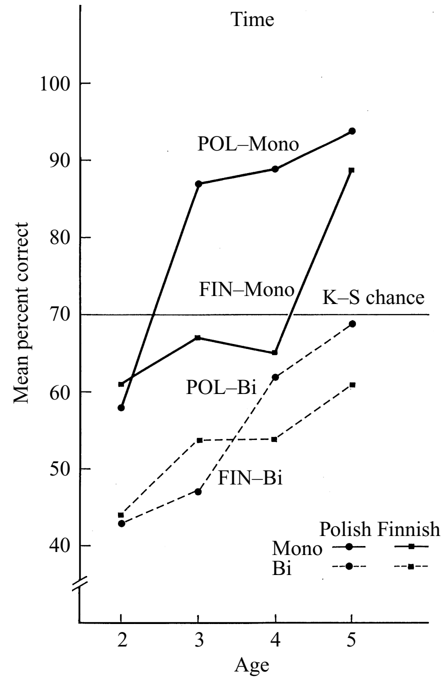

Fig. 8. The mean percent correct on the temporal problems as a function of age, language (Polish, POL; Finnish, FIN) and level of complexity (Mono- and Bi-referential)

was a general spatial advantage ($F(1, 88) = 63{\cdot}47$, $p < 0{\cdot}001$). The general issue of a spatial advantage will be discussed in more detail below in relation to Clark's (1973) space–time argument. An item analysis was carried out to determine the relative stability of the subcategory performance under the four major problem types. With one exception, bi-referential problems were consistently more difficult than mono-referential problems. The exception to this pattern was found in the four-year-old Polish children where the children made three more errors on the three inherent '*front/back*' problems than either the '*between*' or the deictic '*front/back*' problems which were the same. The overall pattern of results from the item analysis was as follows (i.e. subcategory and probability of an error): for Polish = (1) space and mono-referential = '*in/on*' (0·09) and inherent '*front/back*' (0·26), (2) space and bi-referential = '*between*' (0·33) and deictic '*front/back*' (0·45), (3) time and mono-referential = past/future (0·20) and imperfective/perfective (0·15), and (4) time and bi-referential = adverbial (0·44) and '*before/after*' (0·38), and for Finnish = (1) space and mono-referential = '*in/on*' (0·04) and inherent '*front/back*' (0·12), (2) space and bi-referential = '*between*' (0·21) and deictic '*front/back*' (0·29), (3) time and mono-referential = past/non-past (0·24) and imperfective/perfective (0·29), and (4) time and bi-referential = adverbial (0·53) and '*before/after*' (0·37). The item analysis shows that bi-referential subcategories are more difficult than mono-referential subcategories. The within category differences varied from language to language. The largest discrepancies were as follows: English = tense versus aspect, Polish = '*in/on*' versus inherent '*front/back*', and Finnish = adverbial versus '*before/after*'.

The Kolmogorov–Smirnov test was applied to determine when the children's performance deviated from chance expectations, i.e. when they 'passed' a subtest. The level which defines the chance expectation varies with the number of children in the group which is 12 in Experiment 2 in contrast to 20 in Experiment 1. Considering the spatial dimension, the Finnish two-year-old children passed the mono-referential problems and failed the bi-referential problems, and at the age of 3, they passed all of the problems. The Polish children followed the same general pattern, but they were one year behind, as can be seen in Fig. 7. On the temporal dimension, the Polish three-year-old children passed the mono-referential problems and failed the bi-referential problems, and the five-year-old children approached passing the bi-referential problems. As for the Finnish children, only the five-year-olds passed the mono-referential problems, but they did not pass the bi-referential problems. This pattern can be compared to previous research (e.g. Weist, *et al.*, 1991; Weist & Lyytinen, 1991). In our prior research, Polish two-year-old children did better on mono-referential temporal problems, and both Polish and Finnish five-year-old children reached higher levels of performance on bi-referential problems in general. The test was not adequately sensitive to the development of bi-referential temporal location. This can be seen in the results of the *when* test, in Table 2 where 75 percent of the five-year-old children produced at least one bi-referential contrast.

Table 1 contains a comparison of Finnish and Polish with English. We expected that the performance of American children would fall in between the Finnish and Polish children on both the space and time dimensions. Children learning the English spatial system cannot benefit from the level of one-to-one morpheme-to-concept coding that is found in Finnish. On the other hand, they will not be impeded by the arbitrary preposition–case pairing found in Polish. Furthermore, the temporal system of English has more complex tense coding than Polish and less complex aspect coding than Finnish. Nevertheless, the American children were as good or better than the Finnish children in the spatial domain, and they were as good or better than the Polish children in the temporal domain. We will return to this finding in the discussion.

There were two elicitation procedures, the *where* test and the *when* test. Given the *where* test, we counted the number of children who were able to produce at least one bi-referential location. Given the *when* test, we determined the number of children at each age level who were able to express

TABLE 1. *The mean percent correct comprehension score for all the children in each of the three languages on the four major problem categories*

	Space-mono	Time-mono	Space-bi	Time-bi
Finnish	92	70	74	53
Polish	82	82	64	56
English	91	82	80	64

TABLE 2. *The percentage of Finnish, Polish and American children at each age level who produced at least one bi-referential distinction on the* where *and the* when *elicitation tests*

	two-yr-old	three-yr-old	four-yr-old	five-yr-old
		Where – Space		
Finnish	8	75	92	100
Polish	0	17	42	67
English	20	70	90	100
		When – Time		
Finnish	8	42	67	75
Polish	8	17	50	75
English	10	45	75	95

the contrast between simultaneous and sequential event configurations. As we described above, the children were required to demonstrate the capacity to combine lexical and aspectual (i.e. situational and/or viewpoint aspect) means in order to meet our criterion. This criterion is somewhat stringent; however, it enables unambiguous categorization. The results are shown in Table 2 where the scores are expressed as percentages to facilitate an English language comparison ($N = 20$ for English and $N = 12$ for Polish and Finnish). The following set of sentences demonstrate complete coding for the *when* test.

7. FIN Isä aj-el-i auto-a ja poika
Father drive-FREQ-PAST car-PART and boy
tek-i tiku-lle noin.
do-PAST stick-ALL so
'Father drove the car around, and the boy did so to the stick.'
'When…' Silloin kun se poika ol-i auto-ssa.
Then when it boy be-PAST car-INESS
'Then when the boy was in the car.'

8. FIN Poika lask-i ensin liukumäke-ä ja
Boy slide-PAST first hill-PART and
sitten katk-ais-i tiku-n.
then break-M-PAST stick-ACC
'The boy slid down the hill first, and then (he) broke the stick.'

In Sentence 7, the verb in the first clause is atelic and marked as frequentative (cf. *aj-ell-a* 'to drive around' versus *ajaa* 'to drive'), and the verb in the second clause is telic. The lexical support, i.e. *kun*, is added in the response to the 'when' question. In Sentence 8, both verbs are telic, and the second verb is marked as momentary (cf. *katk-ais-ta* 'to snap/break off' versus *katketa* 'to snap/break (in two)'). The lexical support comes from *ensin* 'first' and *sitten* 'then'.

9. POL Jak dziewczynka kopa-∅-ł-a piłeczkę
When girl kick-IPFV-PAST-FEM ball
to chłopiec z-łama-ł chyba zapałkę.
boy PFV-break-PAST maybe match
'when/while the girl was kicking the ball, the boy broke maybe the match.'

10. POL Chłopiec z-łama-ł patyk a
Boy PFV-break-PAST stick and
potem s-chowa-ł do biurka...
then PFV-hide-PAST to desk
'The boy broke the stick and then (he) hid (it) in the desk...'

In Sentence 9, the verb in the *jak* clause is imperfect (cf. *kopać* versus *kop-ną-ć*) which gives *jak* the meaning 'while'. In the second clause, the verb is perfective (cf. *z-łamać* versus *łamać*). This configuration embeds the breaking event within the context of the kicking event. In Sentence 10, a sequential interpretation is established with two perfective verb forms (cf. *z-łamać* versus *łamać* and *s-chować* versus *chować*), and lexical support is provided by *potem* 'then'. Since the SIM/SEQ contrast can be established with aspect alone, it may appear that our criterion is too demanding, especially for Polish where children make the perfective/imperfective distinction quite early. In fact, there were very few children who produced clear SIM/SEQ coding and did not combine lexical with aspectual means.

The Finnish children were more proficient than the Polish children on the temporal as well as the spatial test. However, the difference was larger on the spatial dimension with 75 percent of the three-year-old Finnish children at the criterion in contrast to fewer than 50 percent of the four-year-old Polish children. The children learning English produced a pattern which was very similar to the Finnish children. In this experimental situation the investigator has to encourage the children to provide complete responses without exceeding the child's limits. This balance is difficult to obtain and to hold constant cross-culturally. In all three cultures, the young children tried simple answers, e.g. most of the American two-year-olds answered *where* questions with the response 'right here/there', and they answered *when* questions with 'right now' or no response at all. Polish and Finnish children used the same strategies, but this lack of precision was more persistent in the Polish children extending to the three-year-old group. Beyond this general methodological issue, however, in Polish, there is a lack of precision concerning the use of *koło* 'in the vicinity of'. The four- and five-year-old Polish children often answered both inherent and deictic *front/back* problems with *koło*, and some of the children used *koło* twice to express *między* 'between'. This is not just a failure to extract a precise answer because these children who used *koło* in production had difficulty with *front/back* problems on the comprehension test. The fact remains that we did not find the same kind of language × dimension interaction in the production data that we found in the comprehension data.

An item analysis was carried out on the data from the *where* test. Considering all of the children within a language, the probability of a correct response was as follows for the subcategories: for Polish, (1) mono-referential = '*in/on*' (0·67) and inherent '*front/back*' (0·18), and (2) bi-referential = '*between*' (0·18) and deictic '*front/back*' (0·17), and for Finnish, (1) mono-referential = '*in/on*' (0·76) and inherent '*front/back*' (0·60), and (2) bi-referential = '*between*' (0·45) and deictic '*front/back*' (0·43). In Finnish, as was true in English, there was a clear difference between mono- and bi-referential problems. In Polish, the only difference was between '*in/on*' and everything else. Hence, the subcategorisation scheme broke down for Polish.

Language–thought comparison

In order to evaluate the relationship between language and thought, we correlated the composite measures of linguistic and conceptual development in time and space that were discussed above in Experiment 1. The Pearson correlation coefficient was $r = +0.52$ for time and $r = -0.54$ for space. These values are clearly significant with $p < 0.001$. When these correlations are carried out with age partialed out the results were as follows: (1) time, $r = +0.20$, $p < 0.03$, and (2) space, $r = -0.40$, $p < 0.001$. As we found for English, the language–thought association is sufficiently strong to argue that conceptual decentration is related to bi-referential location in time and space.

GENERAL DISCUSSION

Language–thought interaction in development

Regarding the conceptual domain, we found evidence for spatial and temporal decentration during the preschool period in all three cultures.

During the preschool period, the children became better able to make transformations on spatial and temporal representations such as rotation or reversal. On the spatial dimension, the children could formulate a representation which enabled them to locate a primary object relative to a referent object, and on the temporal dimension, they could move forward or backward from a central location within their temporal structures. This result is consistent with previous research. In general, the older children could locate an object or event relative to other objects or events in their representational structures. While this general pattern of development supports neo-Piagetian observations, the level of coordination that we found during the preschool period far exceeds that expected within the traditional Piagetian calendar. In the linguistic domain, we found that children became able to comprehend and produce more complex spatial and temporal 'geometries' during the same period of development. Our research focused on one property of complexity, and that was the number of related referent objects/events in a locative configuration. This dimension of complexity consistently made a significant difference in performance, i.e. mono-referential location was easier than bi-referential location. This finding also confirms previous research.

These changes in the conceptual and linguistic domains were correlated. As the form of representations in space and time becomes more clearly coordinated, so the capacity to comprehend relative locative relations emerges. Age is an obvious third variable, and it is inherently related to both conceptual and linguistic development. Nevertheless, the correlations between the conceptual and linguistic domains remained significant when age was partialed out. These correlations point out that the development of coordinated representations and complex locative systems covary. While it does not prove it, the finding is consistent with the hypothesis that coordinated representational structures provide the conceptual platform for the expression of complex locative relations involving two or more referent objects/events. Furthermore, the form of our interactive argument is consistent with previous research where measures of cognitive development were related to measures of language acquisition (e.g. Gopnik & Meltzoff, 1984; Loveland, 1984; Trosborg, 1982). The alternative argument would be that language and thought are independent, and that the correlations have identified two simultaneous but unrelated patterns of development. The fact that there is a related developmental change in the spatial and the temporal dimensions would be difficult to explain with the independence hypothesis. If the evolution of the linguistic systems was independent of conceptual development, it would be difficult to explain why the acquisition of deictic *front/back* follows the acquisition of inherent *front/back* or why deictic relations in time and space do not emerge at the same time.

The experimental design was embedded in a cross-linguistic framework so as to evaluate the hypothesis that the timing of the acquisition of spatial or temporal systems depends in part on the relative transparency versus opacity of the morpho-syntactic properties of the systems. Utilizing the framework of operating principles outlined by Slobin (1973, 1985), we predicted and found an interaction of language by dimension such that Polish children demonstrated a comprehension advantage on the temporal dimension in contrast to the Finnish advantage on the spatial dimension. This interaction was predicted on the premise that these temporal and spatial linguistic systems are more or less accessible to information processing strategies, i.e. 'operating principles'. However, when English was contrasted with Polish and Finnish, our case for operating principles was not supported. On the static comprehension test, the American children matched the Polish children on mono-referential temporal problems, and they matched the Finnish children on mono-referential spatial problems. Furthermore, they obtained a higher level of performance on both categories of bi-referential problems. As for bi-referential temporal problems, adverbial contrasts were the most difficult in all three languages. These problems involved conventional time concepts which are late to be acquired, but this does not explain any relative differences. A case can be made that the '*before/after*' problems were more natural in English than in either Finnish or Polish, and that in both Finnish and Polish, the distinction cannot be limited to the lexical contrast between *ennen* and *jäkeen* in Finnish or between *przed* (*zanim*) and *po* (*po tym jak*) in Polish. This could explain part of the temporal bi-referential disadvantage, but no such argument can be made for the spatial dimension. It is possible that the argument for operating principles must be made on a morpheme by morpheme basis such as Johnston & Slobin's (1979) analysis rather than a system-wide comparison as we have proposed.

In general, the Polish children were not very responsive on the *where* and *when* tests. We tried to offset this problem of uneven levels of responsiveness by comparing the percentage of children who produced at least one bi-referential distinction. Even with this dependent measure, the production data did not fit into the predicted pattern. The American and Finnish children were relatively similar on the *where* and the *when* tests, and the Polish children lagged behind on both the spatial or the temporal tests. When all of the components of this study are considered, the support for a timing argument is quite limited. This detracts from the overall argument for language–thought interactions as we were not able to consistently show that the interaction involves influences from language to thought as well as thought to language. Of course, the timing of acquisition is only one way in which language might influence conceptual development. Different languages focus on different properties of locative 'geometries', and this influences the nature of the distinctions which children learn (see Bowerman, 1991).

Spatial versus temporal location

A number of linguists have observed relationships between spatial and temporal location, and we will focus on three levels of their argument. At the observational level, Talmy (1983) demonstrated that language structures time much the same way as language structures space. In his analysis, he gave a number of examples of 'geometric' structures which are found in time as well as space, e.g. 'points distributed over a bounded linear extent' as in, *Birds sat all along the ledge/I sneezed all during the performance* (p. 255). At a second level of the argument, Jackendoff (1983: 188) proposed the THEMATIC RELATIONS HYPOTHESIS which states that, 'In any semantic field of [EVENTS] and [STATES], the principal event- , state- , path- , and place-functions are a subset of those used to analyze spatial location and motion.' The temporal field would be an example of such a semantic field, and it is viewed as a derived field. Hence, the representation for the sentence, *We moved the meeting from Tuesday to Thursday* has the same form as the representation for the sentence, *We moved the statue from the park to the zoo*. Clark (1973: 57) brought the argument into the developmental realm by proposing that, 'In general, therefore, spatial expression should appear before time expressions, and in particular, each term that can be used both spatially and temporally should be acquired in its spatial sense first.'

While this research project was not specifically designed as a test of Clark's spatial priority hypothesis, at least one relevant comparison can be made. Within the 'moving-ego' metaphor, the deictic centre is viewed as facing the future (see Clark, 1973: 51; Traugott, 1978: 380). Therefore, the future is in front of the interlocutor while the past is behind. Following this metaphor, the 'geometries' for future and past tense are analogous to those for inherent *front* and *back*. These are both mono-referential locations having a single reference point with the appropriate intrinsic features. Future/past and front/back contrasts constitute subsets of the mono-referential time and space components of the static comprehension test. Since the argument concerns the emerging use of these 'geometries', the data from the youngest children are the most relevant. Considering all the children in this study, the following pattern of results was obtained for the two- and three-year-old children: 2 yr, time = 69 % vs. space = 69 % and 3 yr, time = 77 % vs. space = 79 %. Given the *where* and *when* production tests, we determined the percentage of children who produced at least one correct response to an inherent *front/back* problem and the percentage of children who used past tense at least once in the obligatory context. The results were as follows: 2 yr, time = 86 % vs. space = 25 %, and 3 yr, time = 100 % vs. space = 57 %. There is no evidence for the spatial priority hypothesis. It is quite possible that the ability to construct event representations with chronological structure provides the conceptual framework for tense and not the ability to arrange objects in space.

CONCLUSION

The research concerning conceptual and linguistic development in the areas of time and space has shown that the capacity to construct coordinated representations and to express bi-referential location emerges during the preschool period. This research was designed to discover how these phenomena are related. The research has shown that measures of temporal and spatial decentration consistently covary with measures of bi-referential location. We have argued that there is an interaction of conceptual and linguistic factors in development. When the developmental process is heavily conceptually driven, the phenomena can be found consistently across languages, e.g. the transition from mono- to bi-referential location. Linguistically driven influences were less reliable. While some components of the research supported Slobin's idea that language acquisition depends in part on linguistic as well as conceptual complexity, the results pertaining to the timing of acquisition were inconsistent. We have argued that children enter the preschool period of development with spatial and temporal representations which are experiential in nature. Within the linguistic domain, they have the capacity to process linguistic information. Slobin's (1985) theory provides a solid working hypothesis concerning the form of the child's linguistic information processing system. With operating principles in place, children construct spatial and temporal systems. According to our argument, the form of spatial and temporal representations puts a constraint on language acquisition such that children start with mono-referential distinctions. Linguistic interaction, specifically spatial and temporal location, influences further conceptual development, and consequently, the development of integrated representations and the expression of bi-referential locative relations.

APPENDIX A *The structure of the temporal and spatial systems of Polish and Finnish**

<table>
<tr><th rowspan="3">Direction relative to ST</th><th colspan="2">Temporal structure
(Polish = transparent (1st example)
and Finnish = opaque (remaining examples))</th></tr>
<tr><th colspan="2">Perspective on temporal contour</th></tr>
<tr><th>Internal</th><th>External</th></tr>
<tr><td>BEFORE</td><td>czyta-ł-a-ś
read:IPFV-PAST-FEM-2:S
'(You) were reading.'</td><td>prze-czyta-ł-a-ś
PFV-read-PAST-FEM-2:S
'(You) read (something).'</td></tr>
<tr><td></td><td>lu-i-t kirja-a
read-PAST-2:S book-PARTIT
'(You) were reading (the) book.'</td><td>lu-i-t kirja-n
read-PAST-2:S book-ACC
'(You) read (the) book.'</td></tr>
<tr><td></td><td>ole-t luke-nut kirja-a
be:NPAST-2:S read-PP book-PARTIT
'(You) have been reading (the) book.'</td><td>ole-t luke-nut kirja-n
be:NPAST-2:S read-PP book-ACC
'(You) have read (the) book.'</td></tr>
<tr><td></td><td>ol-i-t luke-nut kirja-a
be-PAST-2:S read-PP book-PARTIT
'(You) had been reading (the) book.'</td><td>ol-i-t luke-nut kirja-n
be-PAST-2:S read-PP book-ACC
'(You) had read (the) book.'</td></tr>
<tr><td></td><td>lue-skel-i-t kirja-a
read-FREQ-PAST-2:S book-PARTIT
'(You) were browsing through (the) book.'</td><td>luk-ais-i-t kirja-n
read-MOMENT-PAST-2:S book-ACC
'(You) skimmed through (the) book.'</td></tr>
<tr><td></td><td>ol-i-t luke-ma-ssa kirja-a
be:PAST-2:S read-3INF-INESS book-PARTIT
'(You) were reading (the) book.'</td><td></td></tr>
<tr><td>AT</td><td>czyta-sz
read:IPFV:NPAST-2:S
'(You) are reading.'</td><td></td></tr>
<tr><td></td><td>lue-t kirja-a
read:NPAST-2:S book-PARTIT
'(You) are reading (the) book.'</td><td>No forms</td></tr>
<tr><td></td><td>lue-skele-t kirja-a
read-FREQ:NPAST-2:S book-PARTIT
'(You) are browsing through (the) book.'</td><td></td></tr>
<tr><td></td><td>ole-t luke-ma-ssa kirja-a
be:NPAST-2:S read-3INF-INESS book-PARTIT
'(You) are reading (the) book.'</td><td></td></tr>
<tr><td>AFTER</td><td>będzie-sz czyta-ł-a
be:FUT-2:S read:IPFV-PP-FEM
'(You) will be reading.'</td><td>prze-czyta-sz
PFV-read:NPAST-2:S
'(You) will read (something).'</td></tr>
<tr><td></td><td>Finnish same as AT
context decisive</td><td>lue-t kirja-n
read:NPAST-2:S book-ACC
'(You) will read (the) book.'</td></tr>
<tr><td></td><td></td><td>luk-aise-t kirja-n
read-MOMENT:NPAST-2:S book-ACC
'(You) will skim through (the) book.'</td></tr>
</table>

* The abbreviations for Appendices A and B are as follows: ABL, ablative; ACC, accusative; ADESS, adessive; ALLAT, allative; ELAT, elative; FEM, feminine; FREQ, frequentative, FUT, future; GEN, genitive; ILL, illative; INESS, inessive; INF, infinitive; INSTR, instrumental; IPFV, imperfective; LOC, locative; MOMENT, momentary; NPAST, non-past; PARTIT, partitive; PAST, past; PFV, perfective; PP, past participle; S, singular; 2, second person.

	Spatial structure (Finnish = transparent (1st example) and Polish = opaque (2nd example)) Perspective on spatial geometry	
Direction	Internal	External
(IN-)TO	talo-on house-ILL w-szedł do dom-u in: went to house-GEN '(He) went into the house.'	tuoli-lle chair-ALLAT w-skoczył na krzesło-θ to: jump on chair-ACC '(He) jumped onto the chair.'
IN/AT	talo-ssa house-INESS w dom-u in house-LOC 'in the house'	tuoli-lla chair-ADESS na krzesæl-e on chair-LOC 'on the chair'
(OUT-) FROM	talo-sta tuoli-lta wy-szedł z dom-u out: went from house-GEN '(He) went out of the house.'	tuoli-lta chair-MBA ze-skoczył z krzesł-a from: jumpoff chair-GEN '(He) jumped off of the chair.'

APPENDIX B *Sentences for the static comprehension test*

Format: Each entry in Appendix B contains a set of three test items. Each test item includes two alternative sentences with the morphological contrasts coded. The first item in each set is in English, the second in Polish, and the third in Finnish.

I. Space

A. Mono-referential

a. *in/on/under*

1. The parrot is (in/on) the cage.
   Papuga jest (w/na) klatc-e LOC.
   Papukaija on (häki-ssä INESS/ häki-n GEN pää-llä ADESS).
2. The dog is (on/in) the house.
   Pies jest (na/w) budzi-e LOC.
   Koira on (kopi-n GEN pää-llä ADESS/ kopi-ssa INESS).
3. The boy is (under/on) the table.
   Chłopiec jest (pod stoł-em INSTR/ na stol-e LOC).
   Poika on pöydä-n GEN (alla/ pää-llä ADESS).

b. *inherent front/back*

1. The cow is (in front of/behind) the tractor.
   Krowa jest (przed/za) traktor-em INSTR.
   Lehmä on traktori-n GEN (ede-ssä INESS/takana).
2. The monkey is (in front of/ in back of) the tractor.
   Małpa jest (przed/ za) słoni-em INSTR.
   Apina on elefanti-n GEN (ede-ssä INESS/ takapuole-lla ADDES).
3. The dog is (in back of/ in front of) the lady.
   Pies jest (za/przed) pani-ą INSTR.
   Koira on naise-n GEN (takana/ ede-ssä INESS).

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B. Bi-referential
  a. *deictic front/back*
    1. The butterfly is sitting (in back of/ in front of) the glass.
       Motyl siedzi (za/ przed) szklank-ą INSTR.
       Perhonen istuu lasi-n GEN (takana/ ede-ssä INESS).
    2. The sand castle is (in back of/ in front of) the ball.
       Zamek z piasku jest (za/ przed) piłk-ą INSTR.
       Hiekkalinna on pallo-n GEN (takana/ ede-ssä INESS).
    3. The doll is (behind/ in front of) the flower vase.
       Lalka jest (za/przed) wazon-em INSTR.
       Nukke on kukkamaljako-n GEN (takana/ ede-ssä INESS).
  b. *between*
    1. The glasses are between (the teapot and the flower vase/ the flower vase and the telephone).
       Okulary są między (czajniki-em INSTR a wazon-em INSTR/ wazon-em INSTR a telefon-em INSTR).
       Aurinkolasit ovat (teekannu-n GEN ja kukkamaljako-n GEN/kukkamaljako-n GEN ja puhelime-n GEN) väli-ssä INESS.
    2. The doll is between (the clock and the scissors/ the scissors and the clock).
       Lalka jest między (zegar-em INSTR a nożyczk-ami INSTR/ nożyczk-ami INSTR a szczotk-ą).
       Nukke on (kello-n GEN ja saksie-n GEN/ saksie-n GEN ja harja-n GEN) väli-ssä INESS.
    3. The bird is between (the garbage can and the tree/ the tree and the bench).
       Ptaszek jest między (kosz-em INSTR na śmiecie a drzew-em INSTR/drzew-em INSTR a ławk-ą INSTR).
       Lintu on (roskapöntö-n GEN ja puu-n GEN/ puu-n GEN ja penki-n GEN) väli-ssä INESS.

II. Time
A. Mono-referential
  a. *past/future*
    1. The girl (lit/ will light) the candle.
       Dziewczynka (zapali-ł-a PAST/ zapali NPAST) świeczk-ę.
       Tyttö (sytytt-i PAST/ aiko-∅-o NPAST sytyttä-ä INF) kynttilä-n ACC.
    2. The man (jumped/ will jump) into the water.
       Pan (wskoczy-ł PAST/ wskoczy NPAST) do wody.
       Mies (hyppäs-i/ aiko-∅-o NPAST hypät-ä INF) vete-en ILL.
    3. The boy (will catch/ caught) the ball.
       Chłopiec (złapie NPAST/ złapa-ł PAST) piłkę.
       Poika (saa-∅ NPAST/ sa-i PAST) pallon kiini.
  b. *aspect : internal/ external*
    1. The girl (was drawing/drew) a flower.
       Dziewczynka (rysowała IPFV/ na-rysowała PFV) kwiatek.
       Tyttö piirsi (kukka-a PART/ kuka-n ACC).
    2. The man (built/ will build) the doghouse.
       Pan (z-budował PFV/ budował IPFV) budę dla psa.
       Mies rakensi (koirankopi-n ACC/ koirankoppi-a PART).
    3. The men (were loading/ loaded up) the truck.
       Panowie (ładowali IPFV/ za-ładowali PFV) ciężarówkę.
       Miehet (ol-i-vat PAST lastaa-ma-ssa 3INF-INESS auto-a PART/lastas-i-vat PAST auto-n ACC).

B. Bi-referential
   a. *adverbial*
      1. The children made a snowman (yesterday/ last winter).
         Dzieci ulepiły bałwana (wczoraj/ ubiegłej zimy).
         Lapset tekivät lumiukon (eilen/ viime talvena).
      2. The girl (just had an accident/ had an accident three days ago).
         Dziewczynka (właśnie miała wypadek/ miała wypadek trzy dni temu).
         Tytölle (on juuri sattunut onnettomuus/ sattui onnettomuus kolme päivää sitten).
      3. Daddy will take the picture (in an hour/ in a second).
         Tata zrobi zdjęcie (za godzinę/ za chwilę).
         Isä aikoo ottaa kuvan (tunnin kuluttua/ hetken kuluttua).
   b. *before/after*
      1. The boy played (before/after) dinner.
         Chłopiec bawił się (przed obiadem/ po obiedzie).
         Poika leikki (ennen ruokaa/ ruuan jälkeen).
      2. The boy put on his shoes (after/before) he put on his pants.
         Chłopiec założył buty (po tym jak/ zanim) założył spodnie.
         Poika pani kengät jalkaansa (housujensa jälkeen/ ennen housujaan).
      3. Mother answered the phone (after/before) taking a bath.
         Mama odebrała telefon (po kąpieli/ przed kąpielą).
         Äiti vastasi puhelimeen (kylvyn jälkeen/ ennen kylpyä).

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