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Teasing apart the role of cognitive and verbal factors in children's early metaphorical abilities

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ABSTRACT

Metaphor plays a unique role in cognitive development by structuring abstract concepts and leading to conceptual change. Existing work suggests early emergence of metaphorical abilities, with five-year-olds understanding and explaining metaphors that involve cross-domain comparisons (e.g., SPACE to TIME). Yet relatively little is known about the factors that explain this developmental change. This study focuses on spatial metaphors for time, and asks whether cognitive and/or verbal factors best explain developmental changes in three- to six-year-old children's comprehension and explanation of metaphors. The results show that children's grasp of the time concept—but not verbal ability—predicts their metaphor comprehension. Verbal ability, on the other hand, is a predictor of metaphor explanation, even after controlling for age. The results thus suggest that cognitive and verbal factors selectively predict children's emerging metaphorical abilities.

INTRODUCTION

Metaphor is a pervasive aspect of human language (Lakoff & Johnson, 1980, 1997). Metaphor also plays an important role in abstract thought by structuring concepts (Gibbs, 1994) and leading to conceptual change (Gentner & Wolf, 2000). Previous work suggests early emergence of metaphorical abilities, with five-year-olds performing reliably above chance in understanding and explaining metaphors that involve cross-domain mappings (e.g., SPACE to TIME as in '*hours crawl by*'; Özçalışkan, 2005). However, we know relatively little about the factors that contribute to this developmental change. In this study, we focus on *SPATIAL METAPHORS FOR TIME* that involve cross-domain mappings between spatial motion and time, and ask whether cognitive and/or verbal factors best explain developmental changes in children's comprehension and explanation of metaphors.

We know from previous work that children can spontaneously produce a range of metaphorical expressions that highlight similarities between objects during early preschool years (Billow, 1975, 1981; Gardner et al., 1978; Winner et al., 1980; Winner, 1979). They, for example, call a baldheaded man as having 'a barefoot head' (Chukovsky, 1968), a half-peeled banana 'a flower' (Elbers, 1988) or a mushroom as looking 'like an ice-cream cone' (Özçalışkan & Goldin-Meadow, 2006). During this time, children can also understand metaphorical expressions based on perceptual similarities between objects (Gardner et al., 1975; Mendelsohn et al., 1984; Vosniadou & Ortony 1983). For example, when asked to complete a sentence, such as 'an eye is like a ______', they choose a similarity-based match (a button) as the word that best completes the sentence (Epstein & Gamlin, 1994). These early perceptual metaphors based on object commonalities (i.e., similarity matches) provide stepping-stones for the development of more complex metaphorical abilities that involve structural mappings between different domains in early to late school years (Cicone et al., 1981; Gardner et al. 1975; Winner et al, 1976). For example, older children can understand and explain metaphors that describe personality traits in terms of physical sensations (cold water: cold person; Asch & Nerlove, 1960), or various abstracts concepts in terms of spatial motion (Özçalışkan, 2005). In these metaphors there is typically a mapping from a physical source domain (i.e., temperature, motion) to a more abstract target domain (personality or time; Lakoff & Johnson, 1997)

At the same time, metaphorical ability is not determined solely by the child's age; the nature of the conceptual domains that constitute the metaphor also matters. For example, five-year-old children could correctly map animate terms onto cars ('the car is thirsty')—a target domain that they know well, but have difficulty in understanding metaphors that involve mappings between taste terms and personality ('she is a sweet person')—a target domain that they have limited knowledge of (Keil 1986). Similarly, five-year-old children can both understand and explain metaphors that are structured by motion ('ideas run through the mind'*;* Özçalıskan, 2005, 2007)—a source domain that structures a wide range of abstract concepts—but have difficulty deciphering the meaning of metaphors that involve extensions of object properties ('The prison guard is a hard rock'; Winner et al. 1976). These findings thus suggest that the development of metaphorical ability shows different developmental trajectories based on child's knowledge of the source and/or the target domain that constitute the metaphor. Yet there is very little existing work that systematically examines how children's grasp of the source and target concepts in a metaphor is related to their burgeoning metaphorical abilities.

Previous work also suggests that children's language abilities are closely related to their metaphorical abilities. An earlier study (Özçalışkan, Goldin-Meadow, Gentner, & Mylander, 2009) that examined non-signing deaf and hearing children's production of perceptual metaphors showed that acquisition of the word 'like' by hearing children allowed hearing children to produce more complex perceptual metaphors as compared to their deaf peers (i.e., homesigners), who have never developed a gesture akin to the comparison term 'like'. Similarly, previous work on children with language impairments, compared to children with other learning impairments, showed that children with language impairments performed more poorly on metaphor comprehension tasks (Lee and Kamhi, 1990), even in studies when metaphor comprehension was assessed using nonverbal metaphor tasks (Highnam, Wegmann, & Woods, 1999). Taken together, these findings suggest that language ability might also serve as a good predictor of children's emerging metaphorical abilities.

In this study, we focus on a subsystem of metaphors that structure our concept of time. Time not only constitutes a fundamental domain of human experience, but it is also an abstract concept that is predominantly conveyed through metaphors (Iwasaki, 2009; Nunez & Sweetser, 2006; Özçalışkan, 2003). In fact, one of the common ways we think and talk about time is in terms of spatial motion, using one of the three dominant metaphors: (1) *MOVING-TIME*, in which time moves in relation to a stationary observer (e.g., 'summer approaches'), (2) *MOVING-EGO*, in which observer of time moves in relation to a stationary time point (e.g., 'we approach summer'), and (3) *SEQUENCE-AS-*

RELATIVE-POSITION-ON-A-PATH, in which events in time move in relation to each other independent of the observer of time (e.g., 'summer follows winter'; Moore, 2000, 2006). Spatial metaphors for time are frequent in the adult language that surrounds the child and are also acquired early. Previous work that focused on one of the metaphor types for time (time-moving) showed that children can comprehend the meaning of time-moving metaphors by age 4 and can provide explanations for the underlying metaphorical mappings by age 5 (e.g., 'time flies by means it goes by fast without giving me enough time to color'; Özçalışkan, 2007). These results thus suggest that children's grasp of time metaphors is an early emerging ability. However, the question still remains as to which factors best explain changes in children's acquisition of spatial metaphors for time.

In this study, our goal is to identify developmental changes in children's comprehension and explanation of a system of spatial metaphors for time and to determine whether cognitive and/or linguistic factors best explain the changes in children's metaphorical abilities. There are three possibilities. One possibility is that changes in children's metaphorical abilities are most closely tied to changes in their language abilities. Namely, if metaphor is primarily a *linguistic ability,* then children with better verbal abilities will perform better in understanding and explaining metaphors. A second possibility is that changes in metaphorical ability are best explained by changes in children's understanding of the conceptual domains (space, time) that constitute the metaphor, above and beyond the influence of verbal ability. That is, if metaphor is primarily a *cognitive ability*, then children who have better grasp of the concepts that constitute the metaphor will also show better comprehension and explanation abilities. Yet a third possibility is that linguistic and cognitive factors selectively predict changes in children's metaphorical abilities: explanation of metaphors—which requires use of oral language—will be closely associated with children's language abilities, while comprehension of metaphors—which does not require language production, might be more closely related to children's understanding of the conceptual domains that constitute the metaphor.

We tested these predictions by examining three- to six-year-old children's metaphor comprehension and explanation abilities in relation to their understanding of the conceptual domains that constitute the metaphor (space, time) and their language abilities. We asked whether grasp of the source or target concepts and/or language ability best predict children's metaphorical abilities.

METHOD

Participants

Sixty children, at the ages of *three* (mean = 3;5, range = 3;1-3;11), *four* (mean = 4;6, range = 4;1-4;11), *five* (mean = 5;6, range = 5;2-5;10), and *six* (mean = 6;7, range = 6;3-6;11)—with 15 participants per age—along with 15 *adults* (mean =22, range = 18-48) participated in the study. Children were recruited from schools in the metro-Atlanta area, and were predominantly Caucasian (62%) and African-American (27%). Adults were recruited through a research participant pool at a university in Atlanta; they were predominately African-American (60%), Caucasian (20%) or had mixed ethnic and racial backgrounds (20%). All children and adults were monolingual English speakers, with roughly equal numbers of males and females in each age group.

Procedure for data collection and coding

Each participant was interviewed individually in their school or in our laboratory and asked to complete four tasks: (1) a metaphor comprehension and explanation task, (2) a physical motion description task assessing the child's knowledge of the source domain, (3) a time conservation task assessing the child's knowledge of the target domain, and (4) a standardized vocabulary task assessing the child's language ability. A few children did not complete either the time conservation task (N=4) or the vocabulary task (N=2).

Metaphor comprehension and explanation task

Children's metaphor comprehension was tested using six short stories, each containing one of the three different spatial metaphors for time (*TIME-MOVING, EGO-MOVING, SEQUENCE-AS-RELATIVE-POSITION-ON-A-PATH*), with two stories per metaphor type. The choice of the metaphorical statements in the stories was based on previous work that examined adults' production of different spatial metaphors for time in popular newspaper articles and web logs (blogs) written in English. For this study, we used the metaphorical expressions that are produced most frequently in describing each of the three spatial metaphor types for time, after simplifying them for syntactic form to make them more accessible to young children. The stories were similar in length and linguistic complexity (MLU_{range}= 4.2-5.6), and were accompanied by black and white drawings of the two characters in each story. Each child first listened to each story and then took part in a metaphor comprehension task, followed by a metaphor explanation task. *Metaphor comprehension* involved answering a forced-choice question about the metaphor in each story and was scored as either 0 (correct response) or 1 (incorrect response), resulting in a maximum possible score of 6 across the six stories for each child. The forced-choice questions and the answers were comparable in length and linguistic complexity across the six stories. *Metaphor explanation* involved explaining each forced-choice response and was scored on a three-point scale as either: 0 (irrelevant explanation), 1 (semi-relevant explanation), or 2 (relevant explanation), leading to a maximum possible score of 12 across the 6 stories for each child. A second rater recoded 50% of all explanations, with 85% agreement (k= .81, N=32). The presentation order of the stories was randomized across subjects within each age group. To make the task child friendly, two puppets provided the answers to each question (Elmo, Grover); the child's task was to choose the puppet with the correct answer and give an explanation for the choice. We counterbalanced the puppet that provided the correct choice across children within each age group and across the stories, as well as the order in which the correct answer was given. Adult data collection followed the same procedure, but without the use of the puppets.

The stimulus stories were chosen from among a larger set of stories that were tested for their informative content *without* the metaphors with a group of adults (N=83, M_{age}=25;2) to ascertain that children were providing correct choices based on their understanding of the metaphors but not simply because of the story context; only stories that led to random forced-choice responses (50% correct:50% incorrect) without the metaphors were selected and included in the study as stimulus stories after the addition of metaphors (see Appendix for all six stimulus stories used in the study).

<u>Physical motion (source domain) comprehension task</u>

Children's understanding of the literal (i.e., source domain) meanings of the linguistic expressions (verbs, prepositions) used in the metaphor comprehension and explanation task was assessed in a picture-choice task. For this task, children were presented with six physical motion descriptions one at a time; each of these six descriptions matched to one of the six metaphorical phrases in the stories (e.g., 'the dog is coming up on boy' as a match for 'trip to the zoo is coming up'). Each child was presented with the physical motion description (e.g., 'the dog is coming up to the boy') and asked to choose the picture that best matched the description between a choice of two pictures (e.g., dog approaching boy *vs.* dog moving away from boy; see Figure 1 for an example picture pair). The purpose of this task was to determine whether there were any individual or group differences in children's understanding of the source domain meanings of the motion terms used in the metaphorical statements in the story task. This task was only administered to children.

INSERT FIGURE 1 HERE

Time concept (target domain) comprehension task

Children's understanding of the time concept (i.e., target domain) was assessed by using a conservation of velocity of time task, adapted from Piaget (1969). We followed Piaget's definition of time as "a relationship between an action—something which gets done—and the speed with which it is done" (1970, p. 70). Accordingly, we defined time concept understanding as understanding the relation between duration, distance, and speed. To assess time concept understanding, children were introduced to a sand-timer and given time to familiarize with it. The sand-timer was then placed on a stool; children were first asked to walk as rapidly as they could and then as slowly as they could around the stool until all the sand ran down in the sand timer. They were then asked to compare the two experiences in terms of the three dimensions of the time concept, namely duration, distance and speed (see Figure 2 for a schematic drawing of the time conservation task), with three follow-up questions: (1)'First you walked quickly around the stool, and then you walked slowly around the stool. Did the sand fall quickly and slowly as well or did it fall the same way?' (2)'When you walked quickly around the stool how did the sand run?' (3)'When you walked slowly around the stool how did the sand run?' The conservation of velocity of time task varied both speed and distance (quicker speed-longer distance, slower speed-shorter distance), while keeping duration (i.e., amount of time passed) constant. In this way we were able to measure whether the child had a full grasp of the time concept by displaying an ability to understand the relationship between distance and speed, instead of focusing on the speed alone or the distance alone. Children's performance on this task was scored on a binary scale as either 0 (fail) or 1 (pass), following Piaget (1969). To receive a 'pass' the child had to answer all three questions correctly, or subsequently clarified their initial incorrect answer to show understanding of the time concept. We followed the same procedure in assessing adults' time concept understanding. Reliability was assessed with a second coder, who recoded 50% of the data, with 95% agreement (k = .92, N = 32).

INSERT FIGURE 2 HERE

Verbal ability task

We assessed child's language ability using the Peabody Picture Vocabulary Test-IV (PPVT-IV; Dunn & Dunn, 2007), which is standardized measure of the number of words the child knows. Words were read aloud one at a time, and the child was asked to choose the picture that best matched the word from a choice of four pictures. The PPVT-

IV yields both a raw score (range= 0-228) and a standard score (range= 20- 160) normed across ages 2;6-to-90+, rendering it as an appropriate measure for assessing the language ability of all participants in our study.

Procedure for data analysis

Data were analyzed using ANOVAs (with age as a between-subject factor), independent t-tests, and linear regressions (with age, language score, time concept score as predictors). We conducted two separate regression analyses, one for metaphor comprehension (Table 1) and one for metaphor explanation (Table 2), as outcome variables. In both regression analyses, we first entered *age* into the regression equation—to control for variance in scores due to child age (Model 1), followed by *language score*—to examine the additional variance explained by verbal ability but not by age (Model 2). As the last step, we entered *time concept score* into the equation, to identify the unique variance explained by time concept understanding, while partitioning out variance explained by age and verbal ability (Model 3).

RESULTS

We first looked at changes in children's metaphor comprehension and explanation abilities, and not surprisingly, found steady improvements over time. Children showed better metaphor comprehension with increasing age ($F(4,54)= 15.81$, $p<.001$)[1], from a mean correct response rate of 2.87 at age three to a mean correct

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[1] The assumption of homogeneity of variance was violated for children's metaphor comprehension scores, as indicated by a significant Levene statistic, $p=.02$. We

response rate of 5.13 at age six (see Figure 3, panel A). And by age 5, they were providing correct responses to the forced-choice questions about the metaphors reliably above chance (t(14)=3.17, p=.007). Moreover, six-year-olds did *not* differ from adults in their rate of correct responses (p= .25, *Games-Howell*), suggesting emergence of adult-like metaphor comprehension abilities by age six. Children's ability to provide relevant metaphorical explanations also improved over time ($F(4,70)=8.39$, $p<.001$), with a reliable change at age 6 ($p<.05$, *Tukey*; see Figure 3, panel B). Similar to metaphor comprehension, six-year-olds did *not* differ reliably from adults in the quality of their explanations (p=1, *Tukey*), suggesting that children begin to show adult-like reasoning patterns in their justifications for their choices as early as age six. One interesting difference, however, was that unlike 6-year-olds who focused their explanations on the metaphorical statements in the stories, adults tended to focus on the reasons for the emotional reactions of the characters in their explanations, which also led to overall lower explanation scores for the adults. Sample responses by a 3, 4, 5 and 6-year-old child and an adult are provided in example 1.

(1) Stimulus story on moving-time metaphor

Experimenter (E): *This is Patrick* [E points to picture of a child character]. *This is Patrick's mom* [E points to picture of an adult character*]. Patrick's mom tells him that his trip to the zoo is coming up. Patrick is excited. He shouts "YEAH!" Why is Patrick excited?* Elmo: *His trip to the zoo is soon* (correct choice), Grover: *His trip to the zoo is now* (incorrect choice) E: *Why did you choose Elmo/Grover?*

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therefore used Brown-Forsythe F-ratio and Games-Howell for main effect and posthoc comparisons, respectively, in comparing children's metaphor comprehension.

(3;1) [incorrect choice]: 'Because he is trying to have fun at the zoo'

(4;2) [incorrect choice]: 'Because the zoo is fun'

(5;4) [correct choice]: 'Because his mother said it'

(6;10) [correct choice]: 'Coming up means you have to wait a little bit more'

(Adult) [correct choice]: 'Coming up means that the trip is later, not now'

INSERT FIGURE 3 HERE

Our results showed early onset of metaphorical abilities, with children understanding spatial metaphors for time by age 5 and beginning to explain them by age 6. We next asked what explained these developmental changes in metaphor comprehension and explanation. We first looked at children's understanding of the source domain (physical motion) as a potential predictor of metaphor comprehension and explanation abilities. Almost all children (N=58/60) performed at ceiling in understanding physical motion meanings of the metaphorical phrases, making its contribution to metaphor comprehension and explanation comparable across children, without any individual differences.

Unlike their performance in the physical motion comprehension task, children showed individual variability in their performance in the time concept task and the language task. First, to determine whether *target domain knowledge* would predict metaphor comprehension and explanation, we regressed children's metaphor comprehension (Table 1) and explanation (Table 2) scores on age, vocabulary scores, and time concept score. We found that understanding the time concept was a significant predictor of metaphor comprehension, $\beta(69)=.23$, $p=.04$, $R^2=.35$, but *not* metaphor explanation, $\beta(69)=.11$, $p=.4$, controlling for age and vocabulary (see Tables 1 & 2, Model 3). Next, to determine whether *verbal ability* would predict metaphor comprehension and production, we regressed metaphor comprehension and explanation scores on age, vocabulary scores, and time concept scores; we found that children's language ability was a reliable predictor of metaphor explanation, β (69)=.3, p=.01, R^2=.16, but *not* metaphor comprehension, β (69)=.16, p=.14, after controlling for age and time concept understanding (Tables 1 & 2, Model 3).

INSERT TABLES 1&2 HERE

DISCUSSION

We examined early developmental changes in children's metaphorical abilities and asked whether cognitive and/or linguistic factors best explain the changes in children's comprehension and explanation of spatial metaphors for time. Our findings showed that linguistic and cognitive factors selectively predict changes in children's metaphorical abilities. The child's grasp of the target domain (time concept)—but not verbal ability, was a predictor of metaphor comprehension. Language ability, on the other hand, was a reliable predictor of metaphor explanation. Our results also further extended previous work on *time-moving* metaphors (e.g. 'time flies by', 'hours crawled by'; Özçalışkan, 2007) to the two other metaphor types for time—*ego-moving* ('we are approaching summer')*, sequence-as-position-on-a-path* (spring follows winter)—by showing early onset of both metaphor comprehension and metaphor explanation abilities for all three spatial metaphor types for time.

Why do children learn spatial metaphors for time at *an early age?* Previous work suggests that adults comprehend metaphorical language by creating online simulations of the actions conveyed through the metaphors (e.g., visualizing grasping objects when asked to interpret ‘grasping an idea’; Gibbs, 2006; see also Richardson & Matlock, 2007). More recent work (Miles et al., 2010) also suggests that our sensory experiences of moving forward or backward are closely associated with our concept of time. Blindfolded adults, when asked to visualize their past or future life experiences while standing upright, showed bodily sways in line with the location of time they were visualizing. That is, when thinking about the past they swayed backward and when thinking about the future they swayed forward.

There is also growing body of literature that suggests that our bodily experience is an important ingredient in forming knowledge representations and that linguistic meaning is grounded in sensorimotor experiences (Barsalou, 2008; Glenberg & Kaschak, 2002; Lakoff, 1987). In fact, previous work (Stites & Özçalışkan, in press) that examined developmental differences in children’s grasp of the three spatial metaphors for time showed that children were better at both understanding and explaining time metaphors based on the movement of their own bodies (moving-ego, moving-time) than metaphors that are less directly tied to their sensorimotor experiences (sequence-as-position). Unlike sequence-as-position metaphors, which rely on the observation of the relational movement of events that are independent of the self (e.g., bedtime follows storytime), both moving-time and moving-ego metaphors rely on the child’s first person perspective—with either time moving towards a stationary self (e.g., bedtime approaches) or self moving towards a stationary time point (e.g., we approach bedtime). As such, metaphors based on spatial motion—particularly the ones involving first person bodily experience, might be easier to master for young children, who rely largely on sensorimotor schemas to make sense of their experiences with the world (Piaget, 1969;

Mandler, 1999). In addition, spatial metaphors for time are quite frequently observed in the adult language (Özçalışkan, 2003). As such they might also be frequent in the input that the child hears, which, in turn, might facilitate their earlier acquisition compared to other metaphor types.

Why do cognitive and verbal factors *selectively predict* children's metaphor comprehension and explanation abilities? One possibility is that children's initial understanding of an abstract concept, such as time metaphors, is at an implicit representational level, accessible only in the nonverbal modality. The metaphor comprehension task only asked for a simple nonverbal response (pointing at the puppet with the correct answer), thus making it easier for the young child to convey their emerging metaphorical knowledge. However, understanding the time concept did not predict children's ability to *explain* time metaphors. Instead, it was the language ability that was a significant predictor of children's metaphorical explanations. In other words, children who had better language skills were also the ones who expressed themselves better in the explanation task. This is not surprising in the sense that verbalization of underlying metaphorical knowledge typically necessitates greater verbal ability as the child needs to learn not only what the words mean but also how this meaning can be extended in novel ways to convey metaphorical meanings, and it takes time for children to take this linguistic step.

Our finding that cognitive and verbal factors selectively predict comprehension and explanation of metaphors might also be indicative of a mutual coupling between cognition and language in the development of metaphorical abilities. Previous research on several other domains of development suggests bidirectional influences between language and cognition—with children producing words for the concepts that they are in the midst of learning (e.g., Gopnik & Meltzoff, 1984; 1986), or with changes in cognitive and linguistic abilities influencing each other in a cyclical manner over developmental time (see Clark, 2004 for a review). Language initially builds on early cognitive schemas that stem from children's perceptual experiences of objects, relations and events in their environment, and the generalizations they draw from such experiences (Bloom, 2000, Mandler, 2004). However, soon after children begin to produce language, the language itself starts to influence cognitive development, and can even play a crucial role in transforming early basic cognitive abilities into higher mental processes (Vygotksy, 1986). Applied to the domain of metaphor, a similar process might be at work as well. Existing theoretical work (Grady, 1997, 1999; Johnson, 1999) suggests that children's earliest metaphors are learned initially by correlating basic perceptual and cognitive abilities in everyday encounters with the world, independent of language (e.g., seeing an object in a box and understanding that there is an object in the box, resulting in the metaphorical mapping SEEING IS UNDERSTANDING). With the emergence of increasingly complex language abilities, children can begin to express particular instantiations of such a metaphorical mapping (e.g., *I see what you mean*, *I see what you want*), which in turn, might allow them to draw parallels between these different instances, thus arriving at a more global cognitive understanding of the metaphorical mapping itself. Similarly, greater language ability, through increased verbal interactions with the adults, might provide children with opportunities to get greater verbal exposure to the different instantiations of a metaphorical mapping, also allowing them to develop a broader cognitive understanding of a metaphorical mapping across its many exemplars.

As such, changes in children's metaphorical abilities might be an outcome of bidirectional influences between language and cognitive development, with each influencing as well as drawing inferences from the other throughout development.

Our findings also showed that a working knowledge of the target domain and its dimensions (duration, distance, speed) is critical to understanding the metaphorical expressions that are structured by this target domain—independent of the child's age and vocabulary. Spatial metaphors for time construe movement of time in various ways as passing slowly or as passing rapidly—even though time moves at the same steady rate regardless of our psychological evaluation of its passage. As such, in the time conservation task, the child has to understand that the psychological perception of time when walking fast or slow is different from the actual passage of time (i.e., the amount of time required for the sand to run all the way down) by focusing on multiple dimensions of the time concept. Similar to the time concept, understanding a metaphor also necessitates the ability to attend to multiple dimensions of the metaphorical expression, including a source domain (motion in space), a target domain (time) and the metaphorical mapping between the two. As such, understanding the concept of time and spatial metaphors for time might stem from similar cognitive abilities, namely the development of the ability to attend to multiple dimensions of an event simultaneously in an integrated fashion. However, the question still remains as to whether it is the understanding of the metaphor that leads to grasp of the target concept or it is the grasp of the target concept that leads to metaphor comprehension; future experimental work is needed to provide a more definitive answer to this question.

One limitation of our study was that the time conservation task was linguistic in nature—as is typical of many Piagetian cognitive tasks. At the same time, however, we found no evidence of a relation between children's verbal ability and their performance on the time concept task, showing that children with higher and lower vocabulary scores did not differ reliably in their grasp of the time concept. Nonetheless, future work that examines children's time concept using tasks that are less linguistic might shed further light on the development of the time concept as a cognitive construct. Our results also showed that children were at ceiling in understanding the source domain meanings of the metaphorical expressions used in the stories. Even though this finding ascertained that all children in our study understood the literal meaning of the linguistic terms in the metaphors, future work using a more difficult physical motion comprehension task might be useful in detecting individual differences in children's understanding of the source domain in relation to their metaphor comprehension and explanation abilities.

In sum, our findings underscore the tight link between early cognitive and linguistic abilities as predictors of children's burgeoning metaphorical abilities. Our results provide further empirical support for the view that metaphor is both a linguistic and a conceptual phenomenon (Gentner, 2001; Lakoff & Johnson, 1997), by showing that mastery of metaphors over developmental time reflects changes in both children's knowledge of conceptual domains that constitute the metaphor and their verbal ability.

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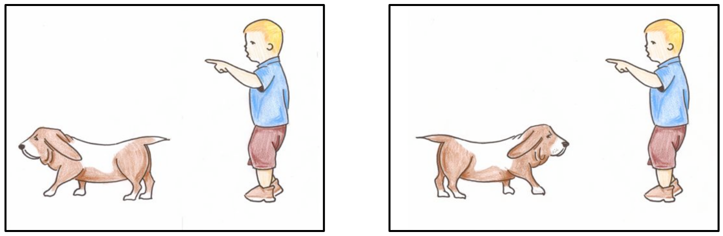

Figure 1. Sample picture pair for 'dog coming on the boy'

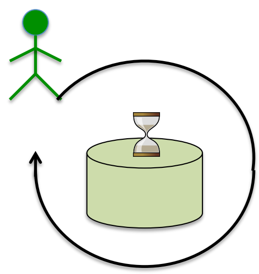

Figure 2. Schematic drawing for the time conservation task

A. METAPHOR COMPREHENSION B. METAPHOR EXPLANATION

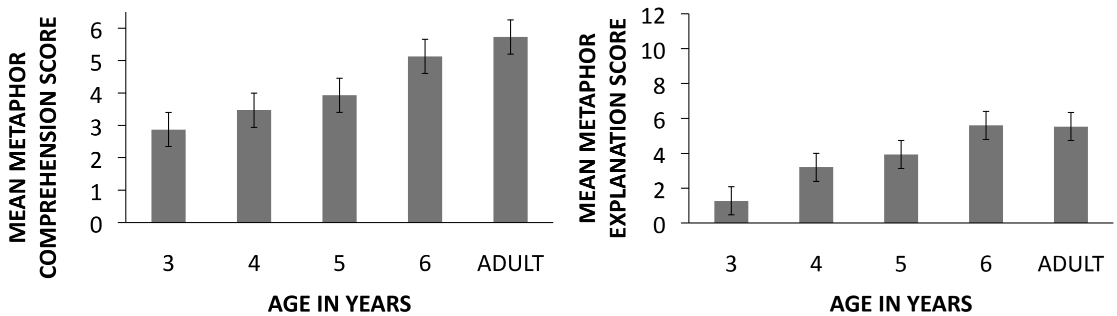

Figure 3. Mean metaphor comprehension score (panel A, max possible score=6) and mean metaphor explanation score (panel B, max possible score=12) by age

Table 1. Regression values of different predictors for metaphor comprehension

Predictors[a]	Model 1	Model 2	Model 3
Age at testing	.52***	.57***	.46***
PPVT Score		.18	.16
Time Concept Score			.23*
R^2	.27	.3	.35

*p<.05, ***p<.001

[a]*Predictors are listed in the order that they were entered into the regression equation; Model 3 includes all three predictors, with age and time task—but not language (i.e., PPVT score), as significant predictors for metaphor comprehension; this model explains 35% of the total variance in children's metaphor comprehension.*

Table 2. Regression values of different predictors for metaphor explanation

Predictors [a]	Model 1	Model 2	Model 3
Age at testing	.25*	.33**	.28*
Language Score		.31**	.30**
Time Task			.11
R^2	.06	.15	.16

**p*<.05, ***p*<.01

[a]*Predictors are listed in the order that they were entered into the regression equation; Model 3 includes all three predictors, with age and language (i.e., PPVT score)—but not time concept score, as significant predictors for metaphor explanation; this model explains 16% of the total variance in children's metaphor.*

APPENDIX
Stimulus Stories

A. Moving-time stories

(A1) This is Patrick. This is Patrick's Mom. Patrick's mom tells him that his trip to the zoo is coming up. Patrick is excited! He shouts "YEAH!

Why is Patrick excited?

(a) His trip to the zoo is now

(b) His trip to the zoo is soon (correct choice)

(A2) This is Ed. This is Ed's sister Ann. Ann tells him that the time for bed has come. Ed is sad. He says "Ugh!"

Why is Ed sad?

(a) He has to get up now

(b) He has to go to sleep now (correct choice)

B. Moving-ego stories

(B1) This is Erin. This is Erin's teacher. Erin's teacher tells her that they are coming up on recess. Erin is happy. She says "alright!"

Why is Erin happy?

(a) Recess is now

(b) Recess is soon (correct choice)

(B2) This is Rob. This is Rob's friend Kyle. Kyle tells Rob that he has to long way to go until his party. Rob is disappointed. He says "Ugh".

Why is Rob disappointed?

(a) His party is later

(b) His party is over (correct choice)

C. Sequence-as-position stories

(C1) This is Stacy. This is Stacy's sister Carol. Carol says that ice cream follows lunch.

Stacy is excited. She's says "Yippee!

Why is Stacy excited?

(a) Ice cream is now

(b) Ice cream is soon (correct choice)

(C2) This is Polly. This is Polly's dad. Polly's dad tells Polly lunch follows washing up.

Polly is disappointed. She says "oh."

Why is Polly disappointed?

(a) Lunch is over

(b) Washing-up is now (correct choice)