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Authors
Glebkin, Vladimir V.
Olenina, Ekaterina O.
Safronov, Nikita A.

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Vladimir V. Glebkin (gleb1514@gmail.com)
Russian Presidential Academy of National Economy and Public Administration,
Prospect Vernadskogo, 82, Moscow, Russian Federation 119571**;**
School 1514,
Krupskoi Street, 12, Moscow, Russian Federation 119311

Ekaterina O. Olenina (katerinaoleninam@mail.ru),
School 1514,
Krupskoi Street, 12, Moscow, Russian Federation 119311

Nikita A. Safronov (nikita1997.08.21@mail.ru),
Moscow Region State University,
Radio Street, 10, Moscow, Russian Federation 105005

Abstract

Event cognition is a rapidly developing and promising research area. Meanwhile, some domains are not considered in detail in this scope. In particular, event cognition is not precisely explored from the perspective of cognitive development. In this paper, we compare the capacity to cut a visual narrative into events for kindergarten students, primary school students, high school students and adults. “The pear film” by W. Chafe (1975) is used as the material for our experiment. We also examine a correlation between event comprehension and other cognitive skills for primary school students. Our work provides clear evidence that, in contrast with high school students and adults, kindergarten students and primary school students perceive visual narrative on the surface level.

Keywords: event cognition, event model, cognitive development, primary school students, narrative comprehension.

Introduction

Event cognition is an intensively developing domain of cognitive science and a promising avenue of research. A number of insightful conjectures and seminal ideas supported by dozens of experiments have been suggested in this domain over recent decades (Suh & Trabasso 1993; Zwaan et al. 1995; Zacks et al. 2001; Rinck & Weber 2003; Ditman et al. 2008; Shipley & Zacks 2008; Yarkoni et al. 2008; Zacks et al. 2009; Tamplin et al. 2013; Radvansky & Zacks 2014; Zacks 2015; Richmond & Zacks 2017, etc.).

The main results of this research line can be presented as follows:

- Humans do not perceive reality in a continuous way; they cut it into a number of chunks called events. This feature is a fundamental characteristic of humans that underpins their way of reasoning and making decisions.
- There is a high level of coherence among humans in cutting the stream of life into events; they detect event boundaries in a highly similar way.
- A shift through event boundaries impairs an ability to predict a future state of affairs and also event memory; this is caused by a change of space, time, characters, objects, causes, and goals, concerned with a particular situation.
- Event cognition is based on the creation and further elaboration of event models that "capture the entities and functional relations involved in understanding a specific state of affairs" (Radvansky & Zacks 2014, 17); event models allow to predict a development of such state of affairs within an event.
- "...event cognition, and event memory in particular, appears to have distinct neurological underpinnings apart from more general knowledge... it seems possible to disrupt the long-term storage of event models, leaving more general knowledge intact, as well as the reverse, disrupting general knowledge, but leaving the ability to process and remember individual events" (Radvansky & Zacks 2014, 131).

At the same time, some methodological flaws seem to hinder further development in this direction. Strangely enough, we could not find any working definition of both event and event model in works of event cognition researchers. We admit that the demand to define correctly the concept ‘event’ may sound a bit scholastic in this scope (see, e.g., Shipley 2008; Schwartz 2008 as an example of the discussion), but the concept ‘event model’ is the key concept which underpins the body of experimental research addressing event cognition. Nevertheless, the researchers usually focus on event boundaries and changes what take place when these boundaries being passed, whereas a structure of an event model within boundaries is only sketched. The definition by Radvansky and Zacks quoted above is not clear-cut enough to apply it to a particular experiment (What does ‘a specific state of affairs’ mean? How can we measure it?), and it is not clarified in other works. Scholars usually pick out five aspects characterizing event model: temporality, spatiality, protagonist(s), causality, and intentionality (e.g., Rinck & Weber 2003, 1284–1285; Radvansky & Zacks 2014, 61); however, it is not clear how these aspects are represented in a particular event model.

In other words, there is a bunch of important questions which remain unanswered in this scope. Let us stress only few of them. How many basic types of event model can be singled out? What is the structure of each of them; what are the cornerstones of this structure and links between them? Are there any discrepancies between event boundaries which separate events of the same type and boundaries which separate events of different types? Is the ability to produce event models innate, or it is a result of cognitive development? If the latter, how it develops through the life span? Is there any difference between event model typology for kids and adults?

Indeed, there is no opportunity to tackle all these and similar questions here. We address only some of them concerned with the problem of cognitive development. To be more precise, we have explored how an ability to cut reality into events and to produce event models is acquired in childhood, what is the difference between kids and adults in event cognition, how an acquisition of this capacity correlates with language acquisition and the development of other cognitive skills (there are a few papers addressing age differences in event cognition (e.g., Copeland & Radvansky 2007; Kurby & Zacks 2011), but they do not explore the problem from the perspective of cognitive development). This paper can be considered as the first step in this direction.

Our work examines age differences in cutting a visual narrative into events as a part of a process of cognitive development. We have used "the Pear Film" made by Wallace Chafe and his colleagues in 1975 as a material for the experiments. Importantly, "the Pear Film" includes actions, pictures and sounds, but no words, deploying the same chain of events for all viewers. This film contains a wide range of interactions between protagonists, spatial and temporal changes; its understanding presupposes the capacity to ‘read’ complex intentions and distinguish between physical and social causality. In other words, it provides good material for producing different event models, and, therefore, for exploring event cognition from the perspective of cognitive development. It is worth also noting that "the Pear Film" has opened an avenue of research tackling different aspects of a language and culture interconnection in the process of conceptualizing particular stream of events (Bernardo 1980; Chafe 1980; Clancy 1980; Downing 1980; Du Bois 1980; Tannen 1980; Orero 2008; Fon et al. 2011; Matzur & Mickievicz 2012; Vilaró et al. 2012; Blackwell 2015; Cummings 2015, 59–63; Kibrik et al. 2015; Glebkin et al. 2017).

A plot of "the Pear Film" is important for understanding the results of our experiment, therefore, it looks reasonable to begin with a brief description of the story taken from Chafe 1980, XIII–XIV.

The film begins with a man picking pears on a ladder in a tree. He descends the ladder, kneels, and dumps the pears from the pocket of an apron he is wearing into one of three baskets below the tree. He removes a bandana from around his reek and wipes off one of the pears. Then he returns to the ladder and climbs back into the tree.

Toward the end of this sequence we hear the sound of a goat, and when the picker is back in the tree a man approaches with a goat on a leash. As they pass by the baskets of pears, the goat strains toward them, but is pulled past by the ruin and the two of them disappear in the distance.

We see another closeup of the picker at his work, and then we see a boy approaching on a bicycle. He coasts in toward the baskets, stops, gets off his bike, looks up at the picker, puts down his bike, walks toward the baskets, again looking at the picker, picks up a pear, puts it back down, looks once more at the picker, and lifts up a basket full of pears. He puts the basket down near his bike, lifts up the bike and straddles it, picks up the basket and places it on the rack in front of his handlebars, and rides off. We again see the man continuing to pick pears.

The boy is now riding down the road, and we see a pear fall from the basket on his bike. Then we see a girl on a bicycle approaching from the other direction. As they pass, the boy turns to look at the girl, his hat flies off, and the front wheel of his bike hits a rock. The bike falls over, the basket falls off, and the pears spill out onto the ground. The boy extricates himself from under the bike, and brushes off his leg.

In the meantime we hear what turns out to be the sound of a paddleball, and we see three boys standing there, looking at the bike boy on the ground. The three pick up the scattered pears and put them back in the basket. The bike boy jets his bike upright, and two of the other boys lift the basket of pears back onto it. The bike boy begins walking his bike in the direction he was going, while the three other boys begin walking off in the other direction.

As they walk by the bike boy’s hat on the road, the boy with the paddleball sees it, picks it up, turns around, and we hear a loud whistle as he signals to the bike boy. The bike boy stops, takes three pears out of the basket, and holds them out as the other boy approaches with the hat. They exchange the pears and the hat, and the bike boy keeps going while the boy with the paddleball runs back to his two companions, to each of whom he hands a pear. They continue on, eating their pears.

The scene now changes back to the tree, where we see the picker again descending the ladder. He looks at the two baskets, where earlier there were three, points at them, backs up against the ladder, shakes his head, and *tips up his hat. The three boys are now seen approaching, eating their pears. The picker watches them pass by, and they walk off into the distance.*

We chose four age groups for the experiment: 5-7-year-old kindergarten students (KS), 7-9-year-old primary school students (PS), 14-16-year-old high school students (HS), and adults (A).

Based on the previous experiments (Glebkin et al. 2017), we expected that kindergarten students and primary school students would be less skillful in producing event models than high school students and adults which would entail serious problems in detecting event boundaries for KS and PS subjects. In particular, in the case of "the Pear Film" they would be inclined to 'paste' event boundaries and to minimize a number of parts in this visual narrative. To be more precise, we supposed that a mean number of events for kindergarten students and primary school students would be less than for high school students and adults, and kindergarten students and primary school students would determine event boundaries in a less systematic way. We also expected to discover some correlation between the ability to cut a narrative into events and other cognitive and communicative skills concerned with story retelling for primary school students. Our hypothesis in this scope was that the more correct and more detailed was a film retelling the more accurate was a choice of event boundaries by a subject.

Experiment

Method

Subjects. 34 (14 m, 20 f) 5-7-year-old kindergarten students; 73 (35 m, 38 f) 7-9-year-old Moscow primary school students; 36 (12 m, 24 f) 14-16-year-old Moscow high school students; 35 (13 m, 22 f, mean age 37) adults.

Material. "The Pear Film" by Wallace Chafe (6 min 32 sec).

Procedure. The procedure of the experiment followed the model well-established in modern cognitive psychology (e.g., Newtson 1973; Speer et al. 2003). Each subject was processed individually. Where were two versions of the experiment. In the first version subjects watched the film on MacBook Air, 13,3″, 2560x1600 two times. Before the first viewing, the subjects were instructed to watch the film closely as passive viewers. Before the second viewing, they were asked to cut the film into events, i.e., the largest meaningful parts, in any way they find appropriate (this task is similar to the coarse segmentation task in Speer et al. 2003). In addition, a special explanation was given to the groups of kindergarten students and primary school students. The idea of the event segmentation was illustrated on the example of book chapters and some other similar examples. Then the subjects watched the film for the second time and pressed a button at the beginning and at the end of any meaningful part of the film.

In the second version, the procedure was similar, but after the first viewing the participants were asked to retell the story as precisely as they can. This version of the experiment was carried out only for primary school students. In order to make sure that the retelling has no significant influence on the event segmentation task, a control group of 20 primary school students was tested in the first version before the main experiment. No significant difference between two groups was discovered both in a total of episodes each subject cut the film ($F(1, 89) = 0.017$; $p=0.89$) and in the percentage of subjects identifying main event boundaries ($\chi^2 (12)=16.56$, $p=0,17$).

Two groups of parameters were measured. The first group represented the event segmentation task. It included two variables: a total of episodes that the film was cut into by each subject (TE), and, accordingly, a number of subjects pointed to a particular point as an event boundary (NS) (more precisely, because of some difference in subjects' reaction time it was a set of points located near each other which can be considered as characterizing the same change of a situation). Also for PS group a total of "right" boundaries for each subject (TB_r) (i.e., the boundaries picked out by a significant number (40% and more) of adults and high school students) was calculated. We considered TB_r as a characteristic of cognitive skills involved in event cognition important for the comparison with cognitive skills involved in narrative comprehension and retelling.

The second group of variables, actual only for the primary school students, was concerned with the film retellings. It checked memory for events and also basic cognitive and communicative skills important for narrative understanding and retelling, namely, an ability to categorize objects, an ability to understand the causal chain of events and represent it in the retelling, the richness of language used by subjects. The set of variables was an extended version of the set of variables presented in Glebkin et al. 2017. The following variables were measured: the total number of words exploited in retelling, discounting selfrepetitions and false starts (TW); a total of events presented in retelling (TE_r); a total of events correctly presented in retelling (TEc); a total of errors in action description (FA) (e.g., 'guys picked up pears' instead of 'the boy hands pears to one of the guys'); a total of errors in object description (FO) (e.g., 'apples' instead of 'pears'); a total of incorrect description of causal chain of events and sub-events (FC) (e.g., ambiguous reference, missing connections within an event and between events); a total of interpretations (TI) (e.g., 'stole a basket of pears' instead of 'picked up a basket of pears'); a total of dependent words (TDp) (such as 'who', 'which', 'because', etc.); a total of details mentioned in the retelling (TDt) (e.g., the color of the bike, the peddleball, etc.).

TE_r, TEc and TDt may need a clarification. A total of events was calculated according to the most frequent event boundaries picked out by high school students and adults. These boundaries divide the film into meaningful episodes some of which are connected with others and some are autonomous (e.g., appearance and disappearance of a man with a goat). The primary school students mentioned some episodes in their retellings and missed others. Some of mentioned episodes were retold correctly (all protagonists and main interactions between them were included in the description), others were presented with serious gaps (e.g., in the episode with the fall of the boy on the bike some subjects missed the girl on the bike). In other words, the complex TE-TEc characterizes the correctness of the film framework representation in a retelling.

TDt points to another feature of the retellings. As a rule, PS subjects focused on actions and missed an appearance of protagonists, their clothes, scenery, etc. Only few of them mentioned such details. For us, such interest to particular details is a special cognitive characteristic important to event cognition. Some arguments for that are presented in the next sections.

Results

As predicted, a mean number of episodes that the pear film was cut into by each subject (TE) for KS was less than for PS, and TE_{PS} was less than TE_{HS}. At the same time, there were no significant difference between TE_{HS} and TE_{A} (TE_{KS}=2.61; TE_{PS}=4.58; TE_{HS}=8.61; TE_{A}=8.23; F_{KSPS} (1, 102) = 61.38; p_{KSPS}<0.001; F_{PSHS} (1, 105) = 18.36; p_{PSHS}<0.001; F_{HSA} (1, 68) = 0.26; p_{HS}=0.6).

As we expected, KS were less consistent in the determination of event boundaries than PS, and PS were less consistent in that than HS and A. The distribution of subjects' choices through the event boundaries, which are most frequent and most important for the narrative, is presented in Table 1.

Table 1. The percentage of subjects identifying most frequent event boundaries

№	Event boundaries	A	HS	PS	KS
1	A man with a goat appears	49	47	17	11
2	A man with a goat disappears	57	56	23	2
3	A boy on a bike appears	49	52	26	22
4	The bike boy stops near the baskets	17	13	20	11
5	The bike boy steals a basket	71	69	30	13
6	A girl on a bike appears	17	17	13	2
7	The bike falls over	71	69	41	25
8	Three boys appear	46	43	20	11
9	The free boys finish to put the pears back in the basket	49	47	27	11
10	The exchange of the pears and the hat	14	8	19	11
11	The boy with the paddleball hands a pear to each his two companions	40	39	24	8
12	The scene changes back to the tree	60	56	24	5
13	The three boys pass by the picker	40	39	19	5

The difference between the results of KS and PS and, accordingly, between the results of PS and HS is significant ($\chi^2_{KSPS}(12)$=26.27; p<0.05; $\chi^2_{PSHS}(12)$=70.18; p<0.001). Meanwhile, data for HS and A are located extremely close to each other. Fig. 1 presents these results in a graphic form.

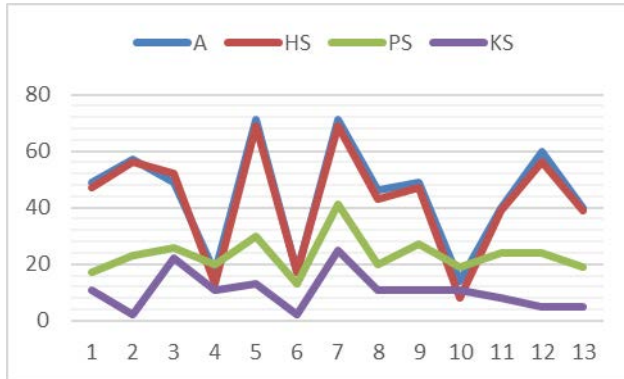

Fig. 1. The diagram of a percentage of subjects identifying main event boundaries for A, HS, PS and KS.

Interestingly, a comparison of data within PS does not reveal any significant differences. In particular, the comparison of TE of 34 first year PS and TE of 26 second year PS (TE_{1PS}=4.62; TE_{2PS}=5.42) gives p=0.34; the comparison of TE of 26 second year PS and TE of 13 third year PS (TE_{3PS}=4.77) provides p=0.54.

We also checked, as mentioned, a possible correlation between event cognition skills and skills in narrative comprehension and retelling for the group of primary school students. It seems reasonable to distribute all correspondences among three groups. The first group (p<0.001) includes the correlation between a total of episodes that the film was cut and a total of details mentioned in the retelling (r(TE,TDt)=0.422); the correlation between a total of "right" boundaries and a total of details ($r(TB_r,TDt)$=0.410); and the correlation between a total of "right" boundaries and a total of events correctly presented in retelling ($r(TB_r,TE_c)$=0.420). The second group (p<0.01) includes the correlation between a total of episodes and the total number of words exploited in retelling (r(TE,TW)=0.383); between a total of "right" boundaries and the total number of words ($r(TB_r, TW)$=0.344); between a total of episodes and a total of events correctly presented in retelling ($r(TE,TE_c)$=0.382); between a total of "right" boundaries and a total of events presented in retelling ($r(TB_r, TE_r)$=0.339). The third group (p<0.05) includes the correlation between a total of episodes and a total of events presented in retelling ($r(TE, TE_r)$=0.250); between a total of episodes and a total of incorrect description of causal chain of events and sub-events (r(TE,FC)=-0.245); between a total of episodes and a total of interpretations (r(TE,TI)=0.287); between a total of "right" boundaries and a total of dependent words (r(TB_r, TDp)=0.263); between a total of "right" boundaries and a total of incorrect description of causal chain of events and sub-events (r(TB_r,FC)=-0.266); and between a total of "right" boundaries and a total of interpretations (r(TB_r,TI)= 0.261).

Discussion

The results support the conjecture of serious problems that kindergarten students and primary school students encounter when cutting a visual narrative into events. They lose some key event boundaries, and they are less consistent in detecting event boundaries than high school students and adults. In other words, they are inclined to interpret the narrative as the whole story not picking out any significant parts within it. Indeed, this does not mean that kindergarten students and primary school students do not cut the film into events when they watch it. They may encounter serious difficulties in making sense of the task. This is especially important for kindergarten students (primary school students perform similar tasks from time to time in their school lessons). Therefore, it is hard to distinguish between difficulties in defining events and event borders in process of real viewing (which is, mainly, unconscious) and difficulties in conscious efforts to cut the film into events.

In order to cast additional light on this issue, some other data need to be addressed. In Glebkin et al. 2017 clear evidence was provided for serious problems which kindergarten students encounter in "The Pear Film" retellings in comparison with high school students (TW, TE_r, FA, FO, FC, TI, TDp values differed significantly for KS and HS groups). Further investigations have shown that similar problems characterize retellings of primary school students. Therefore, difficulties in event cognition correlate in age aspect with difficulties in narrative comprehension and retelling, and we can expect substantial correlation in the acquisition of these groups of cognitive skills.

A precise look to the data presented above might clarify this issue. In particular, the figures in Table 1 (and the diagrams in Fig. 1) are interesting. There are only three points in which high school students and adults are less consistent (or almost equally consistent) than primary school students: the moment of bike boy stopping near the baskets (Point 4); the moment when a girl on a bike appears (Point 6); and the moment when the bike boy and the boy with the paddleball exchange the pears and the hat (Point 10). Why high school students and adults do not generally detect these points as event boundaries?

In order to clarify this issue, let us focus on "The Pear Film" narrative at hand. Point 4 and Point 10 characterize some local changes in the narrative, but there are strong arguments for interpreting these points as situated within events; they are unlikely to be basic event boundaries. In particular, Point 4 is situated within the event "The bike boy steals a basket of pears", and this was the reason for high school students and adults not to detect it as an event boundary. Similarly, Point 10 – the exchange of the pears and the hat – is not an event boundary, because the boy with the paddleball when taking three pears from the bike boy is expected to hand the pear to each of his two companions to end the event.

The case of Point 6 – a girl on a bike appears – is a bit more complicated. The girl is a new character, and she is introduced in the story with a close-up, therefore, her appearance may look as the beginning of a new event. Meanwhile, she is not a main character; she is engaged in the event "The bike boy rides down the road". Her part in this event is implemented later on when she brings to bear the boy's fall. If so, this moment is unlikely to be an event boundary.

Why, in this case, primary school students did often detect these points as event boundaries? There are, at least, two aspects of PS subjects' strategy in event boundaries detecting which may underpin these particular decisions. Firstly, two levels in the structure of event model can be singled out. The first level characterizes changes in location, actions and interactions given in visual perception, situated, so to say, on a superficial level. For instance, "the boy's bike falls over". Some of such changes are autonomous, but some others are signs of elements, which are located on a deeper level and need a special interpretation (e.g., the fact, that the boy places the basket on the rack in front of his handlebars, and rides off, means that he steals the basket). On average, primary school students do not include some important links on the deeper level into their event models. As a result, their models are 'poorer' than and models of high school students and adults addressing the same event; they are 'flat', but not 'volumetric' ones. If it is so, some changes in the visual field, such as ones, happened in Point 4, Point 6, and Point 10, are sufficient for them to detect these points as event boundaries.

Secondly, an analogy with language comprehension helps to explore this issue from another perspective. Researchers single out three levels of text representation: the surface form, the propositional textbase, and the situation model (e.g., Schmalhofer & Galvanov 1986; Radvansky & Zacks 2014, 57–58). A difference between sentences on the first level concerns words and grammatical structures, but not the facts and their interpretation (e.g., *Anna cleaned the room and then went to the cinema* and *After cleaning the room Anna went to the cinema*). On the second level, a situation is the same, but a focus and an interpretation may be different (e.g., *The ball flew into the goal from the foot of Peter* and *Peter scored a goal*; in the first case it may be also ricochet). On the third level, the situations are different.

If expanding this model on a visual narrative, a difference on the first level would mean different wide shots of the same event; difference on the second level – e.g., a close-up of different objects within the same event; and difference on the third level – different events. From this perspective, in contrast with high school students and adults, primary school students are inclined to 'paste' together different levels. In particular, the close-up of the girl on a bike may be a reason for them to detect Point 6 as an event boundary.

Finally, let us zoom in on the comparison between event cognition skills and skills in the narrative comprehension and retelling. These data support the conjecture that the 'flat' event model dominates for primary school students. The variable, which shows the most significant correlation with both a total of episodes and a total of right boundaries, is a total of details mentioned in the retelling (TDt). At the same time, TDt is hardly to be a characteristic of logical aspects of the narrative comprehension; rather, it characterizes visual attention and visual memory. In other words, high TDt values are not valid signs of high quality of event models.

Also, the strong correlation between a total of right boundaries and a total of events correctly presented in retelling, and a significant correlation between both a total of right boundaries and a total of events and the total number of words exploited in the retelling, between a total of episodes and both a total of events presented in retelling and a total of events correctly presented in retelling show that the more detailed a retelling is the more event boundaries are detected by the subject.

The correlation between a total of events (or a total of right boundaries) and characteristics of understanding and representation of logical structure of the narrative (a total of incorrect description of causal chain of events and sub-events; a total of interpretations; a total of dependent words) is less significant. It is worth paying special attention to the lack of any correlation between a total of events and a total of errors in object description (a variable characterizing categorization skills).

Overall, our data support the conjecture that event models evolve through the life span, and event models of kindergarten students and primary school students subjects are 'poorer' than whose of high school students and adults. Therefore, the age of 10-14 years old is likely to be crucial for the development of event cognition ability. The problem of correlation between this ability and other cognitive skills in diachronic perspective needs further investigation.

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