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Abstract

Discourse comprehension relies on the construction of a mental model that represents the unfolding in time of the events described. In causal scenarios, where the action of one agent (the enabler) temporally precedes and enables the action of another agent (the causer), discourse may reflect the underlying event structure by describing the enabler's action first and then the causer's action (story order) or may describe the causer's action first (backward order). Studies in the literature have shown that adults consider causers to be more responsible than enablers in moral scenarios. Based on the assumption that story order favors the construction of a mental model of events, we conducted an experiment to test the prediction that preference for the causer over the enabler should be greater when events are presented in story order than in backward order. The participants in the experiment were 42 fifth grade children, 42 adolescents, and 42 adults. The results of the experiment confirmed the prediction for all three groups of participants. We discuss the practical implications of these results for learning contexts, for legal contexts, and for the psychology of moral judgments.

Keywords: story order, moral responsibility, mental models, mental simulation.

1. Introduction

The order in which we encounter information affects both discourse comprehension and decision making. These so-called story-order effects have been found in comprehending stories that report the same events in different orders (Ohtsuka & Brewer, 1992). The participants' task in this study was to listen to stories that contained passages describing events with different temporal structures. In stories with 'canonical passages', the sentences describing the events used temporal markers such as 'next', 'after this,' and 'then' to establish discourse cohesion. In stories with backward passages, each sentence was related to the next with the initial phrase 'before that,'. The following is an excerpt from a canonical passage story: "Sara then circled around Bald Mountain in order to go down into the valley. Finally, Sara followed the Cairn River back home"; the parallel excerpt from the backward passage story reads, "The last thing Sara did the day she walked in the forest was to follow the Cairn River back home. Before that, Sara had circled around Bald Mountain in order to go down to the valley." As the results showed, story order (i.e., the canonical passage story) favored story comprehension compared to backward order (the backward passage story). Story-order effects have also been found in the evaluation of different events. Participants in one study listened to a tape recording that summarized the evidence originally heard by jurors in a murder trial: part of the evidence favored the prosecution's side and part of the evidence favored the defense (Pennington & Hastie, 1988). Each type of evidence followed either a story order or a random presentation order of events. In story order presentation, events were structured in a story-like format, whereas in random presentation order they were presented without the temporal sequence of cause-effect typical of narrative reconstruction of events. The rationale was to manipulate the ease with which a particular summary of the evidence (story) could be constructed. As the results showed, the manipulation of the events order affected judgments: Verdicts were in favor of the evidence presented in story order, regardless of whether it was

the evidence presented by the prosecution or defense side. These findings reinforce the assumption that jurors construct a causal model to explain the available facts and that story order facilitates their understanding of the evidence and allows them to base subsequent decisions on the causal explanation they have imposed on the evidence (Heller, 2006).

Mental model theory (Johnson-Laird, 1983; 2006), our theoretical framework, claims that deep understanding of a discourse is based on the construction of a kinematic mental model of the events described. From this assumption derives the prediction that the order in which events are presented should influence how easily the simulation is run. The results of the studies summarized so far confirm the prediction: they seem to indicate that discourse comprehension is facilitated when the representation of events matches the underlying event structure (see also the "isomorphism principle" proposed by Ohtsuka & Brewer, 1992; Rinck et al., 2001). Whereas the focus of these studies was on story-order effects in understanding stories that report the same events and in evaluating different events, the focus of the present study is on story-order effects in evaluating the same events, namely the action of the enabler and the action of the causer in scenarios with moral/immoral outcomes.

The classic studies of story-order effects involved only adult participants, which is surprising when we consider possible practical implications of these effects for learning contexts. For example, story-order effects might be relevant in learning history and science when causally related events are presented. Therefore, we chose to examine story-order effects in a developmental perspective, from childhood through adolescence and adulthood. Fifth graders were an ideal population to test because they have the ability to construct kinematic mental models (Bucciarelli et al., 2016; 2018). Moreover, they are already sensitive to causal relations in discourse comprehension. Although children do not seem to be able to spontaneously monitor all situational dimensions as adults do, they establish causal relations at a young age, even before formal reading education begins (e.g., Kendeou et al., 2014; van

den Broek & Helder, 2017), and by the end of the primary school years, causal relations are typically dominant for them (Wassenburg et al., 2015). Children's limited monitoring abilities lead them to focus on this particular dimension (see also Bohn-Gettler et al., 2011). But the way one conceives of time is tightly connected with the way one speaks of time (Munte et al., 1998), and children may have difficulty understanding stories that involve temporal connectives such as 'before' and 'after' (see, e.g., Blything et al., 2015; Pyykkonen & Jarvikivi, 2012). And indeed, fifth graders' understanding of the two temporal connectives is not yet fully developed (Karlsson et al., 2019). However, they have already acquired the ability to understand temporal relations expressed by verb tense; as the results of studies have shown, children as young as two years old begin to use the past tense in many or most of their conversations about the past, and they talk about past events significantly earlier, taking their cue from adults' use of tenses (Eisenberg, 1985). The stories in the present study signal the temporal relationship between events through the verb form of juxtaposed clauses. Given this premise, we might expect fifth graders to be sensitive to story-order effects in attributing responsibility to enablers and causers of moral outcomes. Sensitivity to causal relationships follows a developmental trajectory: older children are better able to make causal connections between statements than younger children (e.g., Beker et al., 2017; van den Broek et al., 2013). The participants in the present study were also adolescents; the rationale was to leave open the possibility of also capturing a developmental trajectory in sensitivity to story-order effects.

The results of the study are relevant for understanding and learning from discourse: they can help to develop procedures for improving text structure in order to facilitate the making of meaning connections. The study is also relevant to the psychology of moral judgments; no previous studies have examined story-order effects in the attribution of moral responsibilities to enablers and causers in moral scenarios. Further, like classic studies of

story-order effects, the study has practical implications for legal contexts. The order in which events are presented is important in court cases where judges or juries decide on the responsibility of actors and the punishment deserved. We will return to these considerations in the General discussion.

2. Theoretical framework

When we read or hear a story, we construct a mental model that represents the events, the actors, and the relationship between the events (Bower & Morrow, 1990). According to different theoretical frameworks, such representations are referred to as the "mental model" (Johnson-Laird, 1983; 2006) or "situation model" (van Dijk & Kintsch, 1983; Kintsch, 1998). When we begin to read a story, we construct a "current model" that represents the content of a particular sentence. As we continue to read, our current model is integrated into a "single model" through the updating processes, and when we finish reading the story, we store the integrated model in long-term memory as a "complete model" (Zwann & Radvasky, 1998). Thus, during discourse comprehension, the mental simulation can be dynamically updated to reflect new incoming information (Hoeben Mannaert et al., 2019).

Mental model theory, our theoretical framework, implies that discourse comprehension is based on the construction of a kinematic mental model of the events described (Ianì et al., 2019). One key principle of mental model theory is that models are iconic insofar as possible, their structure corresponds to the structure of what they represent (Johnson-Laird, 1983, p. 419) and so a kinematic model unfolds in time, and the sequence of events it represents corresponds to the temporal sequence of events in the world, real or imagined (Johnson-Laird, 1983; Schaeken et al., 1996); the kinematic simulation is comparable to a mental "movie" (Hegarty, 1992; Johnson-Laird, 1983).

The backbone of discourse comprehension is the representation of causal relations between events, objects, and protagonists (Trabasso & Sperry, 1985; Trabasso & Suh, 1993). In reading causal sequences of events, the distinction between the roles of different agents is important in constructing a mental model of the story. The distinction between the enabler and the causer of an event is relevant to the present study. According to the mental model theory (e.g., Goldvarg & Johnson-Laird, 2001; Khemlani et al., 2014) *enables* and *causes* have different fully explicit models, each referring to a different set of temporally ordered possibilities in which A does occur prior to B:

A enables B		*A causes B*	
A	B	A	B
A	not-B	not-A	B
not-A	not-B	not-A	not-B

Enablers are consistent with three different possibilities: 'enabler and outcome', 'enabler and no outcome', and 'no enabler and no outcome'. Causes are consistent with three possibilities: 'cause and outcome', 'no cause and outcome' (an alternative cause produce the outcome) and 'no cause and no outcome'. In other words, for *A enables B*, A is necessary for B to occur – at least in the stronger sense of *enables*. In contrast, for *A causes B*, A suffices for B to occur. Further, since in daily life the normal constraint on a causal relation between A and B is that B does not precede A in time (see e.g., Tversky & Kahneman, 1980; Bullock et al., 1982), the model theory postulates that given two states of affairs, A and B, if A has a causal influence on B, then B does not precede A in time (Goldvard & Johnson-Laird, 2001).

Adults tend to distinguish between the roles of the causer of an action and the enabler who made it possible when reading a story (Frosch & Johnson-Laird, 2009). Also, they attribute more responsibilities to a causer of an action compared to the enabler of the same action. The participants in a series of experiments were invited to read several scenarios

describing the actions of two agents, i.e. the enabler and the causer, and the resulting outcome (Frosch et al., 2007). Their task was to rate on a five point-scale the responsibility of an agent, the extent to which an agent was the causer and the extent to which an agent was an enabler. Further, they were asked to assign the number of years to which the agent should go to prison and to assess the monetary damages that the agent should pay. Results revealed that participants were able to distinguish between agents with different roles in a causal chain and they attributed more responsibilities to a causer of an action compared to the enabler. Further, in comparison to enablers, causers were rated as more a cause of the outcome, liable to go to prison longer, and liable to pay greater damages.

The main assumption of the present study is that when individuals read a scenario in which events are presented in story order as opposed to backward order, they find it easier to construct a kinematic mental model on which to base an assessment about agents' responsibility; in contrast, reading a scenario in which events are presented in backward order complicates the process of model construction and results in less identification of the causer than the enabler. Indeed, mental models are iconic representations whose structure reproduces the structure of facts described. Therefore, a discourse structure that reproduces the structure of events as they occurred in the real world should facilitate the understanding of the discourse, while the backward order of presentation is an obstacle to mental simulation that hinders the understanding of the story. Given this theoretical background, the main goal of the present study was to test the prediction that the order of presentation of the two agents, enabler and causer, should influence participants' responsibility judgments. To this end, we manipulated the order of the description of the role of the enabler and the causer in the scenario.

We designed the scenarios so that the action of one agent (enabler) enabled the action of the other agent (causer) to cause the outcome (see for a similar procedure Egan et al.,

2008). In addition, each scenario described a real-world event in which the enabler always acted before the causer. For each scenario, we developed a story-order version and a backward-order version. The story-order version described the role of the enabler before the role of the causer; thus, the discourse structure mapped the structure of events as they occurred in the real world. The parallel backward-order version was created by changing the order in which the roles of the two agents were presented, namely the role of the causer was described before the role of the enabler; therefore, the discourse structure represented the events in a reverse order compared to the structure of the events as they occurred in the real world. In elaborating the scenarios, the temporal sequence of the enabler's and the causer's actions was conveyed by the tense of the verbs. For example, consider the following story used in this study, in which the role of the enabler (i.e., Bruno) and the role of the causer (i.e., Gino) are described as they occurred in the real world:

> On a bus, a boy named Bruno asked a girl for information about the bus stops, so to distract her. He wanted to help his friend Gino, a thief, to take the girl's wallet. The girl was robbed.

We shall refer to this chronological account as *story order*. Let us now consider the parallel backward-order version of the story, in which the description of the two roles is in reverse order:

> On a bus, a thief named Gino wanted to take a girl's wallet. Bruno, a friend of the thief Gino, had asked the girl for information about the bus stops, so as to distract her. The girl was robbed.

We already know from the literature that adults judge causers more responsible than enablers in moral scenarios. However, if the order in which their respective roles are described modulates participants' evaluations, then participants will be more likely to rate the causer as

more responsible than the enabler in story order scenarios than in backward order scenarios. If the order of description does not affect participants' ratings, the causer will be rated as more responsible than the enabler to the same extent in both presentation orders. These order effects should be detectable in children, adolescents, and adults.

Because participants' verbal protocols could provide insight into the processes involved in their ratings, half of the participants in each age group in the present study were asked to think aloud. For methodological accuracy, the procedure was identical across all three age groups, although children and adolescents may have difficulty reporting their thinking as they search for a solution to a problem (for a review of the arguments for using the think-aloud protocol, see Cowan, 2019). Nonetheless, our main interest was in adults' think-aloud protocols, as they provide a reliable indication of their strategies when reasoning (see van der Henst et al., 2002). When adults think aloud while making their evaluations, they may first describe a sequence of relevant thoughts that lead to the evaluation (deliberate evaluation). We considered protocols of this type as evidence of deliberative reasoning culminating in a moral evaluation. On the other hand, individuals might reach an immediate evaluation (intuitive evaluation) that is not preceded by chains of inferences, and then may or may not engage in a subsequent process of deliberative thought. We considered such a verbal protocol as evidence of intuition (see the same procedure in Bucciarelli & Daniele, 2015 and in Bucciarelli et al., 2008). In the adult group, it is most plausible that intuitive judgments, but not deliberative judgments, are more likely to occur when agents are presented in story order than in backward order because they tend to reflect lower cognitive effort in discourse comprehension and decision making (Kelly et al., 2020).

We summarize the three main hypotheses derived from our advanced theoretical framework as follows: 1) like adults, adolescents and children should attribute more responsibility to the causer than to the enabler in moral scenarios; 2) individuals should be

more likely to judge the causer as more responsible than the enabler in story order scenarios than in backward order scenarios; 3) intuitive judgments of adults should be more likely compared to deliberative judgments when agents are presented in story order than in backward order.

3. Experiment

Participants in the experiment, children, adolescents, and adults, were presented with scenarios describing a single action from the moral domain and two agents who played different causal roles: The action of one agent (the enabler) made possible the action of the other agent, the causer of the event. We manipulated the order in which the action of the enabler and the action of the causer were described (hereafter: order of presentation of the agents, or agents' presentation order). For each scenario, we designed both a moral and an immoral version so that the experimental material reflected what might occur in everyday life. The participants' task was to rate which of the two agents was more praiseworthy in the case of the moral scenarios and which was more reprehensible in the case of the immoral scenarios. Half of the participants in each age group were asked to think aloud while making their choice. The investigation was approved by the Bioethical Committee of the University of Torino.

3.1. Method

3.1.1. Participants

The participants in the experiment were forty-eight in each of the following age groups: fifth grade children (17 females and 31 males; mean age = 10.65 years, *SD* = 0.49), secondary school adolescents (20 females and 28 males; mean age = 13.82 years, *SD* = 0.49) and adults attending university (45 females and 3 males; mean age = 22.45 years, *SD* = 7.05). Because the expected effect size could not be derived from similar studies in the literature (the

only study was by Frosch and colleagues, 2007, who did not report the effect size or standard deviations from the means), we defined a smallest effect size of interest (η_p^2= .02; Cohen, 1992) with α= .05 and power (1-β) = 0.80, resulting in a total sample size of 123 participants. Therefore, we made the conservative decision to test 144 participants, 48 in each of the three age groups. Children and adolescents were randomly selected from middle school students in two public primary schools and two public secondary schools in Turin, Italy. The inclusion criteria for participation in the experiment were the absence of learning disabilities and the fact that they were native Italian speakers. The children and adolescent participants took part in the experiment after their parents gave their informed consent. The adult participants attended a general psychology course at the University of Turin and voluntarily participated in the experiment for obtaining course credits.

3.1.2 Design

The experimental factors were agents' presentation order (Story order/Backward order) and group (Children/Adolescents/Adults). We created four experimental protocols to which the participants in each age group were randomly assigned (see Appendix A). Each protocol featured 3 story order scenarios and 3 backward order scenarios, for a total of 6 scenarios. Each participant in each age group read the 6 scenarios presented in a random order and were invited to decide which character, either the enabler or the causer was more praiseworthy in moral scenarios or more blameworthy in immoral scenarios. Further, half of participants in each age group were asked to think aloud while making their choice.

2.1.3 Materials and Procedures

The experimental material was in Italian. To test the prediction that the order of presentation of the agents influences the evaluation of their responsibilities, we designed scenarios that were as simple as possible to allow us to manipulate them as neatly as possible. We designed the scenarios according to the following criteria: a) one agent (the enabler) did

something that enabled the other agent (the causer) to cause the action, b) each scenario referred to an event (say in the real world) in which the enabler acted before the causer. We manipulated the order in which the enabler's action and the causer's action were described. The starting point was 6 scenarios in story order (the discourse structure mapped the structure of events as they occurred in the real world), 3 of which were perceived by adult participants in previous studies as clearly moral and 3 as clearly immoral (Bucciarelli, 2008). We then created the parallel immoral versions of the moral scenarios and the parallel moral versions of the immoral scenarios, thus obtaining a total of 12 scenarios in story order. To this aim, we manipulated the propositions in the scenarios concerning norms and values (i.e., cognitive reasons). To make the moral scenarios immoral, we introduced elements of violation of norms and values on behalf of both the enabler and the causer, and to make the immoral scenarios moral, we introduced elements of respect for norms or values on behalf of both the enabler and the causer (for the same procedure see Bucciarelli & Daniele, 2015; Daniele et al., 2020). An example of immoral scenario is:

> In a house under construction, Enzo, the builder, had decided to leave uncovered a hole in the floor. Mr Carlo knew it. Carlo had made a short-sighted visitor walk across the floor. The visitor was badly injured.
>
> Who is more blameworthy?

The parallel moral version was created by inserting propositions describing the respect of the norm TO ADVICE OF DANGER):

(1) In a house under construction, Enzo, the builder, found a hole in the floor. Enzo advised Mr Carlo. Carlo told the short-sighted visitor to pay attention to the hole. The visitor did not hurt himself.

Who is more praiseworthy?

We created the 12 parallel backward order versions of the scenarios (in which the discourse structure represented the events in reverse order compared to the structure of the events as they occurred in the real world) by changing the order of the description of the actions of enabler and causer. For example, the parallel backward order version of scenario (2) is as follows:

(2) In a house under construction, Mr Carlo told the short-sighted visitor to pay attention to a hole in the floor. Enzo, the builder, had found the hole and he had advised Mr. Carlo. The visitor did not hurt himself.

Who is more praiseworthy?

Each scenario was 40 words in length (the full set of scenarios is in Appendix A).

From the 24 scenarios, we developed the four experimental protocols. In each protocol, each content occurred with either the enabler described before or after the causer, and with either the moral or immoral action, for a total of 3 scenarios in story order and 3 scenarios in backward order, and 3 moral and 3 immoral scenarios. The presentation order of the agents (story order/backward order) and the valence of the scenario (moral/immoral) were counterbalanced across all participants rather than per participant in each age group. Each scenario was written on a sheet of paper and the entire set of scenarios was randomly assembled in a notebook.

Participants in all age groups took part in the experiment in the sole presence of the experimenter; children and adolescents were tested in a quiet room in their school and adults were tested in a quiet room in the psychology department. They were instructed as follows:

This is an experiment on how people make decisions. I am going to present you with six scenarios. In each scenario the characters perform an action worthy of praise or

blame. For each scenario I shall ask you which character is more praiseworthy or more blameworthy. You have no time limit to decide.

Then, participants were asked to read each scenario aloud and, after making a decision, to communicate their final choice by writing below the text the name of the agent they considered more praiseworthy/blameworthy. In the Think-aloud condition, participants were instructed to think aloud while making their choice. The experimental sessions were audio-recorded and subsequently transcribed.

Two independent judges, who were unaware of the scope of the experiment, coded participants' verbal protocols in the Think-aloud condition as deliberate or intuitive. Coders were instructed as follows:

Given a scenario to evaluate, participants could:

- Either make an immediate moral evaluation or make an immediate moral evaluation followed by a because clause describing the reasons for the evaluation (intuitive evaluation).
- State a sequence of thoughts leading to a moral evaluation (reasoned evaluation).

For example, consider the following scenario: "In the swimming pool a girl was drowning. The bathing attendant, Fabio, had taken away from the swimming pool's edge all the lifebuoys. Livio, a man who was nearby, pretended not to see the girl. The girl drowned." The following is an intuitive evaluation: "In my opinion Livio, because he didn't do anything for the girl in the end." (Adult 4). The following is an example of deliberative evaluation respect to the scenario in our example: "There is a double guilt because it is the lifeguard's job to be the first to make sure that people don't drown in the pool, or that they don't have a problem anyway. But at the same time, Mr. Livio ... any gentleman who was there at the time, would have been at fault... yes, you could even call it attempted murder, so before the law probably

... even because he was there and did nothing. So at first glance, it still looks like Mr. Livio, because ... God, it's true that the lifeguard again didn't do his duty, but maybe a person who saw and did nothing is more culpable than a lifeguard who took off the life jackets ... although it is not specified here, it looks like that even the lifeguard was probably there but did not see the girl, but it is not specified here, so I can't exactly put the same blame on Mr. Livio. So I think Mr. Livio" (Adult 1). The participant in the example terminates with a clear decision for Mr. Livio after a series of deliberations.

3.2 Results

Preliminary paired t-test comparisons by participants revealed that the choice of the causer did not differ in any age group in the moral scenarios compared to the immoral scenarios. In addition, they also revealed that the choice of the causer did not differ in any age group in the think-aloud protocols compared with the no think-aloud protocols (see the data check analyses in Appendix B); for this reason, the variable was not included in the analyses critical to the investigation and we collapsed the results for moral and immoral scenarios (hereafter, we refer to the entire set of scenarios as "moral scenarios") and for Think-aloud and No think-aloud protocols.

Table 1 shows the percentages of the choice of the causer depending on the order of presentation of the agents. The results detailed for scenario are in Appendix C. To test whether participants attributed greater responsibility to the causer than to the enabler in story order, we ran a 2x3 mixed ANOVA with agents' presentation order as the within-subjects factor (Story order/Backward order) and with group (Children/Adolescents/Adults) as the between-subjects factor on the frequencies of choice of the causer over the enabler. Results showed a main effect of agents' presentation order ($F(1,141) = 20.71$; $p < .001$, $\eta_p^2 = .13$) and a nonsignificant main effect of group ($F(2,141) = .16$; $p = .86$, $\eta_p^2 = .002$). The interaction between group and agents' presentation order was also nonsignificant ($F(2,141) = .11$; $p = .89$,

η_p^2= .002). Identical results were obtained carrying out mixed-effect logistic regression, implemented with the glmer() function from the lme4 package (version 1.1-26) in the R statistical programming environment (version 4.1.0; R Development Core Team, 2021)[1]. As predicted, these results revealed that like adults, adolescents and children attributed more responsibility to the causer than to the enabler in moral scenarios and that individuals were more likely to judge the causer as more responsible than the enabler in story order scenarios than in backward order scenarios.

Table 1.

Percentages of choice of the causer as a function of the order of presentation of the agents (story order/backward order).

Groups	Order of presentation of the agents	
	Story order	Backward order
Children	67	53
Adolescents	67	56
Adults	71	56

Regarding participants' verbal protocols, the two independent judges rated each participant's response as intuitive or deliberate and agreed on 97% of trials (Cohen's *K*= .81,

[1] We carried out a model including agents' order of presentation (Story order/Backward order) and group (Children/Adolescents/Adults) as the fixed factors of interest and Subjects and Item (i.e., the twelve scenarios) as crossed random effects. Following the guidelines in the literature (Barr et al., 2013), we started by including the maximal structure of random effects supported by the design and we applied the BOBYQA optimizer in order to sustain model convergence (Powell, 2009). The model was specified as follows: Participants' choices ~ Agents' order of presentation*Groups + (1 + Agents' order of presentation|Subjects) + (1 + Agents' order of presentation* Groups|Items). We detected a significant effect of Agents' order of presentation (β = .67, *SE* = .30, *t* = 2.22, *p* = .026) on participants' choices. We did not detect a significant effect of Groups (β = .07, *SE* = .19, *t* = .38, *p* = .71) on participants' choices. Also, the interaction between groups and agents' order of presentation was not significant (β = .10, *SE* = .28, *t* = .38, *p* = .71).

$p < .0001$). They resolved the discrepancies prior to statistical analyses. Table 2 illustrates the percentages of intuitive think-aloud protocols as a function of agents' presentation order. To test whether participants produced more intuitive judgments in story order, we run a mixed ANOVA 2x3 with agents' presentation order (Story order/Backward order) as the within-subjects factor and with group (Children/Adolescents/Adults) as the between-subjects factor on the number of intuitive evaluations. Results showed a main effect of the agents' presentation order ($F(1,69) = 5.09$; $p = .03$, $\eta_p^2 = .07$) and a main effect of the group ($F(2,69) = 4.25$; $p = .02$, $\eta_p^2 = .11$). The ANOVA also showed a significant interaction between the

Table 2.

Percentages of intuitive think-aloud protocols as a function of agents' presentation order (story order/backward order). The balance to 100% were deliberative evaluations.

Groups	Order of presentation of the agents	
	Story order	Backward order
Children	100	100
Adolescents	90	89
Adults	92	78

agents' presentation order and the group ($F(2,69) = 3.83$; $p = .03$, $\eta_p^2 = .10$). Post-hoc tests (Bonferroni adjusted) revealed that there were no differences between groups when the story was presented in story order ($F(2,69) = 2.36$; $p = .10$), but when the story was presented in backward order, there were significant differences between groups ($F(2,69) = 5.02$; $p < .01$, $\eta_p^2 = .13$). Post-hoc tests revealed a statistically significant difference between adults and children; children produced more intuitive evaluations than adults ($p < .01$). Furthermore, a

series of t-tests within each age group revealed that intuitive evaluations were greater in story order than in backward order in the adult group ($t(23) = 2.20$, $p = .04$, Cohen's $d = .48$), but not in the children group (their evaluation were always intuitive) and in the adolescent group ($t(23) = .57$, $p = .57$, Cohen's $d = .12$). Thus, as predicted, intuitive judgments of adults were more likely compared to deliberative judgments when agents were presented in story order than in backward order.

4. General discussion

The results of the study confirmed the prediction that children and adolescents consider the causer more responsible than the enabler in scenarios of the moral domain. The same result holds true for adults, which is consistent with previous findings in the literature (Frosch et al., 2007; Goldvarg & Johnson-Laird, 2001). Furthermore, the results confirmed the prediction that the order of presentation of the two agents in a scenario modulates individuals' ratings of moral responsibility: Participants judged the causer to be more responsible when the story was presented in story order compared to backward order. Results regarding verbal protocols showed that, as predicted, adults' intuitive judgments were greater when events were presented in story order compared to backward order; deliberative reasoning occurred more in backward story order. Within our proposed theoretical framework, deliberative reasoning in the adults group reflected greater cognitive effort in constructing a mental model when events were presented in backward order.

Previous studies in the literature have detected story order effects when participants read scenarios that contained logical (but not causally related) sequences of events based on knowledge of the "script" (Schank, 1975) for the situation. In one such study, participants made a decision about the underlying order of occurrence of two events after reading stories written either in story order or backward order (Baker, 1978). An example of the story order

in the study is: “Mary’s annual visit to the doctor was quite traumatic. She had to spend two hours in the waiting room with a scolding mother and four whining children. Then the nurse tried to take a blood sample and couldn’t find a vein until the seventh try. Later, Mary discovered that someone had stolen her coat from the closet. She swore she’s never go back for another check-up.” The parallel version of this scenario in backward order is: “Mary’s annual visit to the doctor was quite traumatic. The nurse tried to take a blood sample and couldn’t find a vein until the seventh try. Before that, Mary had to spend two hours in the waiting room with a scolding mother and four whining children. Later, Mary discovered that someone had stolen her coat from the closet. She swore she’s never go back for another check-up.” As the results showed, responses were consistently faster and more accurate when it came to story order. One possible explanation for the results is that participants relied on their knowledge of the “doctor’s visit” script, which conveys the specific structure in which the events involved follow a precise temporal order; presenting the events in a different way (backward order) implies a break in the script and a greater load on working memory. The results of the present study cannot be interpreted along the same line of reasoning, since they concern scenarios describing series of causally related events, the sequence of which cannot be expected due to the knowledge of a “script” for the situation. Consider, for example, the following scenario: “In a house under construction, Enzo, the builder, had decided to leave uncovered a hole in the floor. Mr Carlo knew it. Carlo had made a short-sighted visitor walk across the floor. The visitor was badly injured”. It is more than unlikely that the participants relied on a script of the situation in assessing the responsibility of the enabler and the causer.

Previous research conducted in the legal field has found a recency effect: When actors in the legal domain gradually discover and learn about different pieces of evidence over time, the most recently discovered piece of evidence has a greater impact on decision making than the previously discovered pieces of evidence. This recency effect was found, for example,

when participants in one study were asked to interpret multiple pieces of evidence, such as eyewitnesses and alibis; as the results showed, the piece of information that emerged at the end of the trial had the strongest influence on investigators (Dahl et al., 2009). Participants in our study judged the causer to be more responsible than the enabler, and they were more likely to judge so in story-order scenarios in which the causer was described at the end of the scenario. This result could be interpreted in terms of a recency effect. However, the results also showed that in both story-order and backward-order scenarios (in which the enabler's role was described last), participants in all age groups rated the causer as more responsible than the enabler. This rules out the possibility that participants were simply biased to attribute greater responsibility to the last agent described in the scenarios. This preference was greater for presentations in story order than for presentations in backward order. One possible interpretation of our results in relation to the findings in the literature is in the following direction. We have argued that reasoners interpret causal assertions by simulating the situation, i.e., by constructing a kinematic mental model to which the assertions refer, and then inspecting this model to draw conclusions. Their initial mental models reflect intuitive interpretations of causal relations, e.g., their initial model of A causes B is identical to that of A enables B, i.e.:

A B
…

The first row of the diagram represents a possibility in which A occurs simultaneously with B, and the second row of the diagram represents the other possibilities that are consistent with the assertion. The theory thus explains why reasoners often confuse causes and enabling conditions, i.e., the mental models of the assertions are the same. However, when asked to consider alternative possibilities, they make fully explicit their models and are able to distinguish causes from enabling conditions (Goldvarg & Johnson-Laird, 2001). The results

of the present study suggest that when individuals think about the different roles of enabler and causer, they represent the full set of possibilities that are consistent with their roles and are therefore less likely to suffer a recency bias. These findings are relevant to the psychology of moral judgments. Previous studies have shown that adults distinguish between the roles of enabler and causer of a moral outcome and consider the causer to be more responsible than the enabler. The present results extend these findings to children and adolescents. They also suggest that long before adulthood, individuals are able to represent all possibilities consistent with the roles of enablers and causers in causal assertions.

Story-order effects can also be relevant to learning contexts. Deep comprehension and learning from a text or discourse correspond to the construction of an articulated mental model of the content to be learned (Cutica & Bucciarelli, 2008; 2013). The results of the present study suggest that the order in which enablers and causers of outcomes are presented may be a crucial factor in the construction of a coherent mental representation. This may be the case in science learning, given how challenging for readers the multicausality of scientific phenomena is (see, e.g., Britt et al., 2014). It is more than likely that story-order effects are also relevant when memorization plays an important role in learning, as in the case of history. Some studies investigated the relationship between memory for texts and the degree of causal relationship between sentences within the text (Keenan et al., 1984; Myers et al., 1987). Results showed that the moderately related sentences were better remembered (and recognized) than the highly related or distantly related pairs. It is possible that when events are presented in backward order rather than in story order, the effort in generating a causal link pays off in terms of better recall of the material being learned.

Enabler and causer are terms relevant to the legal system, where it is not always obvious whether an agent played either role. For example, in some famous lawsuits in the United States, plaintiffs (relatives of fire victims) sued gun manufacturers for negligence

because their products were used in some fire attacks; in their view, the manufacturers enabled others to use the gun to kill or injure someone (see, e.g., Merrill v. Navegar, 1999; 2001). Any outcome regarding story-order effects has potential implications for multiple actors within the legal system (see Charman et al., 2016). In forensic practice, prosecutors, lawyers, and judges must evaluate evidence, integrate it into a coherent narrative, and make a decision based on that narrative. They also strategically construct versions of events to pursue their respective institutional goals (see, e.g., van der Houwen & Sneijder, 2014). For example, lawyers may want to understand how the order of presentation affects their decision making when preparing their arguments in court; this information will help them guide their presentation of evidence at trial. Our results suggest that the order of presentation of the agents' role may influence judges' decisions. More generally, the results of the present study may inform cognitive models of judicial information integration (see Nori et al., 2012, for a review); seemingly irrelevant aspects such as the order in which enablers' and causers' roles in unlawful acts are presented can influence judgments.

The present investigation has three main limitations. First, the scenarios described real events in which the enabler acted first, whereas we did not use scenarios that described possible real events in which the causer acted earlier than the enabler; future studies could include these types of scenarios to more thoroughly examine the effects of story order in causal moral scenarios. Second, we did not consider how much time participants needed to reach a decision. Future studies could test a prediction that follows from our theoretical framework, namely that response times should be longer for backward order scenarios than for story order scenarios. Third, eye-tracking studies could examine the implicit aspects of participants' judgments and further support the assumption that processing load is greater for scenarios in which events are presented in backward order than for scenarios described in story order

5. Conclusions

Whitin the theoretical framework of mental model theory, discourse comprehension is based on the construction of a kinematic mental model of the events described. We assumed that the specific roles of enablers and causers in causal scenarios can be better appreciated when their actions are described in the same order in which they occur in real life, namely in story order, compared to when they are described in backward order. Studies in the literature have already shown that adults attribute more moral responsibility to a causer of an action than to the enabler of the same action; we predicted that this preference should be greater in story order scenarios than in backward order scenarios. Because story-order effects are relevant to understanding and learning from discourse, we tested the prediction derived from mental model theory's assumptions in children, adolescents, and adults. The results confirmed the critical prediction: individuals attributed more responsibility to causer than to the enabler in story order as compared to backward order.

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Appendix A

The quadruples of the scenarios in the experiment relating to the moral realm, translated from the Italian and their assignment to four experimental protocols.

1.1 Story order/Moral

On a bus, a thief was about to take a girl's wallet. Bruno, a boy, noticed this and told another boy, Gino. Gino stopped the thief. The girl wasn't robbed.

Who is more praiseworthy?

1.2 Story order/Immoral

On a bus, a boy named Bruno asked a girl for information about the bus stops, so as to distract her.

He wanted to help his friend Gino, a thief, to take the girl's wallet. The girl was robbed.

Who is more blameworthy?

1.3 Backward order/Moral

On a bus, a thief was about to take a girl's wallet. Gino, a boy, stopped him. It had been Bruno, another boy, to notice the thief and tell it to Gino. The girl wasn't robbed.

Who is more praiseworthy?

1.4 Backward order/Immoral

On a bus, a thief named Gino wanted to take a girl's wallet. Bruno, a friend of the thief Gino, had asked the girl for information about the bus stops, so as to distract her. The girl was robbed.

Who is more blameworthy?

2.1 Story order/Moral

The backer Gianna gave as a present to lady Laura two flat loaves. In the street, Laura encountered a tramp who said he was very hungry. Laura gave as a present the two flat loaves to the tramp. The tramp was happy to eat something.

Who is more praiseworthy?

2.2 Story order/Immoral

The backer Gianna gave two mildew flat loaves to Mrs Laura as a present. Laura realized that. Laura came across a very hungry tramp in the street. Laura gave the tramp the two mildew flat loaves as a present. The tramp couldn't eat anything.

Who is more blameworthy?

2.3 Backward order/Moral

In the street, lady Laura encountered a tramp who was very hungry. Laura gave as a present two flat loaves to the tramp. The backer Gianna had given as a present to Laura the two flat loaves. The tramp was happy to eat something.

Who is more praiseworthy?

2.4 Backward order/Immoral

In the street, lady Laura encountered a tramp who was very hungry. Laura gave as a present two mildew flat loaves to the tramp. The backer Gianna had given as a present to Laura the two flat loaves. Laura had realized that. The tramp couldn't eat anything.

Who is more blameworthy?

3.1 Story order/Moral

In the swimming pool a girl was drowning.

On the swimming pool's edge the bathing attendant, Fabio, had put some lifebuoys. Livio, a man who was near the swimming pool, threw a lifebuoy to the girl. The girl was safe.

Who is more praiseworthy?

3.2 Story order/Immoral

In the swimming pool a girl was drowning.

The bathing attendant, Fabio, had taken away from the swimming pool's edge all the lifebuoys.

Livio, a man who was nearby, pretended not to see the girl. The girl drowned

Who is more blameworthy?

3.3 Backward order/Moral

In the swimming pool a girl was drowning.

Livio, a man who was near the swimming pool, threw a lifebuoy to the girl. The bathing attendant Fabio had put the lifebuoys on the swimming pool's edge. The girl was safe.

Who is more praiseworthy?

3.4 Backward order/Immoral

In the swimming pool a girl was drowning. Livio, a man who was nearby, pretended not to see the girl. The bathing attendant, Fabio, had taken away from the swimming pool's edge all the lifebuoys. The girl drowned.

Who is more blameworthy?

4.1 Story order/Moral

In a house under construction, Enzo, the builder, found a hole in the floor. Enzo advised Mr Carlo. Carlo told the short-sighted visitor to pay attention to the hole. The visitor did not hurt himself.

Who is more praiseworthy?

4.2 Story order/Immoral

In a house under construction, Enzo, the builder, had decided to leave uncovered a hole in the floor. Mr Carlo knew it. Carlo had made a short-sighted visitor walk across the floor. The visitor was badly injured.

Who is more blameworthy?

4.3 Backward order/Moral

In a house under construction, Mr Carlo told the short-sighted visitor to pay attention to a hole in the floor. Enzo, the builder, had found the hole and he had advised Mr Carlo. The visitor did not hurt himself.

Who is more praiseworthy?

4.4 Backward order/Immoral

In a house under construction, Mr Carlo knew of an uncovered hole in the floor. Carlo had made a short-sighted visitor walk across it. Enzo, the builder, had decided to leave the hole uncovered. The visitor was badly injured.

Who is more blameworthy?

5.1 Story order/Moral

A lady threw a lighted cigarette into the garden near some dry leaves. Lady Chiara saw the burning leaves while she was on the balcony and told that to lady Giulia. Giulia aimed some water onto the fire. The neighbor's houses did not burn down.

Who is more praiseworthy?

5.2 Story order/Immoral

Lady Chiara threw a lighted cigarette into the garden. The cigarette was going out, when lady Giulia saw it. Giulia aimed some petrol onto it. The neighbor's house burnt down.

Who is more blameworthy?

5.3 Backward order/Moral

A lady threw a lighted cigarette into the garden near some dry leaves. Giulia aimed some water onto the fire. Lady Chiara had seen the burning leaves while she had been on the balcony and told that to lady Giulia. The neighbor's houses did not burn down.

Who is more praiseworthy?

5.4 Backward order/Immoral

Lady Giulia had seen a cigarette that was going out.

Giulia aimed some petrol onto the cigarette. Lady Chiara had thrown the cigarette into the garden.

The neighbor's house burnt down.

Who is more blameworthy?

6.1 Story order/Moral

Mario repaired the brakes of his car which did not function much. Mario lent the car to Luca. Luca went to the mountain and drove prudently. Luca avoided plugging.

Nobody hurt himself.

Who is more praiseworthy?

6.2 Story order/Immoral

Mario lent his car to Luca.

Mario knew that the brakes were not functioning much. Mario had advised Luca.

Luca drove in a reckless way. Luca hit a car. Luca was not injured, but the other driver was.

Who is more blameworthy?

6.3 Backward order/Moral

Luca went to the mountain and drove prudently Mario's car.

Luca avoided plugging.

Mario had repaired the brakes of his car which did not function much.

Nobody hurt himself.

Who is more praiseworthy?

6.4 Backward order/Immoral

Luca drove in a reckless way. Luca hit a car. Mario had lent him the car. Mario knew that the brakes were not functioning much. Mario had advised Luca. Luca was not injured, but the other driver was.

Who is more blameworthy?

Protocol 1:	1.1	2.3	3.2	4.4	5.3	6.2
Protocol 2:	1.2	2.4	3.1	4.3	5.4	6.1
Protocol 3:	1.3	2.1	3.4	4.2	5.1	6.4
Protocol 4:	1.4	2.2	3.3	4.1	5.2	6.3

Appendix B

Data check analyses.

Table B1 summarizes the percentages of choice of the causer as a function of the valence of the scenario (moral/immoral) and response modality (think-aloud/no think-aloud). By participants paired t-test revealed that the choice of the causer did not differ in moral scenarios compared to immoral scenarios for either children (mean 61% vs. 60%, respectively; $t(47) = .27$, $p = .79$, Cohen's $d = .04$), adolescents (mean of 58% vs. 65%, respectively; $t(47) = 1.27$, $p = .21$, Cohen's $d = .18$), and adults (mean of 61%, and 65%, respectively: $t(47) = 1.06$, $p = .29$, Cohen's $d = .12$). They also showed that choice of the causer did not differ in Think-aloud compared to No think-aloud protocols for children (mean of 58% vs. 63%, respectively: $t(46) = .87$, $p = .39$; Cohen's $d = .25$), adolescents (mean of 60% vs. 63%, respectively: $t(46) = .28$, $p = .78$; Cohen's $d = .08$), and adults (mean of 60% vs. 67%, respectively: $t(46) = .93$, $p = .36$; Cohen's $d = .27$).

Table B1.

Percentages of choice of the causer depending on the valence of the scenario (moral/immoral) and response modality (think aloud/no-think aloud).

Groups	Think-aloud		No think-aloud	
	Moral	Immoral	Moral	Immoral
Children	58	57	65	60
Adolescents	58	63	57	65
Adults	54	65	67	64

Appendix C

Table C1.

Percentages of choice of causer for each scenario by participants in each age group.

Story order					Backward order				
Scenarios	Children	Adolescents	Adults	OVERALL	**Scenarios**	Children	Adolescents	Adults	OVERALL
1.1	67	67	67	67	1.3	58	50	83	64
1.2	42	42	8	31	1.4	50	25	8	28
2.1	83	100	100	94	2.3	75	92	75	81
2.2	50	67	75	64	2.4	33	17	75	42
3.1	100	83	67	83	3.3	75	75	83	78
3.2	92	92	92	92	3.4	67	100	67	78
4.1	58	25	42	42	4.3	25	17	25	22
4.2	83	92	100	92	4.4	25	67	58	50
5.1	50	50	83	61	5.3	67	67	42	58
5.2	50	67	92	69	5.4	58	83	17	36
6.1	42	33	33	36	6.3	33	42	33	36
6.2	92	92	92	92	6.4	75	83	100	86