Received: 17 January 2020 | Revised: 9 April 2021 | Accepted: 17 April 2021

DOI: 10.1111/desc.13116

Developmental Science WILEY

PAPER

Representing agents, patients, goals and instruments in causative events: A cross-linguistic investigation of early language and cognition

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Funding information
Eunice Kennedy Shriver National Institute of Child Health and Human Development, Grant/Award Number: R01HD055498; Eunice Kennedy Shriver National Institute of Child Health and Human Development, Grant/Award Number: R01HD055498

Abstract

Although it is widely assumed that the linguistic description of events is based on a structured representation of event components at the perceptual/conceptual level, little empirical work has tested this assumption directly. Here, we test the connection between language and perception/cognition cross-linguistically, focusing on the relative salience of causative event components in language and cognition. We draw on evidence from preschoolers speaking English or Turkish. In a picture description task, Turkish-speaking 3-5-year-olds mentioned Agents less than their English-speaking peers (Turkish allows subject drop); furthermore, both language groups mentioned Patients more frequently than Goals, and Instruments less frequently than either Patients or Goals. In a change blindness task, both language groups were equally accurate at detecting changes to Agents (despite surface differences in Agent mentions). The remaining components also behaved similarly: both language groups were less accurate in detecting changes to Instruments than either Patients or Goals (even though Turkish-speaking preschoolers were less accurate overall than their English-speaking peers). To our knowledge, this is the first study offering evidence for a strong—even though not strict—homology between linguistic and conceptual event roles in young learners cross-linguistically.

KEYWORDS

causative events, change blindness, cross-linguistic differences, event cognition, event perception, thematic roles

1 | INTRODUCTION

A fundamental aspect of human cognition is the segmentation of the continuous stream of activity in the world into discrete units known as *events*. An event is composed of a "set of participants, activities, and outcomes that are bound together by causal interrelatedness" (Elman, 2009, p. 572) along spatial and temporal contours (Zacks & Tversky, 2001). In addition to creating meaningful representations of events, from a young age onwards, humans frequently communicate about the events they perceive (Choi & Bowerman, 1991; Pinker, 1989). How do event representations in language and cognition make contact with each other?

Influential theories of language production and language acquisition assume that event representation in language and cognition are tightly linked. According to psycholinguistic theories, the act of speaking involves selection of information to be encoded in an utterance, followed by the formulation of a linguistic message, and the execution of speech (Levelt, 1989). This linguistic phase is preceded by a preverbal event apprehension phase that involves the rapid identification of broad details of the event, including information about people, objects, entities, spatio-temporal information and the relatedness among them (ibid.; Bock et al., 2004; see Papafragou & Grigoroglou, 2019, for a recent review). Along similar lines, language acquisition theories posit that learners are equipped with a set of basic (and to some extent universal) concepts responsible for representing objects, people, space, and the relations among them; learning a language, at least to some extent, involves mapping linguistic input onto these conceptual representations (Gleitman, 1990; Hespos & Spelke, 2004; Jackendoff, 1996; Pinker, 1989).

Although it is widely assumed that the linguistic description of events is based on a structured representation of event components at the perceptual/conceptual level, little empirical work has tested this assumption directly. Furthermore, since languages differ in the way they encode events, it is an open possibility that children who acquire different languages map language onto event representations in different ways. Here, we address these questions cross-linguistically, focusing on thematic roles within event structure in both language and cognition. As we review below, although a growing body of linguistic and experimental work has focused on thematic roles and their conceptual basis, the link between the two has not been studied extensively. Existing evidence on parallels between event roles in early event apprehension and linguistic conceptualization comes from the study of simple events with a small number of event roles and mostly in English speakers. We begin with a brief description of the linguistic theory of thematic roles, and then proceed to review the most relevant experimental literature on the topic of interest.

Research Highlights

- We test the link between language and event perception/cognition in preschoolers cross-linguistically by focusing on the relative salience of causative event components.
- In language, Agents were mentioned less frequently in Turkish than in English; in cognition both language groups were equally accurate at detecting changes to Agents.
- Patients, Goals and Instruments behaved similarly in language and cognition cross-linguistically, with Instruments being the least salient role.
- Our findings offer first cross-linguistic evidence for a homology between linguistic and conceptual event roles in children.

1.1 | Thematic roles and the internal structure of events

In linguistic theory, thematic roles capture the relation between a verb and its arguments (i.e., Noun or Prepositional Phrases) and encode information about who did what to whom (Fillmore, 1968; Jackendoff, 1990). Some of these thematic roles include the Agent, the entity that causes the action (e.g., *A man is playing*), the Patient, the entity that is being affected by the action (e.g., *A man is hitting a ball*), the Goal, the endpoint of the action (e.g., *A man is hitting a ball into a hole*) and the Instrument, the means used to perform the action (e.g., *A man is hitting a ball into a hole with a golf club*).

Furthermore, within linguistic theory, there have been several attempts to formulate a ranking of event roles, known as the *Thematic Hierarchy* (Grimshaw, 1981; Pinker, 1989; Rissman & Majid, 2019). Those roles that contribute to event structure to a greater extent are ranked higher in the hieararchy and thus are more prominent (Levin & Rappaport Hovav, 2005). Linguistically, the Thematic Hierarchy guides how and how often different event roles are encoded in different syntactic positions. More prominent entities tend to be encoded more frequently, and in certain syntactic positions, such as Subject or Object (Grosz et al., 1995), or at the beginning or end of an utterance (Gernsbacher, 1989; Meyer et al., 1998). According to an influential formulation of the Thematic Hierarchy (Baker, 1997; Jackendoff, 1990), Agents are the most prominent role, followed by Patients and then Goals; Instruments are considered to be the least prominent of these major roles. This ranking is based on the fact that Agents are linguistically encoded as subjects and Patients as direct objects of the verb. Goals and Instruments are much less likely to be encoded in these syntactic positions which are considered to be obligatory elements in a sentence. Instruments, in particular, are considered to be the least prominent (Baker (1997) calls them "secondary roles"), since they are rarely selected as verb arguments and their linguistic expression is highly variable across languages. The Thematic Hierarchy provides an attractive way of representing generalizations about the syntactic realization of verb arguments, even though disagreements remain about the nature, inventory and other aspects of thematic roles (Davis, 2011; Levin, 2014).

For present purposes, it is important to note that thematic roles in language are often taken to directly reflect underlying non-linguistic event structure (Jackendoff, 1983, 1990 ; Baker, 1997). According to Jackendoff (1990), thematic roles are "relational notions defined structurally over conceptual structure" (p. 47), and "every putative thematic role assignment must be justified on the grounds of its place in conceptual structure" (ibid, p.50). On such views, linguistic roles such as Agents and Patients map relatively directly onto underlying conceptual event roles (see also Dowty, 1991; Levin & Rappaport Hovav, 2005; Levin & Pinker, 1991; Pinker, 1989). Similarly, the Thematic Hierarchy, even though primarily designed to capture linguistic generalizations about recurrent verb-argument relations, has been taken to bear on—and perhaps reflect—mappings between the linguistic and conceptual structure of events (Grimshaw, 1981; Pinker, 1989; Dowty, 1991; Strickland, 2017; Rissman & Majid, 2019). Specifically, a powerful hypothesis emerging from the linguistics literature is that the salience asymmetries among linguistic event components that are captured in the Thematic Hierarchy also characterize, at least in part, conceptualizations of the same event participants in non-linguistic knowledge systems. As detailed in the next section, prior psycholinguistic work has found evidence for the presence of homologies between the linguistic representation of event roles and non-linguistic role conceptualization beginning at the earliest moments of event apprehension (see also Ünal et al., 2021).

1.2 | Event roles in language and cognition

A first piece of support for the idea that the linguistic components of events draw on conceptual structure comes from studies with adults. This work has shown that viewers rapidly extract roles of event participants from line drawings of two-participant events (e.g., a woman shooting a man) while describing them; indicating that they activate knowledge about thematic roles during language production (Griffin & Bock, 2000). Furthermore, event role identification is more rapid for coherent scenes than incoherent scenes (Dobel et al., 2007, see also Dobel et al., 2011; Webb et al., 2010; Zwitserlood et al., 2018). Other work suggests that formulation of linguistic messages is flexible and may also be susceptible to bottom-up influences. For instance, using a more diverse set of event categories, one study demonstrated that a briefly presented attention cue capture that shifts attention to an event participant influence linguistic choices during production; these findings suggest that formulation of linguistic messages may begin prior to the extraction of event structure (Gleitman et al., 2007). Finally, after briefly viewing two-participant events, people correctly identified the event, its participants and the combination of the two even under the shortest viewing durations (Hafri et al., 2013). Importantly, information about Agent and Patient roles that are relevant for language can be extracted even when it is not directly encouraged by the task and while viewers' attention is occupied by an irrelevant task (Hafri et al., 2018). These findings demonstrate parallels between linguistic and non-linguistic event conceptualization during early stages of language production and processing.

Research with pre-linguistic infants also support homologies between linguistic and non-linguistic event role structure (see Göksun et al., 2010; Wagner & Lakusta, 2009, for an overview). This work has shown that infants are sensitive to the notion of Agency in simple causative events (Leslie & Keeble, 1987; Saxe et al., 2005), show novelty preference when Agent and Patient roles in an event are switched (Golinkoff & Kerr, 1978; Leslie & Keeble, 1987) or replaced by completely new entities (Cohen & Oakes, 1993), are sensitive to the cues that signal the intentional nature of Agents (Baldwin et al., 2001; Gergely & Csibra, 2003; Gergely et al., 1995; Woodward, 1998), and encode spatial Goals (Lakusta et al., 2007, 2017). These findings suggest that infants show some understanding of the conceptual correlates of event roles such as Agents, Patients and Goals before they acquire language.

Several studies support the idea that the relative prominence of event components varies. For motion events that involve a Figure moving away from a Source object towards a Goal object, both preschoolers and adults are more likely to linguistically encode the Goal path (*to the tree*) compared to the Source path (*from the flower*; Lakusta & Landau, 2005, 2012 ; Johanson et al., 2019; Papafragou, 2010). In non-linguistic tasks, preschoolers and adults are more likely to notice changes to Goals than Sources (Lakusta & Landau, 2012; Papafragou, 2010; Regier & Zheng, 2007) and pre-linguistic infants preferentially encode Goals over Sources (Lakusta & Carey, 2015; Lakusta et al., 2007, 2017). Thus, similar asymmetries characterize linguistic and non-linguistic conceptualization of Sources and Goals.

Finally, a set of older and more recent findings corroborate the idea that Instruments have a fragile status in event representation. English-speaking adults frequently omit instruments in retelling stories involving instrument events, especially when the instrument is typical compared to when it is atypical (e.g., *stabbing with a knife/an icepick*; Brown & Dell, 1987; Lockridge & Brennan, 2002). Recent developmental work with English speakers also shows that both 4- and 5-year-olds and adults tend to mention atypical instruments in event descriptions, especially when communicating with an interactive conversation partner (Grigoroglou & Papafragou, 2019a). Furthermore, children but not adults continue to omit the instrument even when their conversation partner cannot see the pictures being described (Grigoroglou & Papafragou, 2019b). Importantly, the perceived centrality of instruments to event structure depends on the nature of the event. English-speaking adults are more likely to consider Instruments as key event participants for events that require an instrument (e.g., *slicing*) compared to events that merely allow an instrument (e.g., *drinking*; Rissman et al., 2015).

1.3 | Current study

At present several questions remain open with regard to our understanding of how the linguistic description of events and event roles connects with the representation of event components at the perceptual/conceptual level. First, although there is a large literature on how children acquiring different languages talk about events (e.g., Allen et al., 2007; Furman et al., 2014; Papafragou et al., 2002, 2006), this work has not considered non-linguistic event apprehension measures (but see Bunger et al., 2012, 2016 ; Papafragou & Selimis, 2010). Inversely, infancy work focusing on non-linguistic event conceptualization (Göksun et al., 2010; Wagner & Lakusta, 2009) has not considered whether and how early event representations change after language acquisition.

Second, current work on the perception of event roles relevant for language has typically focused on simple events, with Agents and Patients being two roles that have been studied most commonly (Griffin & Bock, 2000; Dobel et al., 2007; Hafri et al., 2013, 2018). However, it is important to integrate various event roles, including, Goals (Lakusta et al., 2007; Lakusta & Landau, 2012) and Instruments (Grigoroglou & Papafragou, 2019a, 2019b ; Rismann et al., 2015), and investigate their relative salience within a single more complex event. This is especially important because asymmetries between event components can be seen most clearly when individual components are studied together within an event (Lakusta et al., 2007; Lakusta & Landau, 2012; Papafragou, 2010; Do et al., 2020), and disagreements remain in the literature about the ranking of roles beyond Agents and Patients (Baker, 1997; Fillmore, 1968, 1971; Grimshaw 1990; Jackendoff, 1972; Wolff, 2007).

Finally, existing empirical evidence on the relative prominence of event roles comes primarily from speakers of English (Lakusta et al., 2007; Lakusta & Landau, 2012; Wilson et al., 2011). It remains an open question whether and how existing evidence on the salience of event components in both language and cognition generalizes to speakers of different languages, especially since general linguistic prominence asymmetries are likely to interact with language-specific encoding preferences (see Johanson et al., 2019 on the Source/Goal asymmetry). This issue connects to broader debates about the presence and extent of linguistic and cognitive universals. On one view, linguistic categories are independent from and map onto conceptual categories that are largely shared between speakers of different languages (Gleitman & Papafragou, 2016; Landau et al., 2010). According to an alternative view, cross-linguistic semantic differences create cognitive discontinuities between speakers of different languages (Boroditsky, 2006; Levinson, 2003; see also Whorf, 1956).

In the current study, we address these open issues by examining the relative prominence of event roles in language and cognition across learners of different languages. We focused on caused motion events that have multiple components; more specifically, events in which an (animate) Agent makes a Patient move towards a Goal endpoint using an Instrument (e.g., a woman hitting a tennis ball into a basket with a tennis racquet). We chose to focus on causative events because their structure and relative complexity provide a good test bed for evaluating the claim that event roles in language and cognition are tightly linked. We used the same events across a linguistic description task and a non-linguistic change blindness task (Rensink et al., 1997) performed by the same participants. The change blindness paradigm was chosen as a measure of salience: prior studies using this paradigm have shown that changes that are more central for a visual scene can be detected more easily compared to more peripheral changes (Levin & Simons, 1997; Rensink et al., 1997; Simons, 2000). Since in our stimuli Agents were always animate and often human, we examined (animate) Agents and (inanimate) Patients, Goals and Instruments event components separately. This was done to ensure that the relative salience of different roles indeed reflects the roles themselves and not just a property of the entities which usually fill those roles, such as animacy. We studied child speakers of English and Turkish. Turkish is a head-final language characterized by rich morphology and flexible word order (Kornfilt, 1997; Erguvanlı, 1984). It was chosen because it differs from English in two critical respects: the potential for argument drop (particularly relevant for Agent mentions) and the number of options used to mark thematic roles (particularly relevant for the remaining roles, as we detail below).

Our first main question was whether the likelihood of mentioning event components in the linguistic description task would display asymmetries in accordance with the Thematic Hierarchy (Baker, 1997; Jackendoff, 1990), and whether these asymmetries might interact with language-specific encoding preferences. Beginning with Agents, we expected this component to be mentioned quite frequently in English (as a Subject Noun Phrase, see example (1)) in accordance with the high ranking of Agents in the Thematic Hierarchy (Baker, 1997; Jackendoff, 1990, and many others). For Turkish, since the verb is marked for number and person and subjects tend to be dropped (Göksel & Kerslake, 2005), we expected Agents (as Subject Noun Phrases) to be regularly omitted (see examples (2) and (3)).

1. A woman$_{[AGENT]}$ hit the ball$_{[PATIENT]}$ into a basket$_{[GOAL]}$ with a tennis racquet$_{[INSTRUMENT]}$.
2. Kadın$_{[AGENT]}$ topu$_{[PATIENT]}$ sepetin içine$_{[GOAL]}$ raket ile$_{[INSTRUMENT]}$ attı.
   woman ball-ACC basket inside racquet with throw-PAST.3sg
   'a woman threw the ball inside the basket with a racquet'
3. Topu$_{[PATIENT]}$ sepetin içine$_{[GOAL]}$ raket ile$_{[INSTRUMENT]}$ attı.
   ball-ACC basket inside racquet with throw-PAST.3sg
   'threw the ball inside the basket with a racquet'

Turning to the remaining three event components, following the Thematic Hierarchy, we expected Patients to be mentioned more frequently than Goals, and both Patients and Goals to be mentioned more frequently than Instruments in both English and Turkish. Nevertheless, we could not exclude language-specific prominence patterns, since the availability of surface encoding options for Goals and Instruments differs across the two languages. These roles are encoded as Prepositional Phrases in English, (see (1)), and as Postpositional Phrases in Turkish (see (2)). Additionally, however, because in Turkish case-marking can indicate thematic roles (Özge et al., 2019), Goals can be encoded as Noun Phrases in dative case and Instruments can be encoded as Noun Phrases in comitative case (see example in (4)).

4. topu sepete$_{[GOAL]}$ raketle$_{[INSTRUMENT]}$ attı.
   ball-ACC basket-DAT racquet-COM throw-PAST.3sg
   'threw the ball to the basket with a racquet'

Turkish-speaking children, therefore, have to map these two roles onto multiple linguistic structures (Postpositional Phrases and case-marked Noun Phrases) whereas English-speaking children have to map these roles onto Prepositional Phrases only. Variability in the surface syntactic realization of a thematic role has generally been taken to indicate more peripheral status in the hierarchy (especially cross-linguistically; Baker, 1997). Furthermore, even though the acquisition of basic aspects of the case-marking system begins before the age of 2, some aspects of this system including the comitative case are learned much later (Ketrez & Aksu-Koç, 2009). In sum, because of this one-to-many mapping, Turkish-speaking children might mention Goals and Instruments less frequently than English-speaking children and the Goal vs. Instrument asymmetry might not surface in linguistic encoding in Turkish. Consistent with this possibility, there have been reports of rampant omissions of Goals, Sources and Instruments in young Turkish learners' descriptions of multi-participant events (Furman et al., 2014; Göksun et al., 2008, Ketrez & Aksu-Koç, 2009), even though the data cannot be directly compared to English learners' omissions of these event components (see Bunger et al., 2012, on Goals; and Grigoroglou & Papafragou, 2019a, 2019b , on Instruments).

Our second main question was whether the salience of event components in the change blindness task would also be asymmetrical as predicted by the Thematic Hierarchy, and whether this asymmetry would hold across learners of English and Turkish, especially given cross-linguistic differences in how event components are encoded. We can distinguish at least three broad possibilities here. One possibility is that the relative accuracy of detection of changes to event components would follow a stable ranking (consistent with the broad outlines of a hierarchy of event participants; Baker, 1997; Jackendoff, 1990) regardless of language-specific patterns of role encoding. If so, change detection accuracy for different event components would be similar in Turkish- and English-speaking children despite cross-linguistic variation in how and how often event components are mentioned cross-linguistically. For instance, both English- and Turkish-speaking children would be highly—and equally—likely to detect Agent changes non-linguistically, despite the fact that Turkish learners are likely to encode Agents less frequently than their English-speaking peers. Similarly, both English- and Turkish-speaking children would be more accurate for Patient changes than Goal changes, and for Goal changes than Instrument changes. This would be consistent with the view that conceptual event categories are largely shared between speakers of different languages (Gleitman & Papafragou, 2016; Landau et al., 2010). According to an alternative possibility, change detection accuracy across event components might mirror the differences in the frequency of mention of these event components in the linguistic description task. If so, Agent changes should be detected with higher levels of accuracy in English compared to Turkish (and similarly for any other components that elicit cross-linguistically variable descriptions). This would be consistent with the view that semantic distinctions in language constrains conceptual event categories across speakers of different languages (Boroditsky, 2006; Levinson, 2003). A final possibility is that non-linguistic change detection might behave in some other manner that is partly or wholly misaligned with the linguistic encoding of event roles within or across languages. Depending on how exactly this last possibility is borne out in the developmental data, it might challenge the assumption that event roles in language reflect available perceptual/conceptual event structure.

2 | METHOD

The methods reported in this study were approved by the Institutional Review Board of the University of Delaware and Özyeğin University.

2.1 | Participants

Data were collected from 96 preschoolers who were monolingual native speakers of English (n = 50, mean age = 3.96, range = 3.00-4.90) and Turkish (n = 46, mean age = 4.06, range = 3.04-4.98). English speakers were recruited through preschools in Newark, DE. Turkish speakers were recruited through preschools in Istanbul, Turkey. None of the children had a parent or teacher reported history of speech-language or any other developmental disorders. Data from 20 additional preschoolers (10 English-speaking, 10 Turkish-speaking) were discarded due to not completing or missing more than half of the trials in the picture description task (n = 12), describing the pictures during the change blindness task (n = 3), experimenter or equipment error in the change blindness task (n = 4) or fussiness (n = 1).

FIGURE 1 Example event: [A man]$_{AGENT}$ hit a [ball]$_{PATIENT}$ [into a bucket]$_{GOAL}$ [with a golf club]$_{INSTRUMENT}$

2.2 | Stimuli

The stimuli consisted of 24 clip-art images that were created using Adobe Illustrator. The pictures depicted midpoints of various caused motion events in which a person or an animal (Agent) moved an object (Patient) to a destination (Goal) using a tool or a body part (Instrument). A sample event is provided in Figure 1: in this event a man hit a ball into a bucket with a golf club. The complete list of events used is provided in the Appendix. In each picture the Agent was the only animate entity, and the Patient, Goal, and Instrument were always inanimate objects. Additional sample stimuli can be found in https://osf.io/fetgs/.

2.3 | Procedure

All participants were tested individually in a quiet room in their preschool. The tasks were run on a Dell laptop computer, using E-Prime (Schneider et al., 2002a, 2002b). All participants were tested in their native language by a native speaker.

Picture description task. Stimuli were 14 of the images from the set of caused motion events. Participants were instructed that they would see some pictures of events and were asked to describe what happened in each picture as soon as they saw the image. The image remained on the screen until the participants finished describing the picture. Once the participants finished describing the event, the experimenter pushed a button to advance to the next picture. Individual items were arranged in a different random order for each participant. Participants' descriptions were audio recorded. The task lasted approximately 10 min.

Change blindness task. Stimuli were the complete set of 24 caused motion events. For each image, four additional versions were created by changing the color of one event component (Agent, Patient, Goal or Instrument). Agent-changes were created by changing the color of the Agent's clothes. A sample change item is presented in Figure 2. Each

FIGURE 2 Sample change item (Goal-change) corresponding to the event in Figure 1

participant saw six instances of each type of change. Changes to event components were counterbalanced across participants, such that for a given event, changes to all four components were seen by four different participants, but each participant saw each event only once.

The procedure was adapted from Rensink and colleagues (1997). In each trial, the original event was displayed for 240 ms, followed by a gray mask that was displayed for 80 ms. Then, the change event was displayed for 240 ms, followed by the same gray mask that was displayed for 80 ms. This 640 ms cycle (original event-gray mask-change event-gray mask) was repeated for a maximum of 20 s. Individual items were arranged in a different random order for each participant.

Participants were told that they would see a picture that would flicker and change, and that the change would be something in the scene changing color. They were told to either point at or name the changing object as soon as they spotted the change. Participants were given 20 s to respond. If they did not respond within 20 s, a time out screen was displayed, and the next trial began. The task lasted approximately 15 min.

All participants received both the picture description and the change blindness tasks. The order of tasks was kept constant for all participants, such that all participants completed the change blindness task first. This was done in order to avoid transfers from a task that involves using language to a non-linguistic task.

2.4 | Coding

Children's event descriptions were transcribed by a native speaker. Descriptions were coded for whether an event component was mentioned and how it was mentioned. Entities had to be appropriately construed as the Agent, Patient, Goal or the Instrument of the event. Simple mention of an entity was not sufficient to be considered as mention. For example, for an event in which a mouse pulled a cheese into a hole with a rope, descriptions such as "*A mouse and a cheese*" were not coded

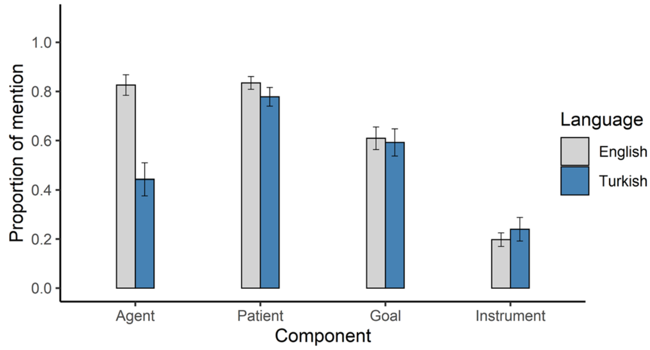

FIGURE 3 Proportion of mention of event components in English and Turkish. Average of Subject means. Error bars indicate standard error of the mean

as Agent and Goal mentions since this description merely names the entities without capturing the relations among the entities and assigning them any roles. We excluded 9% of the data corresponding to trials in which children did not speak or describe the event.

In English, Agents were encoded as Subject Noun Phrases, Patients as either Direct Object Noun Phrases or Subject Noun Phrases, and Goals as Prepositional Phrases. Instruments were encoded as either Prepositional Phrases, Verbs or Direct Object Noun Phrases of verbs such as *use*. In Turkish, Agents were mentioned as Subject Noun Phrases Patients as either Direct Object Noun Phrases or Subject Noun Phrases, and Goals as either Postpositional Phrases or Noun Phrases in dative case. Instruments were encoded as either Noun Phrases in comitative case or verbs. See Tables S1 and S2 in Supplementary Material for details.

3 | RESULTS

Data from both tasks were analyzed using generalized binomial linear mixed effects modelling (*glmer*) with crossed random intercepts for Subjects and Items. All models were fit with the *lme4* package (version 1.1.17; Bates et al., 2015) in *R* (R Core Team, 2018). All figures were produced using *ggplot2* package (Wickham, 2016). Data are available at https://osf.io/fetgs/.

3.1 | Picture description task

First, we investigated how frequently each event component was mentioned as a proportion of all descriptions. Figure 3 shows frequency of mention of each event component in English and Turkish.[1] Data from (animate) Agents were analyzed separately from data from the remaining (inanimate) event components. The dependent measure was binary values for mention (1 = present, 0 = absent) at the item level. The

[1] Due to the binary nature of the data, Figure 3 shows only the proportion of trials in which a component is mentioned (separately for each event component). The rest of the time, that event component was omitted. Since all items included all four event components, the proportions do not need to add up to 1.

fixed effect of Language was tested with centered contrasts (–0.5, 0.5). Beginning with Agent mentions, there was a fixed effect of Language ($\beta = -2.864$, $SE = 0.406$, $z = -7.058$, $p < .001$). As expected, English-speaking children mentioned Agents more frequently compared to Turkish-speaking children whose language allows subject-drop.

For the remaining event components, the fixed effect of Component was assessed with planned contrasts. The analysis revealed that children mentioned Patients more frequently than both Goals ($\beta = 1.168$, $SE = 0.100$, $z = 11.659$, $p < .001$) and Instruments ($\beta = 3.48$, $SE = 0.121$, $z = 28.924$, $p < .001$). Furthermore, children mentioned Goals more frequently than Instruments ($\beta = 2.318$, $SE = 0.107$, $z = 21.629$, $p < .001$). There were no fixed effects of Language ($\beta = -0.02$, $SE = 0.224$, $z = -0.084$, $p = .933$) or interactions involving the fixed factor Language, indicating that the same patterns held across both English and Turkish-speaking preschoolers. These findings indicate that the relative salience of event roles in language conformed to the asymmetries predicted by the Thematic Hierarchy (Baker, 1997; Jackendoff, 1990), and was robust across learner communities.

In order to ensure that the role prominence asymmetries in linguistic encoding was independent of low-level perceptual features of individual entities, we ran an additional *glmer* model on binary values for mention that included the Size of the component as a fixed factor in addition to the fixed effects of Language and Component (See Table S3 in Supplementary Material for Sizes of each event component in the stimuli). This model had better fit for the mention of Patients, Goals and Instruments (χ^2 (1) = 20.419, $p < .001$). In addition to the previously reported asymmetries, there was a fixed effect of the factor Size ($\beta = -0.034$, $SE = 0.008$, $z = -4.521$, $p < .001$); however, there were no interactions involving this factor. This indicated that, across all items, as size of each component decreased, frequency of mention increased. Furthermore, this pattern was not specific to a certain type of event component. Thus, Size of the entity fulfilling event roles cannot explain the role asymmetries in our data.

3.2 | Change blindness task

Change detection accuracy for each event component across English- and Turkish-speaking preschoolers is presented in Figure 4. As in the Picture Description task, data from (animate) Agents were analyzed separately from the remaining (inanimate) event components. The dependent measure was binary values for accuracy (1 = accurate, 0 = not accurate) at the item level. The fixed effect of Language was tested with centered contrasts (–0.5, 0.5). For Agent changes, the model did not reveal an effect of the fixed factor Language ($\beta = -0.081$, $SE = 0.395$, $z = -0.206$, $p = .837$). Thus, despite cross-linguistic differences in how frequently Agents were mentioned during language production, English and Turkish-speaking preschoolers were equally accurate in detecting changes to Agents in a non-linguistic task.

For Patients, Goals and Instruments, the fixed effect of Component was assessed with planned contrasts. Children were more accurate in detecting Patient changes than Instrument changes ($\beta = 1.563$, $SE = 0.148$, $z = 10.541$, $p < .001$). Children were also more accurate in detecting Goal changes than Instrument changes ($\beta = 1.562$, $SE = 0.178$, $z = 10.557$, $p < .001$). However, children were equally accurate in detecting changes to Patients and Goals ($\beta = 0.001$, $SE = 0.144$, $z = 0.008$, $p = .994$). Furthermore, English-speaking preschoolers were more accurate in overall change detection compared to Turkish-speaking preschoolers ($\beta = 0.0696$, $SE = 0.283$, $z = 2.462$, $p = .014$). Importantly, there were no interactions between the fixed factors Component and Language, indicating that the English-Turkish difference in change detection accuracy did not stem from a specific event component. Thus, the relative salience of these event roles in cognition is similar in learners who speak different languages and largely—but not entirely—consistent with the asymmetries in event role salience predicted by the Thematic Hierarchy (Baker, 1997; Jackendoff, 1990; see Discussion).

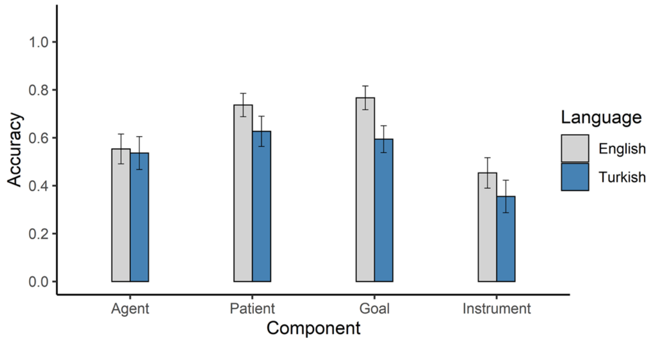

FIGURE 4 Change detection accuracy of event components in English and Turkish. Average of Subject means. Error bars indicate standard error of the mean

To further confirm that the relative change detection accuracy for Patients, Goals and Instruments was independent of low-level perceptual features of individual entities, we constructed an additional *glmer* model on binary values for accuracy that included Size of the event component as a fixed factor in addition to the fixed effects of Component and Language. Adding Size of the component did not improve model fit for the change detection accuracy (χ^2 (1) = 1.148, $p = .284$). Thus, the relative salience of Patients, Goals and Instruments was independent of the perceptual attributes of the individual entities that filled these roles.

3.3 | Relation between tasks

Since the change blindness task always preceded the picture description task, one might hypothesize that the detection of a particular change in a role increased the likelihood that the specific role would be mentioned for that same item in the subsequent picture description task. To rule out this possibility we conducted an exploratory analysis on a subset of the picture description data for the mention of each role only for those trials in which there was a change to that role in the earlier change blindness task. Figure 5 shows the proportion of mention of a particular role split by whether the change in that role had been

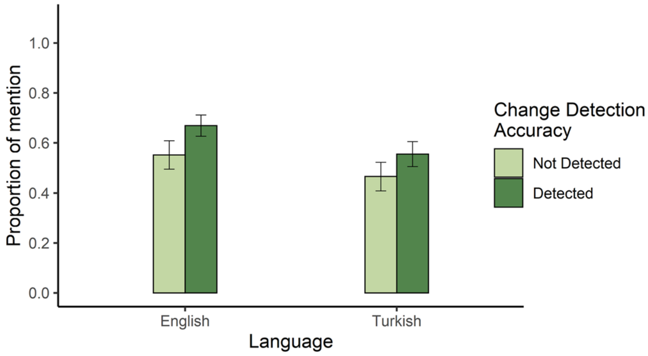

FIGURE 5 Proportion of mention of a particular role when a change in a role had and had not been detected in the change blindness task in English and Turkish. Average of Subject means. Error bars indicate standard error of the mean

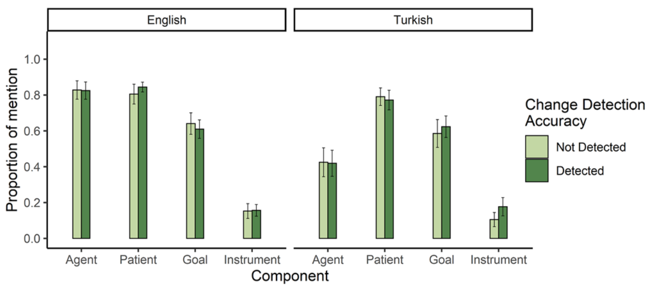

FIGURE 6 Proportion of mention of each component when a change to any event component for that item had and had not been detected in the change blindness task in English and Turkish. Average of Subject means. Error bars indicate standard error of the mean

detected or had gone undetected across English- and Turkish-speaking preschoolers.

We conducted a *glmer* on binary values for mention (1 = present, 0 = absent) at the item level. The fixed effects of Language and Change Detection Accuracy (detected, not detected) were tested with centered contrasts (–0.5, 0.5). Children were more likely to mention a particular role if a change to that role for the same item had been detected earlier in the change blindness task compared to when it was not detected: this was true for both Agents ($\beta = 0.801$, $SE = 0.341$, $z = 2.349$, $p = .019$) and the remaining components ($\beta = 0.836$, $SE = 0.145$, $z = 5.750$, $p < .001$). Crucially, change detection accuracy did not interact with language (Agents: $\beta = -0.718$, $SE = 0.682$, $z = -1.053$, $p = .292$; Patients/Goals/Instruments: $\beta = -0.166$, $SE = 0.289$, $z = -0.576$, $p = .565$) and occurred for all role types.

We also explored whether change detection accuracy predicted the overall pattern of role mentions for an item, regardless of which particular role had been changed in the earlier change blindness task. Figure 6 shows the proportion of mention of each role when change to any role for that item had or had not been detected across English- and Turkish-speakers. Crucially, whether or not a change had been detected did not predict the overall pattern of role mentions for that item (Agents: $\beta = 0.018$, $SE = 0.190$, $z = 0.097$, $p = .923$; Patients/Goals/Instruments: $\beta = 0.096$, $SE = 0.136$, $z = 0.707$, $p = .480$), and this was true of both languages (Agents: $\beta = 0.222$, $SE = 0.376$, $z = 0.591$, $p = .555$; Patients/Goals/Instruments: $\beta = 0.258$, $SE = 0.270$, $z = 0.956$, $p = .339$). Thus, while detecting a change increased the likelihood that a particular role would be mentioned later, it had no effect on mentions of other roles. Furthermore, change detection accuracy did not alter the pattern of role mentions reported in our primary analyses.

4 | DISCUSSION

On a daily basis, children perceive and communicate about events that unfold around them. However, the link between the two core processes of event perception and event representation in language was not well-understood. In this paper, we tested the possibility that event representations in the two domains might be tightly linked to each other, such that event role prominence asymmetries observed in language (Baker, 1997; Dowty, 1991; Jackendoff, 1990; Levin & Pinker, 1991) might also characterize cognition. We also asked to what extent these asymmetries generalize across learners of different languages.

4.1 | Event role prominence in language

Our first main question was whether the Thematic Hierarchy would predict the relative salience of event roles in language and whether the role prominence asymmetries would change cross-linguistically. As expected, frequency of mention of Agents differed cross-linguistically: English-speaking preschoolers frequently mentioned the Agent, whereas Turkish-speaking preschoolers frequently omitted the Agent due to the subject-drop feature of their language. This picture is consistent with prior reports of frequent Agent omission when young Turkish leaners describe caused motion events (Furman et al., 2014).

The linguistic encoding of Patients, Goals and Instruments reveals both cross-linguistic similarities and differences. English and Turkish-speaking preschoolers encoded these three components equally frequently in their speech, and prioritized them similarly: that is, they mentioned Patients more often than both Goals and Instruments, and Goals more often than Instruments. These event role prominence asymmetries are consistent with the predictions of the Thematic Hierarchy (Baker, 1997; Jackendoff, 1990). This is also consistent with prior work with young learners of Turkish showing that when describing caused motion event 1- to 3-year-olds encode the entity that is affected by action (i.e., the Patient) more frequently than the Goal endpoint of the action (Furman et al., 2014).

Within these cross-linguistic similarities in the frequency of mention of event roles, there were differences in the encoding of Goals and Instruments in line with the encoding options available in English and Turkish. Goals appeared exclusively as Prepositional Phrases in English, and either as Postpositional Phrases or as Noun Phrases in the dative case in Turkish. Instruments showed surface variation in both languages. In English, Instruments appeared either as Postpositional Phrases, Verbs, or Direct Objects of the verb *use*, whereas, in Turkish, they appeared either as Noun Phrases in the commutative case or as verbs. Patients were encoded as Direct Object Noun Phrases in both languages. This indicates that asymmetries in event role prominence in language are independent of surface level variation in how role categories are encoded.

4.2 | Event role prominence in cognition

Our second main question was whether the Thematic Hierarchy would predict the relative salience of event roles in cognition and whether role prominence asymmetries would change cross-linguistically. Beginning with Agents, the cross-linguistic differences in Agent encoding were not reflected in the change blindness task: Turkish- and English-speaking preschoolers converged in their change detection performance for Agents. It appears that the level of salience of Agents during event apprehension is shared across speakers of different languages. This is reminiscent of a recent finding showing that although Chinese speakers were more likely to drop the Agents in their event descriptions than Dutch speakers, attention to Agents in a non-linguistic task did not differ cross-linguistically (Flecken et al., 2019). Our data point to a more complex relation between the linguistic and conceptual prominence for Agents, not a simple correspondence between frequency of Agent mention in language production and conceptual salience of the corresponding entity in a dynamic event.

A somewhat surprising finding in our data was that changes to Agents were not detected with a high level of accuracy (especially given that Agents were overwhelmingly mentioned by the very same English-speaking children). This seems to go against what might be expected on the basis of prior cognitive and linguistic evidence about the primacy of Agents in event representation (Baker, 1997; Jackendoff, 1990; see also Baldwin et al., 2001; Gergely & Csibra, 2003; Woodward, 1999). A plausible explanation might lie with the kinds of changes used in this task. We used color changes in order to maintain similarity between the original picture and the changed picture in terms of visual features such as size and shape. Nevertheless, the color change in the Agent condition affected a property of the component (i.e., the clothes) instead of the component itself. Thus, detecting the color changes in the Agent condition might have been harder for children compared to detecting the color changes for the other event components. This caveat needs to be taken into account when using the current change blindness data as an index of the salience of Agents in event cognition.

Furthermore, the biases in the linguistic encoding of Patients, Goals and Instruments seem to have counterparts in non-linguistic event conceptualization: in the change blindness task, children were more accurate in detecting both Patient and Goal changes than Instrument changes. This pattern emerged in both English- and Turkish-speaking preschoolers. This result is consistent with the hypothesis that thematic roles in language build on antecedently available abstract event roles in cognition (Jackendoff, 1990, among others). Furthermore, it integrates and extends prior data on the contribution of Patients (Cohen & Oakes, 1993; Golinkoff & Kerr, 1978; Hafri et al., 2013, 2018 ; Leslie & Keeble, 1987), Goals (Lakusta et al., 2007; Lakusta & Landau, 2012) and Instruments (Grigoroglou & Papafragou, 2019a, 2019b ; Rismann et al., 2015) to event representation in both language and cognition.

It should be noted, however, that, even though the pattern of results was similar across the linguistic description and the change blindness task, it was not exactly identical: in the picture description task, Goals were mentioned less frequently than Patients, but in the change blindness task, Goals changes were detected just as accurately as Patient changes. It is possible that a categorical (accuracy) measure with a 20-s response window in the change blindness task was not fine-grained enough to capture asymmetries between Patients and Goals. If so, reaction time measures should be able to tease apart the relative salience of the two roles.

At present, however, it appears that the homology between linguistic and non-linguistic event roles (and their relative salience) is not strict. That is, there are broad similarities between how event roles are encoded in language and how the entities filling these roles are perceived in cognition. Nevertheless, event role asymmetries do not follow identical patterns in language and cognition. This conclusion is reminiscent of similar observations in the literature on the Source/Goal asymmetry. For intentional/animate events (e.g., a man hopping from a table to a ladder), children and adults are more likely to both mention and remember the Goal compared to the Source path; however, for physical/inanimate events (a paper blown from a container to a ladder), memory for Goals is still better than memory for Sources but the linguistic asymmetry disappears (Lakusta & Landau, 2012). In both the Source/Goal and the Patient/Goal cases, the results suggest that the linguistic asymmetry between event roles is not fully rooted in non-linguistic event representations, and that additional, language-internal factors need to be considered to explain the discrepancy between the salience of event roles across linguistic and non-linguistic tasks.

In the case of Patients and Goals, our findings suggest that the Thematic Hierarchy, even though interfacing with event role representations that are grounded in cognition, works somewhat independently to link thematic roles to their syntactic realization. Linguistically, the relative ranking of Patients and Goals is robust: in our data, Patients have cross-linguistically stable encoding in syntax (in both English and Turkish, they surface as direct object NPs) and cannot be omitted, unlike Goals that are more variable across the two languages, are not selected by the verb as obligatory arguments, and can thus be omitted. Cognitively, the relative ranking of the two roles may not be as strict: recall that a large developmental literature has pointed out the psychological importance of Goals that is in place already in infancy (Lakusta & Carey, 2015; Lakusta et al., 2007, 2017). The misalignment between the relative prominence of Goals in language and cognition is also consistent with evidence that 4-year-old English learners omit Goals more often than adults when describing motion but are just as likely as adults to direct attention to Goal regions of the motion events, as shown by eye tracking evidence (Bunger et al., 2012). Thus, what children say during language production might be related to language-internal constraints on argument realization and not simply to cognitive constrains on event role representation. It remains to be seen whether these findings generalize to other stimuli that involve Patients and Goals beyond causative events.

4.3 | Implications for linguistic and cognitive theories of thematic roles

Taken together, our findings point to homologies between young children's linguistic and cognitive representations of Agents, Patients, Goals and Instruments across communities of learners; they also suggest that these homologies are not strict (as shown by the data on Agents and Patients/Goals above). Our findings go beyond prior linguistic and cognitive research on thematic roles in three ways. First, by combining linguistic and cognitive measures of event roles for the same stimuli and from a single group of children, we get insights on early event representations in a way rarely pursued in the literature (see also Wilson et al., 2011 on adults). Second, by investigating complex, causative events, we obtain the broadest picture to date of how different event participants are processed within a single event (expanding, e.g., the literature on Sources and Goals; Lakusta & Landau, 2005, 2012 ; Lakusta et al., 2007; Papafragou, 2010; Regier & Zheng, 2007). Third, by sampling from two typologically different languages, we provide cross-linguistic evidence for thematic role representations. To our knowledge, this is the first study offering evidence for a tight and subtle mapping between linguistic and conceptual event roles in young learners cross-linguistically.

Our findings are consistent with theories of language production (e.g., Levelt, 1989) that presume tight links between production processes and event perception. On these theories, linguistic processes such as formulation of a message to be conveyed by an utterance is preceded by a non-linguistic apprehension of the broad details of an event, including who is doing what to whom. Similarly, our results cohere with prominent theories of language acquisition (Gleitman, 1990; Pinker, 1989), according to which learners form conceptual categories of the entities and objects involved in events, and later map linguistic input onto these non-linguistic categories. Our findings further suggest that, due to cross-linguistic variation, learners of different languages may have to learn different language-to-event-role mappings. For instance, English learners have to map subject Noun Phrases (e.g., *a woman*, *she*) onto the Agent, whereas Turkish leaners also have to learn to map phonologically unrealized constituents (dropped subjects) onto the Agent role. Nevertheless, these language-specific encoding requirements seem to operate over similar (or at least, similarly salient) Agent representations at the non-linguistic level.

From the perspective of broader discussions on the language-cognition interface, our findings go against the view that cross-linguistic differences in event encoding create cognitive discontinuities between speakers of different languages (Boroditsky, 2006; Levinson, 2003; Whorf, 1956). Instead, our data support the conclusion that core conceptual event categories are shared to a considerable degree among learners of different languages and shape what gets encoded in natural language (see Landau et al., 2010; Gleitman & Papafragou, 2016; Ünal & Papafragou, 2016 for converging evidence). The relation between children's performance across our two tasks—specifically, the fact that children regardless of language community were more likely to mention a role if they had earlier detected a change to that role within the same event—provides further support for this conclusion.

Our findings have implications for the development of the relation between language and event representation. Even though the present study did not test adult samples, there is prior work assessing the relative salience of event roles in language and cognition in English-speaking adults using similar paradigms (Wilson et al., 2014). In that study, English-speaking adults also mentioned Agents with high frequency. They also mentioned Patients frequently, followed by Goals, then Instruments. Furthermore, changes to Agents were not detected very quickly, but Patient changes were detected the fastest followed by Goal changes then Instrument changes. Relatedly, in an eye-tracking study, English-speaking adults were asked to identify Agent, Patient, Goal or Instruments of the same events (Wilson et al., 2011). Looks to target components diverged at different latencies, with Agent looks diverging the earliest, followed by Patient, Goal and then Instrument looks. These findings suggest that the asymmetrical representation of event roles in language and cognition observed with children in the present study is quite similar to adult patterns, at least for English speakers. Further work with Turkish-speaking adults is necessary to complete the cross-linguistic developmental picture.

Several questions about the relation between event roles in language and cognition remain open for further research. First, the bulk of current empirical evidence on the representation of event roles comes from the domain of motion events that involve either spontaneous or caused motion. Future research should investigate whether these patterns generalize to other types of events and event roles. For example, Patients have a central role in the representation of change-of-state events (Hindy et al., 2012; Solomon et al., 2015; Ünal & Papafragou, 2019). Second, communication about events usually takes place in interactive contexts and pragmatic factors are linked to variation in the mention of some more peripheral event components (Grigoroglou & Papafragou, 2019a; Do et al., 2020). It remains to be seen whether the salience of other event roles is susceptible to such pragmatic influences, and how these might surface across languages and learners (Papafragou et al., 2006). Finally, it is important to consider that communication about events is usually multimodal (Furman et al., 2014; Kita & Özyürek, 2003). It is an open question whether these event role prominence asymmetries also extend to children's gestural encoding of events.

ACKNOWLEDGMENTS

This work was supported in part by the Eunice Kennedy Shriver National Institute of Child Health and Human Development under grant #R01HD055498 to Anna Papafragou and John C. Trueswell At the time Anna Papafragou was at the University of Delaware. We thank Frances Wilson and Özge Baturlar for assistance with stimuli preparation and data collection.

CONFLICT OF INTEREST

The authors declare no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Open Science Framework at https://osf.io/fetgs/.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Ünal, E., Richards, C., Trueswell, J. C., & Papafragou, A. (2021). Representing agents, patients, goals and instruments in causative events: A cross-linguistic investigation of early language and cognition. *Developmental Science_* 1-13. https://doi.org/10.1111/desc.13116

APPENDIX

	Event
1	An archer shooting an arrow with a bow towards a target.
2	A man hitting an apple into a basketball hoop with an umbrella.
3	A soldier firing a bouquet at a castle with a catapult.
4	A caveman hitting some meat towards a fire with a club.
5	A clown firing a bomb at a paddling pool with a cannon.
6	A girl hitting a ball of wool towards a hat with a croquet mallet.
7	A man hitting a golf ball into a bucket with a golf club.
8	A man hitting a ball into a net with a mop.
9	A mouse pulling a slice of cheese to a hole with a rope.
10	A man hitting some paper into a bin with a bat.
11	A cricketer hitting a present into a bowl with a cricket bat.
12	A man sweeping dirt into a dustpan.
13	A woman hitting a ball into a basket with a tennis racquet.
14	A soldier pushing a wheel to a truck with a stick.
15	A man kicking a boot into a suitcase.
16	A ninja kicking a phone towards a grandfather clock.
17	A man shoveling gold into a sack.
18	A man pulling a log towards a fire with a rope.
19	A man pulling a block towards a pyramid with a rope.
20	A man raking leaves into a basket.
21	A man shoveling manure into a truck.
22	A man kicking a can into a wheelie bin.
23	A man pulling a television into a cave with a chain.
24	A man pulling a tree towards a house with a rope.

Note. Events (15-24) were only used in the change blindness task.