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The intention-to-CAUSE bias: Evidence from children's causal language

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ABSTRACT

The current study explored causal language in 3.5- to 4-year-old children by manipulating the type of agent (human acting intentionally or unintentionally, or inanimate object) and the type of effect (motion or state change) in causal events. Experiment 1 found that the type of agent, but not the type of effect, influenced children's production of causal language. Children produced more causal language for intentionally caused events than for either unintentionally- or object-caused events, independent of the type of effect. Experiment 2, which tested children's judgments of descriptions for the events, found a similar pattern. Children preferred causal descriptions more for the intentionally caused events than the unintentionally- and the object-caused events. Experiment 3 found no evidence of bias in children's non-linguistic representations of the events. Taken together, these results suggest an intention-to-CAUSE bias in children's mapping of conceptual representations of causality into linguistic structure. We discuss the implications of these results for the acquisition of causal language and for the development of conceptual representations of causality.

1. Introduction

Human adults have the remarkable ability to represent the causal structure of a seemingly infinite set of events. Adults can reason about the effects of their own actions and about the effects of other people's actions. Furthermore, when making causal judgments, the intention of the agent is of no consequence – regardless of whether a person intentionally turned off the television or unintentionally sat down on a remote control, adults will still judge that the person *caused* the television to turn off. Additionally, causal reasoning is not restricted to judgments about human agents – adults are equally capable of causally reasoning about the effects of both animate and inanimate objects – and adults can causally reason about many types of effects, such as object motion, lights turning off, balloons popping, or plant growth. Thus, causal representations extend to a wide range of events – events that crosscut conceptual classes.

The breadth and apparent intricacy of causal reasoning in adults poses a fundamental question concerning the developmental origin of this vast capacity in human cognition. Are human infants and young children able to reason causally about a wide variety of events (Gopnik et al., 2004)? Or, is causal reasoning initially biased towards a certain class of events, such as events of motion (Michotte, 1963) or events involving animate agents acting intentionally (Piaget, 1954)? If early causal representations emerge from a restricted class of events, then biases may not only emerge in the way young infants represent causal events, they may also emerge in the way older children use causal language, since linguistic representations interact with non-linguistic representations early in development (e.g., Bloom, 1973; Clark, 2004; Landau, Smith, & Jones, 1988; Mandler, 1992; Slobin, 1973, 1985). Specifically, children may show a bias to map a certain class of events (e.g., motion events, intentional events) more often into causal linguistic structures than other classes of events.

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The question of whether factors such as the animacy and intentionality in an event influence children's causal language is motivated not only from developmental theories regarding the origin and nature of conceptual representations of causality (Piaget, 1954; White, 1995, 1999), but also from research exploring causal language in adults (Wolff, 2003; see also Song & Wolff, 2005). Such research suggests that while adults use causal language to describe a wide range of causal events, the animacy and intentionality of the agent influences the specific type of causal language adults use to describe causal events. Given the significance of these factors in theorizing about the ontogeny of causal representations, as well as in adults' causal language, the current study explores whether and how these conceptual factors play a role in children's linguistic encoding of causal events.

1.1. Conceptual representations of cause

Two prominent theories of the development of causal representations provide insights into the types of biases that may emerge in children's developing causal language. According to both theories, although later in development causal representations can be applied to all events, early in development a more limited class of events serves as the prototypical schema for causality. The theories differ, however, in which class of events serves as the basis for causal representations. According to one theory, mature causal representations emerge from representations of human actions causing specific effects in the world. Although this idea is closely associated with the ideas of Piaget (1954), its main tenets are also found in philosophy (Maine di Biran, see Michotte (1963)), and more recently in the work of White (1995, 1999). Piaget believed that the child was initially born without any representations of causality. Then, over the first 6 months of life, the infant begins to construct causal representations that are initially limited to his or her own actions. Over development infants' concept of causal action broadens to include other people's intended and unintended actions, and eventually children include objects and other nonhuman agents, such as the weather, as causal agents.

In contrast, Michotte (1963) emphasized the importance of the *type of effect*, rather than the type of agent, in representations of causality. According to Michotte, the initial causal event is a caused motion event. Through extensive psychophysical experiments exploring adult causal perception, he showed that the ability to perceive one object as causing an effect in another object is (1) influenced only by the spatiotemporal parameters of the event (spatial contact, temporal continuity) and (2) limited to events in which the second object was caused to move (rather than, for example, change color). Michotte indeed acknowledged that adults can readily represent nonmotion, change of state events (hereafter called "state change events") as causal. To account for this ability, Michotte proposed that adults' causal representations of state change events are generalizations from an initially domain-specific module dedicated to causal perception of motion events (for a more complete review of both theories, see Muentener & Carey, 2010).

Thus, these two theories make very different claims about the *origin* of causal representations – one emphasizing events involving intentional agents and one emphasizing motion events. In the current paper, we explore how early conceptual representations of causality may influence conceptual and linguistic representations of causality later in development. Our working linking hypothesis is that if causal reasoning is restricted early in development, then later in development, even if causal reasoning becomes unrestricted, biases may remain in children's construal of causal events. If in infancy causal representations are restricted to events involving intentional agents, then later in development when children view a causal event, they may be more likely to encode the event as causal if it is caused by an intentional agent than if it is caused by a nonintentional agent. This conceptual bias may, in turn, increase the likelihood that causal events involving agents acting intentionally are mapped into causal linguistic structures. However, if in infancy causal representations are restricted to events involving caused motion, then, later in development, children may be more likely to encode an event as causal if it is a motion event than if it is a state change event, which may, in turn, increase the likelihood that causal motion events are mapped into causal linguistic structures. The current study aims to bring evidence to bear on these alternatives, and to shed light on children's use of causal language and the mapping of children's conceptual representations into causal linguistic structures. If any differences emerge in children's causal language, this may also provide some insights into the possible origins for conceptual representations of causality.

1.2. Linguistic representation of CAUSE

The unitary causal nature of different types of events (caused motion, caused state change, intentionally caused, unintentionally caused, object-caused, etc.) is captured by linguistic theory, which posits that there is a primitive CAUSE that defines the semantic structure of all causal events (Jackendoff, 1983, 1990, 2002; Levin & Rappaport-Hovav, 1995, 2005; Pinker, 1989). For example, consider a motion event of a golf ball rolling as a result of (1) a boy intentionally moving the ball with a putter, (2) a boy accidentally moving a golf ball by unintentionally hitting the ball with the putter, or (3) a green ball rolling into a red ball, which then contacts the golf ball, making it move. Amongst many other alternatives, we can describe all these events with causal language, such as (1) "the boy moved the ball," (2) "the boy accidentally moved the ball"/"the boy made the ball move", and (3) "The green ball moved the golf ball"/ "The green ball made the golf ball move". Furthermore, CAUSE is not restricted to motion events, but extends also to change of state events. Consider an event in which the boy turns on a light, rather than moves a ball. We can describe this event as "the boy turned on the light," an event that carries the same notion of causality as motion events.

The first step in encoding any of the above causal events in language is choosing a verb, and the choice of verb constrains the syntactic encoding of the event components (Gleitman, 1990, 1965; Jackendoff, 1990; Landau & Gleitman, 1985; Levin & Rappaport-Hovav, 1995, 2005).

Some verbs include both the cause and effect in their semantic structure (we refer to these as 'causal' verbs) and some verbs include only the causal agent or the affected patient in their semantic structure (we refer to these as 'non-causal verbs'). Causal verbs, such as "break" and "roll," include both the cause and effect in their semantic structure, and these components can map into syntax in various ways. First, both the cause and effect may be mapped into syntactic structure in single clause descriptions. In the description, "the boy moved the ball", the causal agent (the boy) is mapped into the subject noun phrase, while the effect (moving ball) is mapped into the verb phrase (verb + direct object). This linguistic structure is referred to as the lexical causative construction. Another possibility is that only the effect may be mapped into syntactic structure, as in the example, "The ball moved." This linguistic structure is referred to as the inchoative construction. Verbs such as 'break' also participate in multi-clause descriptions, such as the periphrastic causative construction ("the boy made the ball move") in which the causal agent (the boy) is mapped into the subject noun phrase, while the effect (moving ball) is mapped into an embedded clause. These various descriptions all involving the verb 'move' illustrate that although the verb 'move' carries a causal meaning in its semantic structure, it participates in a variety of syntactic constructions that either include both the cause and effect (lexical or periphrastic causative) or only the effect (inchoative) (Jackendoff, 1990, 2002; Levin & Rappaport-Hovav, 1995, 2005). We refer to syntactic structures that encode both the cause and effect (lexical and periphrastic) as causal syntactic frames, while the inchoative – a syntactic structure that encodes only the effect – is one of several non-causal syntactic frames.

It is not necessary that causal events be encoded with verbs that include both the cause and/or effect in their semantic structures – speakers have a variety of options. If a speaker is describing an event in which a girl breaks a tower of blocks with a stick, the speaker may describe this event as "the girl hit the tower (with the stick)" – a transitive sentence which encodes only the causal agent and its action (i.e., the cause and *not* the effect) – or "the tower fell" – an intransitive which encodes only the affected patient (i.e., the effect and *not* the cause). When verbs such as "fall," however, are used in the periphrastic causative construction, both the cause and the effect are encoded ("she made the tower fall"). It is also possible to imply both the cause and effect by conjoining two phrases, such as "the girl hit the tower and the tower fell," a structure we refer to as the conjunction. Finally, speakers are not obligated to describe any part of the causal event. They can describe something about the event other than the cause and effect, such as "the girl wore a blue shirt."

Thus far, our discussion of causal language has focused on events that are mediated causal events – events where a causal agent uses an intermediary object to cause an effect (e.g., a boy moving the ball with a putter). In the current study, we focus exclusively on mediated causal events since it is these events in which the intentionality of the agent has been shown to influence the nature of causal language in adults (Song & Wolff, 2005; Wolff, 2003). Generally, lexical causative structures ("he broke the window") seem to map onto only certain types of events, one type of event being mediated events that are intentionally caused, rather than mediated events that are unintentionally caused. This was demonstrated in a study by Wolff (2003) in which adults were presented with direct and mediated causal events that portrayed one of three agents (human acting intentionally, a human acting unintentionally, or inanimate object) causing an effect. In the mediated causal events a person or an inanimate object acted on an intermediary object to cause an effect (e.g., a person/green marble acted on a blue marble that caused a red marble to move); these events included both motion and state changes. The intentions of the human agent varied; in some events the person intentionally caused the effect to occur (a woman pressed a button on a remote which caused the tv to turn off) or unintentionally caused the effect to occur (a woman accidentally sat on a remote which caused the tv to turn off). After viewing each event, adults were asked to choose between a lexical causative description (e.g., "the man/blue marble moved the red marble") and a periphrastic causative description (e.g., "the man/blue marble made the red marble move"), or to choose neither. Adults preferred lexical causatives to describe the mediated events in which a human acted intentionally, and preferred periphrastic causatives to describe the mediated events in which the causal agent was a human acting unintentionally or an inanimate object. Song and Wolff (2005) replicated this pattern of results in a production task. Adults produced more lexical causative structures to describe intentionally caused events than to describe unintentionally caused events and produced more periphrastic and conjunction causative structures to describe unintentionally caused events.

Experiment 1 explores whether 3.5- to 4-year-old children's linguistic descriptions also follow this pattern; i.e., will children prefer lexical causatives to describe events (motion and state changes) that are intentionally caused, and will they use other causal constructions (e.g., the periphrastic and/or conjunction) to describe non-intentionally caused events? Or, will children exhibit a bias in their use of causal language towards intentionally caused and/or motion events, as may be predicted if conceptual representations of causality are restricted to certain classes of events earlier in development (Michotte, 1963; Piaget, 1954)?

1.3. Children's causal language

Studies of the development of causal language have explored both children's comprehension and production of causal events. In the domain of comprehension, studies have found that young children are able to associate novel verbs with causal events and are quite adept at using the syntactic structure of a sentence to guide the mapping of an event into a linguistic structure (e.g., Ammon, 1980; Behrend, 1990; Bunger, 2008; Casasola & Cohen, 2000; Fisher, 1996, 2002; Gentner, 1978; Naigles, 1990; Wolff, 2003).[1] For example, Casasola and Cohen (2000) reported

[1] All of these studies explored children's representations of causal events involving *intentional* agents. In Casasola and Cohen (2000) the causal agent was a car; however it had an animate looking driver. It remains an open question whether children would show similar abilities if the agent in these events unintentionally caused the effect.

that 18-month-olds are able to associate novel verbs presented in isolation ("neem") with causal actions (e.g., pushing), and Naigles (1990) found that 2-year-olds are able to correctly map a transitive sentence (e.g., "the duck is kradding the rabbit") onto an event portraying a causal action (the duck pushing the rabbit down into a squatting position) and an intransitive sentence (e.g., "the duck and the rabbit are kradding") onto a non-causal event (the duck and the rabbit waving their arm around). Further, a recent study by Bunger (2008) has shown that 2-year-olds represent a causal event's sub-events, such as the action and the result, and map these sub-events into the corresponding appropriate syntactic constructions (unaccusative intransitive frames, such as "the flower is blicking," unergative intransitive frames, such as "the boy is blicking," and transitive frames, such as "the boy is blicking the flower").

In the domain of production, studies have shown that children talk about causal events as early as 2 years of age, although the majority of their language focuses on social events involving people (Bloom & Capatides, 1987; Bowerman, 1982; Callanan & Oakes, 1992; Hickling & Wellman, 2001; Hood & Bloom, 1979). For example, in a classic study exploring early causal language, Hood (1979) found that 2- and 3-year-old children predominately talked about events involving causal interactions between the child and the parent (e.g., the child requests the parent to open a toy purse) and did not talk about causal events involving physical interactions between two objects (e.g., one object causing another object to move). More recent studies, however, report that children do talk about events involving physical causal interactions involving a person acting upon an object (e.g., a person pushing a cup off of a table), although they still rarely talk about causal interactions solely between two objects (e.g., a ball knocking a cup off of a table) (Bloom & Capatides, 1987; Callanan & Oakes, 1992; Hickling & Wellman, 2001).

Research has also shown that young children have a full command of the different types of syntactic structures that are used by adults to encode causal events. Bowerman (1982), in a diary study, reported that her two children produced lexical and periphrastic causative linguistic structures by age 2, and that these structures came online at approximately the same time. A further inspection of the examples noted in her paper reveals that most of these constructions were used in the context of two interacting people or a person interacting with an object. Pinker (1989) reported that 3.5-year-old children, similar to Wolff's (2003) study with adults, use lexical causative constructions to describe direct causal events, such as one animal causing another animal to bend over via direct contact, and use periphrastic causative structures to describe indirect mediated causal events, such as one animal causing another animal to bend over by throwing a ball at the second animal. These findings suggest that, similar to adults, children use different causal linguistic structures for direct causal events and for mediated causal events, at least for events that have animate, intentional agents.

In sum, these studies show that children overwhelmingly use causal language to describe events in which people are intentionally causing changes in the world. There are at least two possible explanations for these results: (1) children may simply be most interested in, and talk mostly about, causal events involving intentional agents even though they have the ability to talk about any type of event as causal, or (2) there may be biases either in children's conceptual representations of cause or in the mappings of these representations into language. If causal representations are biased towards events involving intentional agents, then these events may be encoded as causal more frequently, and thus more likely to be mapped into causal language. Findings reported by Wolff (1999) support the latter possibility. Wolff (1999) found that that the animacy of the agent influences 4-year-old children's, but not 3-year-olds', interpretations of lexical causative descriptions. Children were more likely to map lexical causative syntactic frames onto mediated causal motion events than direct causal motion events when the agent was an animate human hand than when it was a typically inanimate object. The current studies will shed further light on children's early causal representations by focusing specifically on children's representations of mediated causal events and exploring whether and how the intentionality of the causer influences causal language in an elicited production task.

1.4. Current study

The aim of the current study is to investigate whether 3.5- to 4-year-old children show biases in the way they map causal events into causal language. Specifically, we ask whether (1) children show a bias to map causal events involving animate agents acting intentionally into causal language, and (2) children show a bias to map causal motion events into causal language. If intentional and/or motion events are privileged in children's initial representations of cause (Michotte, 1963; Piaget, 1954), then one (or both) of these predictions may be supported. Experiment 1 explores these questions with an elicited language production task. We present children with mediated causal events that vary in the type of agent (human acting intentionally, human acting unintentionally, inanimate object) and the type of effect (motion, state change). We focus exclusively on mediated causal events, since the animacy and intentionality of the agent has only been shown to influence adults' causal language for mediated events (Song & Wolff, 2005; Wolff, 2003). If children have a bias to map causal events involving animate agents acting intentionally into causal language, then they should be more likely to use causal language to describe intentionally caused events than to describe unintentionally- or object-caused events. If children have a bias to map caused motion events into causal language, then they should be more likely to use causal language to describe caused motion events than to describe caused state change events. If both biases are operating, then children should be more likely to use causal language to describe motion events caused by intentional agents than to describe state change events caused by unintentional agents or objects. Finally, if 3.5-year-old children already display the typical pattern of descriptions as that of adults (Song & Wolff, 2005; Wolff, 2003), then they should map all causal events into causal linguistic structures; specifically, they should be more

Table 1
Descriptions of videotaped events used in Experiment.

Event	Effect type	Agent's intended action	Agent's unintended action	Object's action	Effect
Ball	Motion	Boy lifts shirt in front of him (ball on shirt; boy sees the ball)	Boy reaches behind and lifts shirt (ball on shirt; boy does not see the ball)	Baseball ball hits red ball, which rolls into beach ball	Beach ball rolls
Cup	Motion	Girl looks at cup and hits cup with spoon	Girl twirls spoon while not looking at cup; spoon hits the cup	Ball flies in, hits bottle, battle rolls into cup	Cup falls off table
Food	Motion	Boy turns over cup	Boy trips and turns over cup	Books fall over, hit cup, cup falls over	Food falls out of cup into garbage can
Train	Motion	Girl presses button	Girl leans against button	Ball flies in and hits button	Toy train moves around track
Balloon	State change	Girl looks at balloon and touches balloon with pen	Girl stretches her arms (does not look at balloon); pen makes contact with balloon	Ball flies in and hits cup, cup falls on balloon	Balloon pops
Block	State change	Girl throws block at block tower	Girl drops block on tower	Ball flies in, hits bottle, bottle falls on block tower	Block tower breaks
Lamp	State change	Girl flips light switch	Girl leans on light switch	Ball flies in, hits light switch	Lamp turns off
Television	State change	Boy pushes button on remote control	Boy sits on remote control	Ball flies in, hits remote control	TV turns off

likely to map intentionally caused events into lexical causatives and more likely to map unintentionally caused and object-caused events into periphrastic and conjunction causative structures.

2. Experiment 1

2.1. Participants

Sixteen 3.5- to 4-year-old children (M = 45 months 11 days, range = 43 months, 12 days to 47 months, 20 days) participated in Experiment 1 (12 females). Participants were excluded if they used the same verb over 33% of the time, suggesting that they might have been perseverating on verb choice. One additional participant was excluded for this reason.

2.2. Stimuli

Participants viewed 32 videotaped events on a laptop computer. The events, modeled after Wolff (2003), were comprised of an *agent* (human or object) acting on a *mediator* (object), which caused a specific *effect* to occur – thus the events were *causal* events. The events varied on whether the agent was animate (n = 16) or inanimate (n = 8), whether the effect was intended (n = 8) or unintended (n = 8), and whether the effects were changes in motion (n = 16) or changes in state (n = 16) (see Table 1; for a complete description of the events, also see Appendix A). Eight 'filler' events were also included in which a human actor performed an action that did not produce an effect (e.g., waving, clapping, transferring objects). All the events were 3- to 5-s long. The 32 events were randomized into two different orders of presentations and the events were presented in two blocks such that each block contained 16 events: 4 intended (two motion, two state change), four unintended (two motion, two state change), four object (two motion, two state change), and four fillers. The order of the presentation of the blocks was counterbalanced.

2.3. Procedure

Participants were told that they would see a short video on a laptop screen. After each video ended and the screen went black, the participant was instructed to tell the experimenter "what happened." Prior to the test events, participants received training where they viewed four videos that were different from the test set. If children gave only a single-word description ("bat" for an event of a boy giving a bat to a girl), they were prompted to provide a more complete description ("what else happened?"). Upon completion of the four training events, the participants viewed and described the 32 test events. The experimenter did not ask the child "what happened" during the test events. Most children spontaneously provided descriptions. If a child did not spontaneously provide a description, the experimenter pointed to the participant to indicate it was his or her turn to speak.

2.4. Coding

The verbal descriptions for each participant were transcribed and coded for the type of verb and the type of syntactic frame. This coding schema below yielded codings for 93.6% of the children's elicited productions. The remaining 6.4% of elicited productions were excluded either because they were inaudible (1.7%), because they were not true descriptions of the event (2.2%), or because they were only single-word descriptions (2.5%).

We coded for three types of verbs: causal verbs, non-causal effect verbs, and non-causal other verbs. Causal verbs were defined as verbs that participate in the causal alternation ("The girl *broke* the tower"/"The tower *broke*"). These verbs directly encoded the causal action and effect of a given event (see Introduction). Non-causal effect verbs were defined as verbs that described the effect, but did

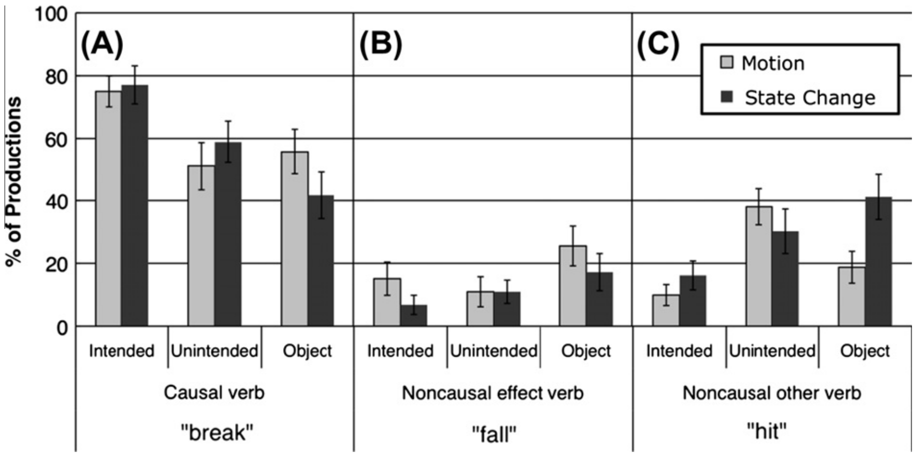

Fig. 1. Percentage of productions children's verb choice (Panel A: causal verbs, e.g., "break"; Panel B: non-causal effect verbs, e.g., "fall"; Panel C: non-causal other verbs, e.g., "hit") as a function of the type of agent (intended, unintended, object) and the type of effect (motion, state change). Error bars depict ±1 SE of the mean.

not participate in the causal alternation ("The tower *fell*"). These verbs always described the effect in a given event, but did not explicitly mark the agent or the action that caused the given effect. Non-causal other verbs were defined as verbs that either described the action of the agent in the event, but did not describe the effect ("The girl *hit* the block"), or verbs that described something true of the event, but outside the causal structure of the event ("The girl walked by the tower"). This classification accounted for 100% of children's coded descriptions.

We coded four types of syntactic frames: lexical causatives, (e.g., "the girl *broke* the tower"), periphrastic causatives in which the effect is encoded in an embedded clause ("the girl *made* the tower *break*"), conjunctions in which one verb encodes the action and another verb encodes the effect (e.g., "she hit the tower *and* the tower fell"), and non-causal intransitive structures ("the tower fell").[2] These four syntactic frames accounted for 100% of the coded descriptions. Lexical causatives, periphrastic causatives, and conjunctions were coded as causal syntactic frames, since both the cause and effect is mapped into the syntax; intransitives were coded as non-causal since only the effect is mapped into the syntax.

A second coder scored all of the utterances for half of the sample ($n = 8$ children) for reliability purposes. The two coders agreed on 94% of the utterances; any differences were discussed until an agreement was reached.

[2] After inspection of children's descriptions, we included the conjunctive causative, in addition to the standard causal syntactic frames (lexical causatives, periphrastic causatives). Both causal and non-causal effect verbs can be mapped into these structures, "the man hit the ball and the window broke/tower fell," such that the entire phrase carries a causal meaning, although neither phrase alone encodes both the causal agent and the causal effect. Including these structures also allowed for a more conservative test of our hypothesis – that children would show biases in the likelihood to use causal language. By including this additional 'causal' structure, we therefore decreased the likelihood we would find a difference as a function of the type of agent (intended, unintended, object) or the type of effect (motion, state change).

2.5. Results

2.5.1. Causal verbs

Fig. 1 (Panel A) displays the percentage of *causal* verbs ("break") as a function of agent type (intended, unintended, and object) and effect type (motion or state change). To assess the influence of agent type and effect type on children's choice of causal verbs, a 3 (Agent type) $\times$ 2 (Effect type) within-subjects ANOVA was conducted on the percentage of causal verbs. This yielded a significant main effect of agent type, $F(2, 30) = 11.58$, $p < .001$. Planned analyses, using Tukey's HSD with p set at .05, revealed that children used significantly more causal verbs for intended events ($M = 76.0\%$) then either unintended ($M = 54.9\%$) or object ($M = 48.7\%$) events ($p < .05$). Children's use of causal verbs did not differ between unintended and object events. Second, the analysis revealed no main effect of effect type, $F(1, 15) < 1$, and no interaction between the two factors, $F(2, 30) = 2.814$, $p > .05$. Children were equally likely to choose a causal verb for motion effects ($M = 60.6\%$) and for state change effects ($M = 59.2\%$). Since the analyses revealed no main effect of effect type (motion vs. state change) in the verb choice analysis, subsequent analyses collapsed across effect type. Further inspection of the data revealed that this pattern of results was not driven by a subset of the children using causal verbs to describe all the events and a subset of the children using causal verbs to describe only the intended events (i.e., a bimodal distribution). All children used causal verbs to describe some of the videos of each event type; however, 12 of the 16 children used more causal verbs to describe the intended events than to describe the unintended and object events.

When children chose a causal verb to describe causal events, they were not obligated to map both the cause and effect into causal syntactic frames. Children could have described an intended event using a causal verb in the lexical causative or periphrastic causative frames ("the girl broke the tower"/"the girl made the tower break"), in the non-causal inchoative frame, which encodes only the effect in the syntax ("the tower broke"), or in a conjunction frame ("the girl dropped the block and the tower broke"). Inspection of the causal descriptions revealed that when children used causal verbs they primarily used causal linguistic frames (i.e., lexical, periphrastic, conjunction); intended: M = 77.3%; unintended: M = 64.8%; object: M = 70.4%) over inchoative. However, as shown in Fig. 2, children were more likely to map causal verbs into lexical causal frames for the intended events (M = 68.4%) than the unintended (M = 53.2%) or object (M = 47.9%) events. This pattern was confirmed by a one-way ANOVA on the percentage of causal verbs mapped into lexical frames with agent type as a within-subject factor, which revealed a main effect of agent, $F(2, 30) = 3.312$, $p = .05$. Planned analyses on the main effect of agent, using Tukey's HSD with p set at .05, revealed that children were more likely to map causal verbs into lexical frames for the intended events than either the unintended or object events, which did not differ from each other. Also, as can be seen in Fig. 2, children seldom mapped causal verbs into the periphrastic or conjunction frames. To assess the influence of agent type on children's mapping into the periphrastic and conjunction syntactic frames, we conducted two separate one-way ANOVAs on each causal frame (periphrastic and conjunction) with agent type as the within-subjects factor. These analyses revealed no significant main effects of agent type for either syntactic frame (periphrastic frame: $F(2, 30) < 1$; conjunction frame: $F(2, 30) < 1$).

In sum, children used more causal verbs to describe the intended events than the unintended or the object events. In addition, when children used causal verbs to describe any of the events (intended, unintended, object, motion, state change) they used lexical causative frames more for the intended events than the unintended or the object events.

2.5.2. Non-causal effect verbs

Fig. 1 (Panel B) displays the percentage of *non-causal effect* verbs ("fall") as a function of agent type (intended, unintended, and object) and effect type (motion or state change). To assess the influence of agent type and effect type on children's choice of non-causal, effect verbs, a 3 (Agent type) $\times$ 2 (Effect type) within-subjects ANOVA was conducted on the percentage of non-causal effect verbs chosen; this yielded a significant main effect of agent type, $F(2, 30) = 7.538$, $p < .01$. Planned analyses, using Tukey's HSD with p set at .05, revealed that children chose more non-causal effect verbs for the object events (M = 21.4%) than either the intended (M = 10.9%) or unintended events (M = 10.9%) ($p < .05$). There was no main effect of effect type, $F(1, 15) < 1$, and no interaction between the two factors, $F(2, 30) < 1$. Therefore, subsequent analysis collapsed across effect type.

Similar to when they chose causal verbs, when children chose non-causal effect verbs ("fall"), they were not obligated to map these verbs into non-causal frames. Children could have described these events with a non-causal syntactic frame ("the tower fell") or with a causal syntactic frame, by mapping the verb into the periphrastic frame ("she made the tower fall") or the conjunction frame ("she dropped the block and the tower fell"). Although children also could have (incorrectly) mapped the non-causal verb into the lexical frame ("she fell/falled the tower"), children in the current study never did so. Fig. 3 displays the percentage of non-causal verbs mapped into the causal syntactic frames (periphrastic and conjunction) as a function of agent type. To assess the influence of agent type on children's mapping into the periphrastic and conjunction syntactic frames, we conducted two separate one-way ANOVAs on each causal frame (periphrastic and conjunction) with agent type as the within-subjects factor. These analyses revealed no significant main effects of agent type for either syntactic frame (periphrastic frame: $F(2, 30) < 1$; conjunction frame: $F(2, 30) < 1$). Thus, children were equally likely to map non-causal verbs into the periphrastic or conjunction syntactic frame for the intended, unintended, and object events.

2.5.3. Non-causal other verbs

Fig. 1 (Panel C) displays the percentage of *non-causal other* verbs ("hit") as a function of agent type (intended,

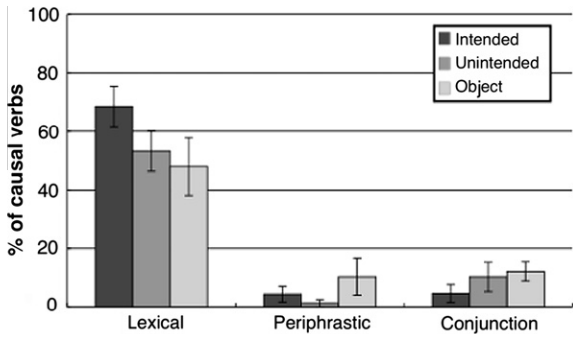

Fig. 2. Percentage of causal verbs (e.g., "break") mapped into causal syntactic frames (lexical, periphrastic, conjunction) as a function of the type of agent (intended, unintended, object). The percentages were calculated by dividing the number of causal verbs mapped into causal syntactic frames for each child by the number of causal verbs each child produced, and then averaging across children. Error bars depict ±1 SE of the mean.

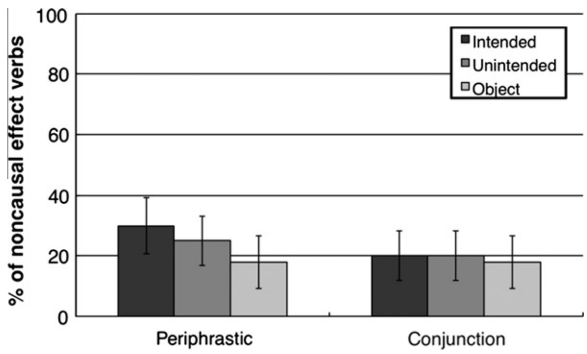

Fig. 3. Percentage of non-causal effect verbs (e.g., "fall") mapped into causal syntactic frames (lexical, periphrastic, conjunction) as a function of the type of agent (intended, unintended, object). The percentages were calculated by dividing the number of non-causal verbs mapped into causal syntactic frames for each child by the number of non-causal verbs each child produced, and then averaging across children. Error bars depict ±1 SE of the mean.

unintended, and object) and effect type (motion or state change). To assess the influence of agent type and effect type on children's choice of non-causal other verbs, a 3 (Agent type) $\times$ 2 (Effect type) within-subjects ANOVA was conducted on the percentage of non-causal other verbs chosen; this yielded a significant main effect of agent type, $F(2, 30) = 7.67$, $p < .01$. Planned analyses, using Tukey's HSD with p set at .05, revealed that children chose more non-causal other verbs for the unintended events ($M = 34.1\%$) and the object events ($M = 29.9\%$) than the intended events ($M = 13\%$) ($p < .05$). There was no main effect of effect type, $F(1, 15) = 2.2$, $p > .05$. Children did not choose more non-causal other verbs for the motion events ($M = 22.2\%$) than the state change events ($M = 29.2\%$). Finally there was a significant interaction between the two factors, $F(2, 30) = 4.5$, $p < .05$. This interaction was due to the fact that children chose more non-causal other verbs for the unintended motion events than the unintended state change events, and that this pattern reversed for the intended events and object events. Since these verbs could not be mapped into causal linguistic structures that described the relevant causal structure of the intended, unintended, and object events, the type of syntactic structures that these verbs were mapped into was not analyzed.

2.6. Discussion

These results show that, when describing a causal event, children were more likely to use causal language to describe intentionally caused events than to describe either unintentionally caused events or object-caused events. This bias showed up strongly both in the verbs that the children chose to describe the events (children chose more causal verbs (''break'') for the intentionally caused events than the unintentionally- and the object-caused events) as well as in the syntactic frames these verbs were mapped into (children mapped verbs into lexical syntactic frames, such as ''she broke the tower'', more for the intentionally caused events than the unintentionally- and the object-caused events). Further, children used more non-causal other verbs (''she *hit* the ball'') to describe the unintended and object-caused events than the intentionally caused events. Children's use of causal language, however, did not differ by the type of effect (motion or state change).

Thus, children have an intention-to-CAUSE bias – children are more likely to encode intentionally caused events with causal language than unintentionally caused or object-caused events, and this pattern holds for both motion and stage change events. This finding is consistent with the hypothesis that in infancy causal representations have their basis in events involving intentional agents, which then leads to biases in children's conceptual representations and the mapping of these representations into language (Piaget, 1954; White, 1995, 1999). The pattern of findings in the current study also extends the pattern observed in Wolff (2003) and Song and Wolff (2005) with adults to 3- to 4-year-old children. The adults in these studies differentiated among intentionally caused, unintentionally caused, and object-caused events; specifically, they described all these events with causal verbs, although lexical causative frames were preferred more for intentionally caused events than unintentionally caused and object-caused events. Similarly, the children in the current study also differentiated among intentionally caused, unintentionally caused, and object-caused events; however, the children in the current study showed a bias to describe the intentional events with causal verbs. Thus, whereas the differentiation for adults in Wolff and colleagues' studies is at the level of syntactic structure, the differentiation for children in the current study appears to be the level of verb choice and the likelihood of using causal language at all to encode the events.

In Experiment 2, we continue to explore the intention-to-CAUSE bias in children's causal language with a language judgment task. If children have a bias to map intentionally caused events into causal language, then they should prefer causal language over non-causal language to describe those events. In this experiment, we present children with the intended, unintended, and/or object events from Experiment 1 and ask them to choose between a causative description (e.g., ''she *made* the balloon *pop*'') and a non-causal description (e.g., ''she touched the balloon with her pen''). Importantly, the *periphrastic causative construction* was the causal language option for all three event types: intended, unintended and object.

We chose the periphrastic causative construction as the causal language option for two reasons. First, it is possible that in Experiment 1 children did not describe the unintentionally caused and object-caused events with causal language simply because the periphrastic causative structure (e.g., ''he made the balloon pop''), the structure that adults chose in Wolff (2003), was too difficult to produce, which in turn led to the children to produce simpler non-causal structures (''the balloon popped''). If this was the case, then when *provided* with this description in Experiment 2, children should prefer the periphrastic causative description over the non-causal description for the unintended and object events. Second, using the periphrastic causative description provides a more robust test of the intention-to-CAUSE bias. If robust, then even when provided with a less preferred causal description for adults (i.e., intentional causal event → periphrastic causative construction), children should still prefer this description more for the intentionally caused events than the unintentionally- and object-caused events.

3. Experiment 2

3.1. Participants

Twenty-five 3.5- to 4-year-old children (M = 45 months, 3 days, range = 42 months, 21 days to 47 months, 16 days) participated in Experiment 1 (14 females). Three additional children were excluded because they failed to pass 3 of the 4 training trials (see below).

3.2. Stimuli

Participants viewed 16 videotaped events on a laptop computer. These were drawn from the same set of events as used in Experiment 1. Children viewed 16 events: eight target events and eight control events. For the target events, one group of children ($n = 12$) viewed four intended events and four unintended events (Condition 1) and a second group of children ($n = 13$) viewed four intended events and four object events (Condition 2). The eight control events depicted transfer events (giving/receiving) and motion events involving a single person (i.e., a girl jumping off of a bench).

For each set of target events (intended, unintended, object), one puppet described the event using a periphrastic causative ("she made the block tower break") and another puppet described the event using a non-causal description ("she dropped the block").

For the periphrastic causative descriptions of each event, we provided children with the most frequent causal verb that was used by the children to describe that event in Experiment 1. The periphrastic causative descriptions all had the following structure: noun/agent made embedded VP/effect; e.g., "X made the tower break." The non-causal descriptions all had the following structure: NP/agent VP/action DO/patient; e.g., "she dropped the block". These descriptions always described the action of the agent in the causal event and were true descriptions of the event. A full list of the descriptions used is available in Table 2.

For the eight control events, half of the events were described with a completely true statement and half were described with a completely false statement. For example, for the control event in which one girl gave another girl some balloons, the true statement would be, "the girl gave the other girl some balloons," and the false statement would be, "the girls at some cake." Children's performance on the control events provided an upper limit on their accuracy with this type of task.

3.3. Procedure

In order to felicitously elicit children's judgments of linguistic descriptions, we concocted a situation where the child would be the teacher and his or her job would be to teach two stuffed animals how to talk. Children were introduced to a frog and a rabbit, and the experimenter explained to the child, "these animals are learning how to talk about the movies and your job is to teach them how to tell good stories about the movies. We will watch a video on my computer, then each animal will tell you a story about the movie. Sometimes the frog will tell a better story, and sometimes the rabbit will tell a better story. Your job is to point to the puppet who told the better story. " The experimenter stressed the importance of being a good teacher so the animals could learn how to talk.

After viewing each video, one puppet described the video with a periphrastic causative ("The boy/The ball *made* the *tv turn off*") and the other puppet described the video with a non-causal action statement ("The boy/The ball *touched* the remote"). For the control videos, one puppet described the video with a true statement and the other puppet described the video with a false statement. For example, following a video in which a girl jumped off of a bench, one puppet said "the girl jumped off the bench" (true statement), and the other puppet said "the girl ran away" (false statement). To counteract any potential perseverative response bias, half of the filler trials were participant controlled, such that the puppet that spoke the true statement was the puppet not chosen on the previous trial.

Before the experiment began, participants received four training trials: a girl waving, a boy giving a girl a bat, a girl falling off of a chair, and a leaf moving from a shoe into a hat. For the training trials one puppet described the event with a true statement (e.g., "The girl waved") and the other puppet described the event with a false statement (e.g., "The girl clapped her hands"). If the child did not answer the training trial correctly (choose the puppet that described the true statement), then he or she was retrained on that specific video. Any child who did not correctly answer at least 3 of the 4 training trails without retraining was excluded from the final analysis ($n = 3$).

3.4. Results

Children's responses for the control videos were first scored for correctness (i.e., choosing the puppet who produced the 'true' statement about the video). Collapsing across the two conditions, children chose the correct descriptions at well above chance response levels, which was 50% ($M = 84.9\%$; one-sample t-test, $t(24) = 14.45$, $p < .001$), suggesting that children were successful at performing this task.

The next analyses explored how often children in the two conditions pointed to the puppet who produced the periphrastic causative (rather than the non-causal statement) for the different event types (intended, unintended, object). As shown in Fig. 4, in the intended vs. unintended condition, children chose the causative description significantly more often for the intended ($M = 66.7\%$) than the

Table 2
Causal and non-causal descriptions used in Experiment 2. For each description, the first agent listed was used to describe the intended and unintended events, and the second agent was used to describe the object events.

Event	Effect type	Causal description	Non-causal description
Ball	Motion	The boy/baseball ball made the beach ball move	The boy lifted the shirt/The baseball ball touched the red ball
Cup	Motion	The girl/boy made the cup fall off the table	The girl moved the spoon/The ball touched the bottle
Food	Motion	The boy/'books made the chips spill	The boy turned over the cup/The books touched the cup
Train	Motion	The girl/ball made the train move	The girl/ball touched the button
Balloon	State change	The girl/ball made the balloon pap	The girl moved the pen/The ball hit the cup
Block	State change	The girl/ball made the tower break	The girl threw/dropped the block/The ball touched the bottle
Lump	State change	The girl/ball made th lamp turn off	The girl/ball touched the switch on the wall
Television	State change	The boy/ball made the tv turn off	The boy sat on the remote/The ball touched the remote

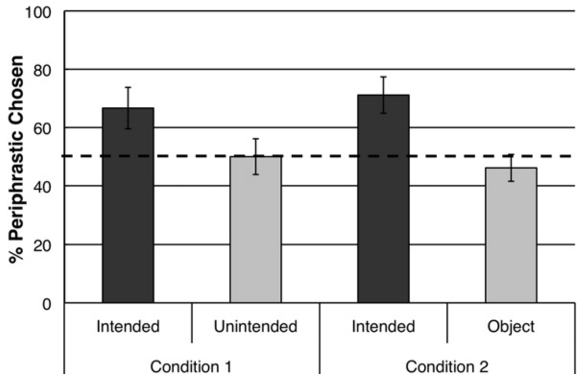

Fig. 4. Children's preference for the periphrastic causal description as a function of the type of agent (Condition 1: intended vs. unintended; condition 2: intended vs. object). Chance performance across both tasks is 50% (dotted line). Error bars depict ±1 SE of the mean.

unintended events ($M = 50\%$), paired t-test, $t(11) = 2.60$, $p < .05$. Further, for the intended events, children chose the periphrastic causative description significantly above chance, one-sample t-test, $t(11) = 2.52$, $p < .05$; this was not the case for the unintended events. Further inspection of the data for all conditions in this experiment revealed that that children's responses for the unintended (and object events described below) were not the result of a bimodal distribution in which half of the children showed a preference for the periphrastic causative description and half of the children showed a preference for the non-causal action description.

The same pattern was found for children in the intended/object condition. As shown in Fig. 4, children chose the periphrastic causative description significantly more often for the intended ($M = 71.2\%$) than the object events ($M = 46.2\%$), paired t-test, $t(12) = .36$, $p < .05$. Further, for the intended events, children chose the periphrastic causative description significantly above chance, one-sample t-test, $t(12) = 3.395$, $p < .01$; this was not the case for the object events, $t(12) = -.485$, $p > .05$. Thus, children preferred causal language for the intended events and had no preference for the object events.

3.5. Discussion

The results from Experiment 2 suggest that the intention-to-CAUSE bias in 3.5- to 4-year-old children is robust. When children viewed intentionally caused, unintentionally caused, and object-caused events and were provided with causal and non-causal statements, they had a greater preference for causal language to describe intentionally caused events than to describe unintentionally caused or object-caused events. This was so even though the causal language that they accepted was the *periphrastic construction* – a construction that children virtually never spontaneously produced in Experiment 1, and a construction that adults do not prefer for intentionally caused mediated events. Thus, Experiment 2 provides strong evidence for the intention-to-CAUSE bias.

In the remainder of the paper, we begin to explore more deeply the nature of the intention-to-CAUSE bias in children. One explanation for this bias is that children do not represent the cause in unintentionally caused and object-caused events, thus making it highly unlikely that these non-causal conceptual representations would ever be mapped into causal linguistic structures. This explanation is ruled out, however, by the results of Experiments 1 and 2. Children produced and chose some causal descriptions for the unintended/object events (i.e., the percentage of children producing/choosing causal language for the unintended and object events was not zero), suggesting that children have the competence to perform a causal analysis for unintentionally caused and object-caused events.

A second explanation is that although children were able to represent the cause for all of the events, they are much more likely to encode intentionally caused events causally than to encode unintentionally caused and object-caused events causally. This is then reflected by language; children use causal language more for intentionally caused events than unintentionally caused and object-caused events. Finally, a third explanation is that children are equally able to represent the cause in all three event types, yet when they map conceptual representations of the causal events into linguistic structure, they are more likely to map both the cause and effect into language for intentionally caused events than for unintentionally caused and object-caused events. Unlike the former explanation, this latter explanation puts the bias in the *mapping* of events into linguistic structure, rather than in formation of conceptual representations per se. This mapping bias may emerge because the perspective that children take on the intentionally caused events (e.g., cause + effect) differs from the perspective they take on the unintentionally caused and object-caused events (e.g., action only or effect only).

Experiment 3 aimed to tease apart these two latter possibilities (unequal likelihood to perform a causal analysis vs. unequal mappings of conceptual representations of causal events into causal language) using a counterfactual reasoning task. In this task, children viewed an event (e.g., a girl accidentally drops an object on a tower, causing it to break) and were asked to predict what the end state of the patient object would be if the potential agent (intended, unintended, object) *had not* performed a given action (e.g., tower intact or tower broken?). If children represent the event as causal, then there is only one correct answer – if the agent did not perform the action, then the effect should not have occurred. Thus, unlike the language tasks in Experiments 1 and 2, which provided children with options about how the event could be encoded (e.g., "the man made the tower break", "the tower broke", etc.), a counterfactual reasoning task directly tests whether children are equally able to compute the causal relation between the agent and the effect in an event across the event types of these studies.

If the intention-to-CAUSE bias emerges because children are more likely to represent intentional events as causal, then children should be better at counterfactually reasoning about the intentionally caused events than the unintentionally caused and object-caused events. In contrast, if the intention-to-CAUSE bias emerges when children map conceptual representations of causal events into language, then children should be able to counterfactually reason equally well for all events.

4. Experiment 3

4.1. Participants

Fourteen 3.5- to 4-year-old children ($M = 44$ months, 15 days, range = 42 months, 22 days to 45 months, 4 days) participated in Experiment 2 (six females). Two additional participants were excluded because they were unable to complete the experiment.

4.2. Stimuli

Participants viewed 24 videotaped events on a laptop computer. These 24 events were the same events as Experiments 1 (eight Intended, eight Unintended, and eight Object events). Eight pairs of photographs were also created depicting the starting state and end state of each patient object (e.g., TV on/TV off, Tower standing up/tower broken in pieces, balloon whole/balloon popped, etc.).

4.3. Procedure

Participants were told they would watch a series of short videos on the laptop computer. After each video the experimenter asked the participant a counterfactual question about the agent, mediator, and patient ("If < the agent > had not < acted on the mediator>, what would the < patient > look like?). The participant responded by pointing to one of two pictures that were presented after each movie had ended and the screen had become black. One picture depicted the beginning state of the patient object, and the other picture depicted the end state of the patient object. For example, for the intended causal event in which the boy turns off the television by touching the remote, the experimenter asked the participant, "If the boy did not touch the remote, what would the tv look like?" The child then responded by pointing to either the 'TV on' picture (correct) or the 'TV off' picture (incorrect). The counterfactual questions for the unintended causal events were identical to the counterfactual questions for the intended causal events. The counterfactual questions for the object causal events differed in that "ball" was substituted in the subject position of the sentence (e.g., "If the ball did not touch the remote, what would the tv look like?").

In addition to the counterfactual questions, we asked two additional questions to ensure that children had accurate representations of the sequence of events in the video as well as to control for any possible picture bias within each pair of photographs. Children were asked a *Beginning* question and an *End* question about the patient object. In the *Beginning* question, children were asked, "What did the <patient> look like at the beginning of the movie?" In the *End* question, children were asked, "What did the <patient> look like at the end of the movie?" The order of the control questions (beginning/end) was randomized and then the order of presentation (before vs. after the counterfactual reasoning task) was counterbalanced; this eliminated the possibility that children would adopt a pattern a responding such as, choose 'TV on' picture, then 'TV off' picture, then 'TV on' picture).

4.4. Results

Children were equally as accurate in answering the control questions (*Beginning* and *End*) for all three conditions, as confirmed by a 3 (agent: Intended, Unintended, Object) × 2 (question: Beginning, End) within-subjects ANOVA, which yielded no main effect of Agent, $F(2, 26) = 1.563$, $p > .05$, no main effect of question, $F(1, 13) = .164$, $p > .05$, and no interaction between the two factors, $F(2, 26) = .166$, $p > .05$. One sample *t*-tests on children's performance for the questions (beginning, end) on the intended ($M = 74.7\%$, $M = 75.8\%$), unintended ($M = 79.9\%$, $M = 79.3\%$), and object events ($M = 70.4\%$, $M = 71.3\%$) confirmed that their performance was above chance (50%) for each event type ($p < .05$ for each event type). Since accurate responding to the counterfactual questions depended upon an accurate representation of the beginning and end state of the patient object, however, the trials in which the child did not answer both of the control questions correctly were subsequently excluded from further analysis.

As shown in Fig. 5, children were quite accurate in answering the counterfactual reasoning questions for all the event types. One sample *t*-tests revealed that children responded above chance for the intended ($M = 80.0\%$), $t(13) = 4.269$, $p < .01$, unintended ($M = 80.4\%$), $t(13) = 5.123$, $p < .001$, and object ($M = 72.8\%$) events, $t(13) = 3.879$, $p < .01$. Furthermore, children's accuracy on the counterfactual questions did not differ by the type of agent; a within-subjects ANOVA on the percentage of correct responses for each agent type (Intended, Unintended, Object) revealed no main effect of agent, $F(2, 26) = 1.58$, $p > .05$.

4.5. Discussion

These results suggest that children were equally likely to represent the intended, unintended, and object events as

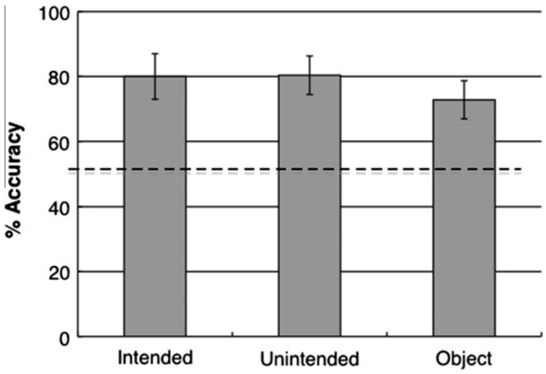

Fig. 5. Children's accuracy in the counterfactual reasoning task as a function of the type of agent (intended, unintended, object). Chance responding is 50% (dotted line). Error bars depict ±1 SE of the mean.

causal. For all three agent types, children correctly reasoned about what the state of the patient would be if the causal agent had not performed a causal action. These findings suggest that the intention-to-CAUSE bias observed for children in Experiments 1 and 2 emerged when children mapped their conceptual representations of the causal events into language. Although children were equally likely to represent the intended, unintended, and object events as causal, children adopted different perspectives on these conceptual representations, as illustrated by their linguistic encoding of the events in Experiments 1 and 2. Children mapped *both* the cause and the effect into linguistic structure when the effect was caused by an intentional actor, but not when the effect was caused by an unintentional actor or object.

5. General discussion

This paper investigated whether there are biases in the way children map causal events into causal language. We presented 3.5- to 4-year-old children with causal events that varied in the type of agent (human acting intentionally or unintentionally, or inanimate object) and the type of effect (motion or state change) and examined how children mapped these events into language. Across two experiments we found evidence that the type of agent, but not the type of effect, influenced children's causal language. In Experiment 1 (elicited production task), children used causal language (i.e., causal verbs, causal syntactic frames) more to describe events that were caused by a human acting intentionally than to describe events that were caused by a human acting unintentionally or by an object. In Experiment 2 (language judgment task), children preferred causal language (periphrastic causative construction) to describe the intentionally caused events; they did not show such a preference for unintentionally caused and object-caused events. These findings suggest that children show an intention-to-CAUSE bias.

Children's intention-to-CAUSE bias is likely a bias in the perspective they adopt on events – a bias that then shows up as children map conceptual representations of cause into language. We regard this bias as akin to other examples in language in which representations of an event can be mapped into language in multiple ways. For example, consider a transfer of possession event. When one views a ball pass from a girl to a boy, he or she may represent all the essential components of the transfer (the ball, the passing, the girl, and the boy), and may adopt one of several perspectives; for example, one may construe the event as the girl *giving* the ball to the boy or as the boy *receiving* the ball from the girl. One's perspective on the event will then influence his or her choice of verb. One may describe this event with the verb 'give,' which maps the giver in the subject position and the goal in the PP ("the girl gave the ball to the boy"), or with the verb 'receive,' which maps the recipient in the subject position and the source, optionally, in the PP ("the boy received the ball from the girl"). Indeed, research has shown that children and adults (Fisher, Gleitman, & Gleitman, 1991; Lakusta & Landau, 2005), and perhaps even infants (Cohen & Oakes, 1993) tend to adopt an agent/goal-biased perspective in such events.

A similar explanation may account for the intention-to-CAUSE bias. As suggested by the results from the counterfactual reasoning task (Experiment 3), although children can represent all the essential components of the causal interaction (the action, the effect, the causal relation between them) for the intended, unintended, and object-caused events, they may have been more likely to adopt a perspective on the event that included all of these components for the intentionally caused events than for the unintentionally caused and object-caused events. Children's perspective of the event then influenced their choice of verb. For the intentionally caused events, children were more likely to use verbs like 'break' and, when they used such verbs, were more likely to map both the cause and effect into syntactic structures. In contrast, for the unintentionally caused and object-caused events, children's perspective led to a verb choice such as 'hit' or 'fall,' and they were more likely to map only the action or the effect, but not the causal relation between the two, into syntactic structure. Thus, the nature of the agent in the event (human acting intentionally vs. human acting unintentionally and object acting) seems to influence the perspective children have of an event, leading children to show an intention-to-CAUSE bias in mapping conceptual representations of causal events into linguistic structure.

The intention-to-CAUSE bias may stem from conceptual biases earlier in development. Recent findings on infants' and toddlers' causal representations are consistent with this hypothesis. Upon viewing a novel state change event, infants attribute the cause of the event to a dispositional causal agent, such as a human hand, and not to a typically inert object, such as a toy train (Muentener & Carey, 2010). Moreover, the type of action that a person performs also influences infants' causal attributions. Infants only attribute the cause of novel state change events to a hand engaging in deliberate, goal-directed action, but not to a hand that flops down in an accidental manner (Muentener & Carey, 2008). A similar pattern has also been shown in toddlers' spontaneous construal of causal events. Toddlers are more likely to represent a mediated predictive event (i.e., block A contacts block B, and then a toy airplane activates) as a causal event when it presented in an agentive context (e.g., the experimenter moves block A) than a non-agentive context (e.g., block A moves spontaneously) (Bonawitz et al., 2010). Thus, it is these conceptual biases that may result in the intention-to-CAUSE bias observed in the current experiment. Further research is needed to link studies on prelinguistic infants' and toddlers' conceptual representations of causality with children's linguistic representations of causality.

In conclusion, the current study suggests that 3.5- to 4-year-old children have a bias to map intentionally caused events into causal language more often than unintentionally caused or object-caused events. These findings have implications for our understanding the nature of children's conceptual representations of causal events, how these representations are mapped into linguistic structures, and also may shed new light on the age-old question of the origin of causal representations. These results open a new avenue of research exploring the precise nature of an intention-to-CAUSE bias in children, and lend support to the idea that causal representations may be closely linked to representations of intentional action early in development.

Acknowledgements

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Appendix A

Descriptions of the Intended, Unintended, and Object events.

A.1. Ball events

Intended event: A ball is resting on a cloth t-shirt. A man is kneeling next to the t-shirt. He lifts the edge of the t-shirt and the ball rolls off of the t-shirt.

Unintended event: A ball is resting on a cloth t-shirt. A man is sitting next to a t-shirt, facing away from the shirt. He fans his face, as if he is warm, picks up the t-shirt without looking at it, and wipes his face with the t-shirt. As he lifts the t-shirt, the ball rolls off of the t-shirt.

Object event: Two balls are resting on the floor, clearly separated in distance. A baseball rolls on screen, contacts the first ball, which then rolls and contacts the second ball. The second ball rolls.

A.2. Cup event

Intended event: A cup is resting on a table. A woman is sitting at the table reading and eating from a bowl with a spoon. She appears to get angry, slams the paper down and uses the spoon to hit the cup. The cup falls off the table.

Unintended event: A cup is resting on a table. A woman is sitting at the table reading and eating from a bowl with a spoon. She is twirling her spoon and not looking at the cup. As she twirls her spoon, the spoon hits the cup. The cup falls off the table.

Object event: A cup is resting on a table. A bottle is resting next to the cup, but not in contact with the cup. A ball flies in from off screen, contacts the bottle, which falls over and rolls into the cup. The cup then falls off the table.

A.3. Food event

Intended event: A man walks in from off screen, with a cup of food in his hand. He walks towards a garbage can and turns over the cup. The food from the cup falls into the garbage can.

Unintended event: A man walks in from off screen with a cup of food in his hand. He appears to trip, falling towards a garbage can. As he falls towards the garbage can, he turns the cup over towards the garbage can. The food from the cup falls into the garbage can. The man appears frustrated that the food is in the garbage.

Object event: A cup of food is resting on a surface next to a stack of upright books. The books spontaneously fall over towards the cup of food. The cup of food then tips over in the direction of a garbage can. The food from the cup falls into the garbage can.

A.4. Train event

Intended event: A toy train is at rest on a table behind a plexiglass screen. A green lever is in front of the screen. A woman walks in, sits down at a chair in front of the lever and presses the lever, looking at the toy train. The toy train then moves partway around a train track.

Unintended event: A toy train is at rest on a table behind a plexiglass screen. A green lever is in front of the screen. A woman walks in, sits down at a chair in front of the lever and rests her elbow on the lever, looking away from the toy train. The toy train then moves partway around a train track. The woman appears surprised.

Object event: A toy train is at rest on a table behind a plexiglass screen. A green lever is in front of the screen. A ball flies in from off screen, landing on the green lever. The toy train then moves partway around a train track.

A.5. Balloon events

Intended event: A balloon is resting on a couch. A woman is sitting on the couch next to the balloon, writing on a piece of paper with a pen. She appears to get frustrated, turns towards the balloon, looks at it, and uses the pen to tap the balloon. The balloon pops.

Unintended event: A balloon is resting on a couch. A woman is sitting on the couch next to the balloon, writing on a piece of paper with a pen. She stretches her arms, moving her pen towards the balloon without looking at it. The pen comes in contact with the balloon. The balloon pops.

Object event: A balloon is resting on a couch. A cup of pens is resting on the top of the couch. A ball flies in from off screen, contacting the cup. The cup falls over and lands on the balloon. The balloon pops.

A.6. Block events

Intended event: A block tower is resting on a table. A woman walks in with another block. She looks at the block tower and throws the block at the block tower. The block tower breaks apart.

Unintended event: A block tower is resting on a table. A woman walks in with another block, twirling it around in her hand. As she walks by the block tower, she drops the block on the block tower. The block tower breaks apart.

Object event: A block tower is resting on a table. A bottle is resting next to the block tower. A ball flies in from off screen and contacts the bottle. The bottle tips over and contacts the block tower. The block tower breaks apart.

A.7. Lamp events

Intended event: A lamp is resting on a table. A woman enters the room and presses the light switch on the wall. The lamp turns off.

Unintended event: A lamp is resting on a table. A woman enters the room and leans against the light switch on the wall, without looking at the lamp or the switch. The lamp turns off.

Object event: A lamp is resting on a table. A ball flies in from off screen and contacts the light switch on the wall. The lamp turns off.

A.8. Television events

Intended event: A television playing a video. A remote control is resting on a chair in front of the television. The man walks in from off screen, picks up the remote control, sits in the chair, points the remote control at the television, and pushes a button on the remote control. The television turns off.

Unintended event: A television playing a video. A remote control is resting on a chair in front of the television. The man walks in from off screen and sits on the chair (and the remote control). The television turns off. The man appears surprised.

Object event: A television playing a video. A remote control is resting on a chair in front of the television. A ball flies in from off screen and lands on the remote control. The television turns off.

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