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The Development of Event Clusters in Autobiographical Memory

by

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Abstract

The prevalence of event clusters in autobiographical memory was examined with an event-cueing task in two parallel experiments. Event clusters are theoretical memory structures that bind specific personal events in narrative-like configurations. Prior research has shown that young adults report fewer event clusters when cued with childhood events than high school events (Brown, 2005). Experiment 1 tested whether the reduced prevalence of event clusters in childhood is due to forgetting. Experiment 2 used the same event cueing task with 4th grade children. Keeping event age constant, children reported a comparable amount of event clusters to adults recalling childhood events. Children's relational judgments between event pairs differed from adults and may have inflated their responses. Together, these findings suggest that event clusters are consequences of other cognitive processes implicated in the development of autobiographical memory.

Keywords: autobiographical memory, event clusters, narratives, child development

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The Development of Event Clusters in Autobiographical Memory

Event clusters are hypothetical memory structures that bind specific personal events in narrative-like configurations. Event clusters are common in autobiographical memory. They can be observed whenever event memories are shared as stories. The formation of event clusters is considered a by-product of other cognitive processes involved in planning, executing, and evaluating meaningful event sequences (Brown, 2005; Brown & Schopflocher, 1998a; 1998b). Support for this position comes from experiments that have used the event-cueing paradigm (Brown, 2005, Brown & Schopflocher, 1998a; 1998b; Fitzgerald, 1980; Sato, 2002; Wright & Nunn, 2000). Of course, events may be related in many ways. However, for the present purposes, it is assumed that personal events are members of the same event cluster when the person who experienced them indicates that s/he believes that one event caused the other, that one event is embedded in the other, or that both are part of a large event sequence. These criteria were established to reflect the wide-spread notion that people represent much of their experience as narratives (Bruner, 1991; Fivush, 1998; Lancaster & Barsalou, 1997; McAdams, 2001; Nelson & Fivush, 2004; Pillemer, 2001).

Prior research using the event cueing paradigm (see below) has demonstrated that the event age and cluster rates are related. Specifically, Brown (2005) found that participants (in all cases university undergraduates) were more likely to recall a clustermate when cued with a high school event than when cued with a grade school event. The present study follows up on this finding with two new event-cueing experiments. One of these replicates and extends the findings using a university-aged sample and the second reports data from a sample of 4th grade children. We report the prevalence of event clusters across various lifetime periods, as well as evaluations of event relations made by children and adults, respectively. Before outlining the experiments, the event cueing paradigm will be briefly described.

An event cueing paradigm includes three phases. In Phase 1, words are used to elicit event memories from specific time periods. In Phase 2, the event descriptions generated in Phase 1 (i.e., cueing events) are re-presented one at a time, serving as retrieval cues for other related events (i.e., cued events). In Phase 3, participants report the ways events within each generated event pair are related. Event clusters are determined by the responses provided in Phase 3. If participants answer positively that two events are causally linked, part of one another, or part of a single, broader event, the event pair constitute an *event cluster*. For example, *arriving at a surprise birthday party* and *eating an ice cream cake* would form an event cluster, as both events were part of my 18th birthday.

Conversely, a non-clustered event would be composed of two related events that are similar in some way, but are not part of an overarching event sequence. For example, one event might include *eating sushi in New York and spotting Madonna at the same restaurant*, while a related event might be *eating sushi in Vancouver with childhood friends*. The events are related because they share the same activity (i.e., eating sushi), but one would not necessarily be told alongside the other in a story about the time I saw Madonna at a sushi restaurant. The two events constitute separate event narratives that took place at distinct times, in different places, and included other people.

The Phase 3 relation menu includes several different kinds of possible event relations. To begin, two events may share the same people, the same activity, or the same location. For example, one event might include *running a race against the tallest boy in junior high at a track and field event*, while another might include, *running a race against the same tallest boy during recess in third grade*. These two events would share the same activity and person, but not the same location. Events could also be related causally. For example, one event might be *skidding on ice while skiing* and the other, *going to the hospital to get a cast for a broken leg*. In this case, one event may have caused the other. These two events might also be coded as being a part of one another and/or belonging to a larger, broader event (i.e., the time I broke my leg). This event pair would meet the criteria for an event cluster. Conversely, the former event pair would not form an event cluster, unless the subject judged the two racing events as being causally related, part of one another, or part of a single, broader event sequence.

Brown (2005) used the event cueing paradigm to investigate the prevalence of event clusters from various lifetime periods, including the past week, the recent past (i.e., high school), and childhood (i.e., grades 1 to 3). In Phase 1, participants were randomly assigned to one of three conditions (i.e., the past week, the recent past, and childhood) and were asked to recall personal events from the given time period. In Phase 2, the cueing events from Phase 1 were used as retrieval cues for related event memories, but the related memories were no longer restricted to a given time period. Brown (2005) found that more than two-thirds (69%) of the high school cued events produced cluster mates. In contrast, only about half (54%) of the event pairs cued by childhood events were clustered. There are at least two explanations for this finding. It could be that (a) the lower number of event clusters from childhood was due to simple forgetting, or (b) the reduced frequency of event clusters was due to developmental factors specific to childhood. These possible explanations yield competing predictions and motivate the present study.

The purpose of this study was to explain what might account for the reduced prevalence of event clusters from childhood (Brown, 2005). Using an event cueing paradigm, these studies tested the first hypothesis which attributes the reduced prevalence of event clusters from childhood to forgetting. To anticipate our results, the forgetting hypothesis was disconfirmed in the first experiment. In Experiment 2 we used the same event cueing paradigm from Experiment 1 with 4^{th} grade children to test the possibility that children might encode, store, retrieve, or evaluate event memories differently than adults. If this was so, we would expect to see fewer event clusters recalled by children than adults. Further, such a finding could explain the reduced frequency of event clusters from childhood (Brown, 2005) as an important developmental feature of autobiographical memory.

The primary aim of Experiment 1 was to test the forgetting hypothesis. There are several reasons to believe that simple forgetting might account for the reduction in clustering found in Brown's (2005) study. First, because recent events exhibited higher proportions of event clusters than those from childhood, the more recent an event is, the more accessible it may be to recall. Second, it has been found that there is a general decline in the probability of recalling childhood events as one matures into adulthood (Crovitz & Quina-Holland, 1976; Fitzgerald, 1991; Fivush & Schwarzmueller, 1998; Rubin, 1982; Van Abbema & Bauer, 2005). Third, events that are considered more important may exhibit greater inter-event cohesion. That is, less important events may be forgotten due to less elaboration, while more important events may be rehearsed through sharing and may, therefore, be more condensed in memory. Moreover, to young adults, high school events may seem more important than events from grades 1 to 3. Finally, inter-event associations may be lost over time. That is, clustered events may be just as prominent in childhood as they are in adulthood, but cohesion between the individual events may disintegrate as time passes.

The main goal of Experiment 2 was to determine the prevalence of event clusters recalled by 4th grade children. Doing so allowed us to examine cluster rates in childhood and to compare them with those observed in adulthood (i.e., Experiment 1). This between-group comparison was possible because we used the same event cueing paradigm while holding the interval between the age of an event and subsequent recall relatively constant. Specifically, 4th grade children were asked to recall events from grades 1 to 3 during Phase 1 of the event cueing task. This time interval was comparable to that of young adults retrieving event memories from high school (i.e., 1 to 3 years). Additionally, it was comparable to young adults retrieving events from the same lifetime period (i.e., grades 1 to 3). Furthermore, sampling children and controlling event age allowed us to control for subsequent cognitive developments that might account for the observations made in adult event memory.

To summarize, the goal of the present study was to investigate the development of event clusters in autobiographical memory. We sought to determine whether the reduced cluster rates reported for childhood events could be accounted for by simple forgetting and to compare cluster rates between children and adults. Differences between children's and adults' cluster rates would suggest that event clusters are implicated in the development of autobiographical memory.

Event Cueing Paradigm for the Investigation of Event Clusters

We now present the event cueing paradigm in somewhat more detail. Event cueing was designed to investigate relations between autobiographical event memories (Brown & Schopflocher, 1998a). Event cueing is an extension of the word cueing paradigm (Crovitz & Shiffman, 1974) which has been used extensively to investigate autobiographical memory (Rubin, 1982; Rubin & Shulkind, 1997). Word cueing has been successfully used with people across the lifespan, including children as young as 7-years of age (Bauer, Burch, Scholin, & Guler, 2007). Event cueing (Brown & Schopflocher, 1998a) extends the word cueing method by using event descriptions, rather than words, as retrieval cues.

This is an important modification because standard word cues do not refer to personal events, and therefore, cannot be used to investigate relations between personal events. Further, because word cueing has been successfully used with children, we can assume by extension that event cueing can also be used.

Before proceeding, it is also important to outline the assumptions upon which the event cueing method is based. First, it assumes that event memories are systematically related to one another. Second, the types of relations between the cued and cueing events correspond to the relations that bind event memories. Finally, the frequency of these relations indexes their organizational importance within autobiographical memory. Based on these assumptions, the event cueing paradigm provides a way to investigate event clusters in autobiographical memory. A brief review of what is known about event clusters is provided next.

Characteristics of Event Clusters

Prior research has shown that events cluster regardless of event age (Brown, 2005) and degree of rated importance (Brown & Schopflocher, 1998a). Brown and Schopflocher (1998a) reported clustered events occurred close together in time (within approximately 2 days) and shared similar content (e.g., common people, activities, and locations). Taken together, event clusters are considered common by-products of the cognitive processes involved in planning, executing, evaluating, and sharing meaningful event sequences (Brown, 1990; Brown, 2005, Brown & Schopflocher, 1998a; 1998b; Fitzgerald, 1980, Sato, 2002; Wright & Nunn, 2000).

Another characteristic, or consequence, of event clusters is that they facilitate memory retrieval (Brown, 2005; Brown & Schopflocher, 1998a). Prior research has consistently demonstrated that cued events are retrieved faster when events are clustered. This finding suggests that event clusters are implicated in direct retrieval (i.e., memory retrieval that requires minimal effort). Direct retrieval has mostly been studied within the context of involuntary memory (Berntsen, 1996; Berntsen & Rubin, 2002; Mace, 2004). When cluster mates are recalled, it is possible that cued events come to mind much like involuntary memories. Or, more specifically, cluster mates may be directly retrieved more often than non-clustered events because related events may be activated when a single event is recalled.

Finally, event clusters may be retained better than isolated events. Pillemer, Picariello, and Pruett (1994) suggest that the ability to organize experiences within narratives is crucial for the long-term retention of events. Because event clusters are narrative-like memory structures, they may also be implicated in memory retention. If this is the case, we would expect to see higher proportions of event memories recalled that are clustered than non-clustered. Further, once event clusters are established in memory, they should be more resistant to forgetting than isolated events.

Development of Autobiographical Memory

The fact that event clusters are narrative-like memory structures holds implications for the development of autobiographical memory. While it remains unknown when and how event clusters emerge, it is worth considering how they may be positioned within the cognitive developmental literature. It has generally been assumed that episodic memory is present in infancy and, as knowledge of the world grows (i.e., semantic knowledge), episodic and semantic representations integrate to form the basis of autobiographical memory. Further, it has been suggested that autobiographical memory is only established once the cognitive capacities for forming self narratives are in place (Fivush & Schwarzmueller, 1998; Nelson, 1993; Nelson & Fivush, 2004). Self narratives are constructed stories about personal experiences; they integrate episodic event memories in relation to the self. The ability to construct self narratives is generally thought to emerge in adolescence (Habermas & Bluck, 2000). As a result, autobiographical memory is also thought to emerge in adolescence. The development of autobiographical memory is briefly reviewed next.

Reese (2009) provides a comprehensive review of autobiographical memory development. To begin, much research suggests that episodic memory develops as early as infancy. For instance, it has been found that by the time infants are 6 months of age, they can recall events over a 24-hour delay (Barr et al, 1996; Collie & Hayne, 1999). By 9 months of age, infants can recall events over a 4-week delay (Carver & Bauer, 1999). Verbal references to a missing object or past event emerge around 15 to 17 months of age (Reese, 1999; Sachs, 1983). And, by the time children are 3 to 3 ½ years of age, they can provide an understandable account of a past event (Fivush, Haden, & Adams, 1995).

Pre-school aged children reveal the first narrative-like components of memory in the form of event scripts (Nelson, 1993; 1996; Fivush, 1997). Scripts are a form of schematic representation involving real-world action sequences, such as *going to a restaurant* or *brushing one's teeth before going to bed* (Schank & Abelson, 1977). Individual events in scripts are not distinct; rather, specific instances are encoded as general representations of reoccurring, conventionalized events. Scripts are the first narrative-like representations to form in memory as consequences of goal directed behaviors.

By the age of 6, children are able to provide a full narrative of a specific past event (Peterson & McCabe, 1983), and by the age of 8 or 9, children can respond to prompts for a life story – a narrative of several distinct episodic events that in some way compose the story of one's life (Bohn & Berntsen, 2008; Habermas & de Silveira, 2008). Finally, by 12 years of age, most children are able to integrate autobiographical memories into self narratives where recalled event narratives prompt self-reflection and insight (Habermas & Bluck, 2000; Habermas & de Silveira, 2008).

As far as we know, Fitzgerald (1980) conducted the only developmental study that examined event clusters in autobiographical memory. The study compared the prevalence of event clusters in adolescents and college students. The basic finding was that adolescents were more likely to cluster events than were college students. This finding is consistent with the literature on the emergence of self narratives in adolescence and suggests that event clusters are an established part of adolescent autobiographical memory. Nonetheless, it remains unclear when and how event clusters emerge.

According to the developmental literature, the abilities to form coherent, temporally ordered, and thematically enriched narratives culminate in adolescence (Habermas & Bluck, 2000; Habermas & de Silveira, 2008). This may hold implications for the emergence of event clusters, as well. As previously mentioned, Fitzgerald (1980) found that event clusters were an established part of adolescent autobiographical memory. This parallel emergence of event clusters and self narratives in adolescence poses an interesting possibility - the same cognitive processes that support the emergence of self narratives may also be implicated in the emergence of event clusters (i.e., narrative configurations of past events). This would suggest that self narratives and event clusters are corollaries of shared cognitive processes. It would imply that events need to be experienced and understood in meaningful ways before they can be formed into a narrative. Further, if events need to be established in memory before they can be implemented into constructed narratives, the prevalence of event clusters at various stages of development may foreshadow their appearance in subsequent self narratives.

To determine a connection between events requires at least one of the following capacities: the ability to link disparate events through causal chains, the recognition that individual events are related to other individual events, and the skill to associate two or more single events with a broader, overarching event. When at least one of these is accomplished, an event cluster is formed. To examine when and how these capacities emerge, we conducted two experiments to determine when event clusters emerge as a part of autobiographical memory, and how inter-event relations are evaluated by children and adults.

Experiment 1

The primary goal of Experiment 1 was to replicate and extend Brown's (2005) finding that event clusters were less frequent for childhood events than events from high school. In particular, we examined whether forgetting could account for the observed decrease in event clusters. To this end, we added an intermediate lifetime period as a comparison group - junior high school. Generally, junior high school includes grades 7 through 9 and corresponds to early adolescence. Participants were randomly assigned to one of three lifetime periods (i.e., high school, junior high school, or grades 1 to 3, respectively) and were required to recall events from the given time period in Phase 1 of the event cueing task.

It is not surprising to suspect that forgetting might be implicated in the low cluster rates from childhood. After all, people tend to forget things as time passes. However, various patterns of forgetting are possible, each containing different implications. For example, the proportion of event clusters could gradually diminish over time, with the most recent events (i.e., high school) clustering most frequently and the more remote events clustering to lesser and lesser extents. This would suggest an Ebbinghaus type of forgetting curve with a sharp initial decline in retention, followed by more gradual forgetting over time.

Another pattern of forgetting might have different implications. For example, it could be that we find comparable clustering rates for high school and junior high school, with an abrupt drop in the grades 1 to 3 group. Typical forgetting would fail to explain such a pattern because junior high occurs approximately three years earlier than high school and should exhibit lower proportions of event clusters if cluster mates diminish over time. Moreover, the sudden drop in childhood (i.e., grades 1 to 3) might signify something more than simple forgetting; it might imply a developmental shift.

Method

Participants. 354 participants took part in this experiment. All were undergraduates enrolled in introductory psychology courses at the University of Alberta. 118 participants were randomly assigned to each of the three conditions (high school, junior high school, and grades 1 to 3, respectively). The sample consisted of 239 females. The mean age of the participants was 19.4 years. All participants provided written consent and received partial course credit for their participation. The only restrictive criterion for participation was having English as a first language.

Procedure. The event-cueing paradigm developed by Brown and Schopflocher (1998a) was used. Event-cueing involves three tasks. In Phase 1, the event-generation task, participants were asked to recall personal events in response to twelve neutral cue words (*food, store, house, animal, friend, work, money, family, vehicle, furniture, music*) and to briefly describe each event by typing it into the computer. Participants were told that an appropriate event: (1) must be related to the cue word, (2) must directly involve the respondent, (3) should be at least a few minutes in duration, but not more than a few hours, (4) should have taken place at a specific time and in a specific location, and (5) should not be a recurring event. Once an event that meets this criteria was recalled, participants hit the space bar and were asked whether the memory came to mind immediately, or if the retrieval was effortful (i.e, was it directly retrieved or generated). They responded to this question by hitting either the Z or M keys on the keyboard. The choice keys were randomized across subjects in order to control for possible left or right-sided biases. Then, they were asked to type in a brief description of the event and to press Enter for the next cue. If an event was not retrieved within 90 seconds, the computer proceeded to present the next cue.

In Phase 2, the event descriptions generated in Phase 1 were presented one at a time and served as cueing events. The participants were asked to recall a related event in response to each of the cueing events they provided in Phase 1. The participants were, again, asked whether the related memory came to mind immediately, or if the retrieval was effortful, and indicated so by hitting either the Z or M keys. They then were asked to type in a brief description of the related event and to press Enter to proceed to the next cue.

In Phase 3, participants were presented with a relation menu for each event pair and were asked in what way(s) the two events they reported were related (*Did Event A (the cueing event) and Event B (the cued event) involve the same person or persons? Did Event A and Event B involve the same location? Did Event A and Event B involve the same activity? Did one of the events cause the other? Is one of the events part of the other? Are both of these events part of a single broader event? Are Event A and Event B related in some other way?*

Did Event A and Event B occur within one year of each other?). The order of each event pair was crossed and randomized across trials. Participants checked off a box labeled Yes or No by clicking the mouse to each corresponding question.

As previously mentioned, participants were randomly assigned to one of three conditions. During Phase 1, participants in the first condition were asked to retrieve events that occurred during grades 1 through 3. Participants in the second condition were asked to retrieve events that occurred during junior high school (grades 7 through 9). And, participants in the third condition were asked to retrieve events that occurred in high school (grades 10 through 12). In Phase 2, the related events were given no time period restrictions in any of the conditions. Response times were measured in Phases 1 and 2, and all cue words and cueing events were randomized across subjects and trials.

Results and Discussion

Once the data were collected, two pairs of research assistants independently coded the responses as either acceptable or unacceptable according to the criteria listed for what constitutes an event. From all of the data obtained, unacceptable responses and participants that had fewer than 50% of acceptable responses were discarded. Also, responses where participants failed to retrieve an event memory within the given 90 seconds were not considered in the overall analysis. The inter-rater concordance for acceptable responses was 93%. The evaluation process resulted in an average loss of 27% of responses across the three conditions (29% from grades 1 to 3, 27% from junior high, and, 25 % from high school). In the end, there were 1004 justified event pairs from grades 1 to 3, 1028 from junior high, and 1047 from high school. Out of the 118 participants per condition, the final analyses had 96 subjects in the high school condition, and 100 subjects in both the junior high and grades 1 to 3 conditions, respectively. Event clusters were determined from the Task 3 relation menu responses. If a person responded positively to any one (or more) of the following questions, the event pair was coded as an event cluster: *(1) Did one of the events cause the other? (2) Is one of the events part of the other? (3) Are both of these events part of a single broader event?*

As expected, Experiment 1 replicated Brown's (2005) finding that event clusters were reduced for events recalled from childhood. Moreover, the proportion of event clusters was not significantly different between the high school and junior high conditions (see Figure 1). As discussed earlier, this pattern ruled out the forgetting hypothesis as a means of fully explaining the reduced clustering rate. That is, since event clusters did not diminish over time (i.e., from high school to junior high school), the precipitous drop in clusters from grades 1 to 3 suggests that something other than forgetting may be accounting for the decline. Moreover, something unique to middle childhood may be contributing to the reduced cluster rate.

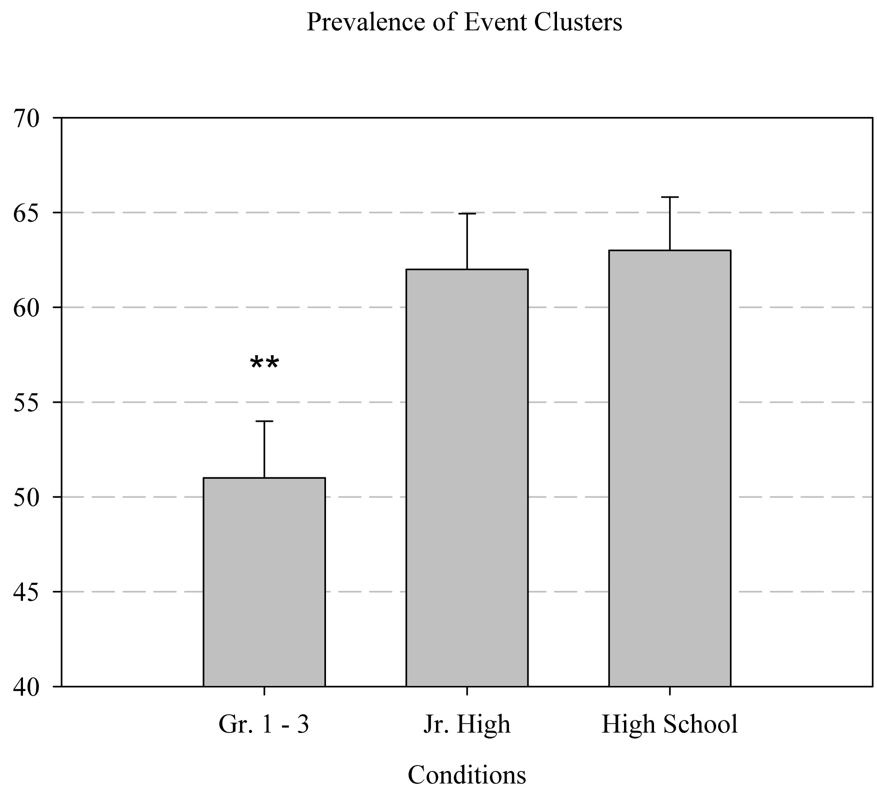

Figure 1. Proportion of event clustering in young adults recalling events from different time periods. Adults recalled events from Grades 1-3 (Gr. 1 – 3), Junior High (Jr. High), and High School. **$p<.01$.*

A clustering rate was computed for each subject. Doing so diminished potential floor and ceiling effects, and allowed each participant to contribute a single clustering rate to the overall analysis ensuring independence among observations. A one-way (between-subjects) ANOVA revealed a significant difference in the proportion of event clusters between the grades 1 to 3 condition (51%), the junior high (62%), and high school conditions (63%), respectively ($F(2,295)=5.21$, $p<0.01$, $\eta^2=0.034$). When the raw percentages of cluster rates were averaged the rates remained consistent: 52% for grades 1 to 3, 60% for junior high, and 63% for high school. Furthermore, a non-parametric test, Kruskal-Wallis, yielded a significant difference (χ^2 (2, *N* = 3107) = 21.96, *p*<.05). This non-parametric test was conducted because the basic assumption of normality required for an ANOVA was not met in the distribution of memories.

Pairwise comparisons with Tukey post hoc corrections were conducted to determine which groups differed from one another. The prevalence of event clusters from grades 1 to 3 was significantly different from both junior high (F(1, 198) = 6.48, p<.01) and high school (F(1, 194) = 8.93, p<.01), with no difference between junior high and high school (F(1, 194) = 0.21, p>.05). Non-parametric Mann-Whitney contrasts yielded the same differences: grades 1 to 3 vs. junior high, *U*=-3.92*, n1=499, n2=591, p*<.05; grades 1 to 3 vs. high school *U*=-5.00, n1=499, n2=627, *p*<.05; and junior high vs. high school *U*=-1.07, n1=591, n2=627, *p*>.05. Again, the resulting pattern suggests that event clusters in childhood may be subjected to different cognitive processes than those present in adolescence. Further, it suggests that event clusters are established by adolescence and remain relatively stable with subsequent cognitive development.

The percentage of clustered events that were directly retrieved ranged from 57% to 69% across the three conditions (i.e., high school - 69%, junior high - 63%, and grades 1 to 3 - 57%). Since the event pairs were conditionalized on direct retrievals, a chi-square test of independence was performed to examine the relation between direct retrieval and event age (i.e., condition). The relation between these two variables was not significant, χ^2 (2, *N* = 2206) = 1.12, *p* >.05).

The proportion of direct retrievals for clustered events was comparable regardless of event age.

Mean log response times confirmed the subjective retrieval reports with direct retrievals being faster than generative retrievals across the three conditions (see Figure 2). Conditionalizing on clustered events across conditions, the back-transformed mean response times for direct retrievals were as follows: 4.15 s for the grades 1 to 3 condition, 3.91 s for junior high, and 4.15 for high school. Additionally, the mean log response times for generative retrievals were 10.61 s for grades 1 to 3, 10.83 s for junior high, and 11.27 for high school. The means based on median response times displayed the same pattern for clustered and non-clustered events, respectively. The mean median response times for Grades 1 to 3 were 4.23 s and 5.49 s, respectively; for junior high 4.74 s and 5.13, respectively; and, for high school 4.50 s and 5.84 s, respectively.

Mean Log Response Times for Direct and Generative Retrievals Across the 3 Conditions

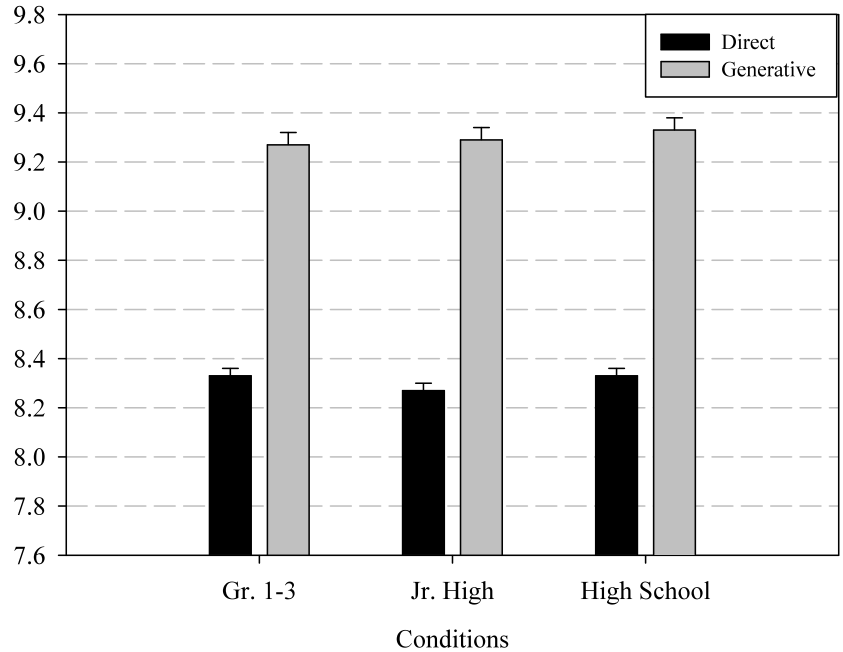

Figure 2. Mean log response times as a function of retrieval strategy (Direct versus Generative retrieval) of acceptable clustered and non-clustered events across the three conditions: Grades 1 to 3 (Gr. 1-3), Junior High (Jr. High), and High School.

A one-way ANOVA was conducted to test for significant differences between and within groups on measures of mean log response times for the direct and generative retrievals of clustered events. There were no between-group differences of response times for direct and generative retrievals for clustered events ($F(2, 190)=0.24$, $p>0.05$). But, there were significant differences between the response times for generative and direct retrievals within each condition ($F(1, 190)=376.44$, $p<0.001$). There was no interaction ($F<1$). This suggests that the same pattern exists across conditions and that the effect is independent of event age. The difference between direct and generative retrieval response times also validates the self-reported measures of direct and generative retrieval.

In summary, the main finding of Experiment 1 revealed that the proportion of event clusters was comparable for events from junior high and high school, but was significantly reduced for events from grades 1 to 3. The fact that junior high and high school resulted in comparable proportions of event clusters ruled out forgetting as the sole explanation for the reduction in event clusters from childhood. Moreover, it suggested that something unique to childhood may be accounting for the difference between conditions. To test this possibility, we conducted Experiment 2 using the same event-cueing paradigm with children.

Experiment 2

The goal of Experiment 2 was to examine the prevalence of event clusters in childhood when recalled by children. Doing so allowed us to compare event clusters in childhood and adulthood. Further, it provided insight into the finding that event clusters are less frequent for childhood events when recalled in adulthood. By comparing 4th grade children with the high school condition from Experiment 1, we were able to compare the effects of event age (i.e., the effects of how long ago an event occurred) on the prevalence of cluster mate retrieval. Further, the effects of lifetime period (i.e., grades 1 to 3) could be compared when recalled from childhood and adulthood, respectively.

Several outcomes were possible. First, it could be that children cluster events to the same degree as adults. This would suggest that the reduced cluster rates in Brown (2005) and Experiment 1 might have been due to forgetting, after all. Second, event clusters could simply be less prevalent in children's memory than adults' - as suggested by Experiment 1 and Brown (2005). Such a pattern would indicate that the cognitive processes that support the formation of event clusters are not yet fully developed in middle childhood. Third, children's cluster rates could be greater than adults'. Such a finding would be surprising and would spawn further investigation into the ways events are being related by children and adults, respectively.

Method

Participants. The participants consisted of 18 fourth- grade children (8 females, 10 males) with a mean age of 9.7 years. They were recruited through local advertising in the community and snowball sampling. The children's participation was completely voluntary. In addition to parental consent and participant assent, the only restrictive criterion for participation was having English as a first language.

Procedure. The procedure used in Experiment 2 was identical to the one used in Experiment 1 with a few modifications. During Phase 1, all participants were instructed to retrieve event memories from grades 1 to 3. The participants were given two extra word cues (*park, toy*) in addition to the twelve used in Experiment 1. And, rather than typing their responses into the computer themselves, the first author guided the children through all of the tasks and typed in their responses as directed by the children.

Results and Discussion

Before analyzing the data, they were reviewed for acceptable and unacceptable responses according to the same criteria given for what constitutes an event. As with Experiment 1, unacceptable and timed-out responses were discarded. No participants produced less than 50% of acceptable responses; so all 18 participants were retained in the analysis. In total, 16.4% of the responses were discarded and 83.6% retained, resulting in a total of 207 out of a possible 252 event pairs.

4th grade children reported event clusters for 57% of the recalled event pairs, while young adults recalling events containing a similar time interval (i.e., events from high school) reported 63%. The 4^{th} graders' cluster rates were slightly closer to young adults' recall of high school events (63%) than they were to adults' recall of events from grades 1 to 3 (51%). Given the 6% difference between both adult groups and 4^{th} graders, a non-significant one-way ANOVA was unsurprising ($F(1, 465)=0.56, MS_e=834, p>.05$ between 4^{th} grade children and adults recalling events from high school; $F(1, 463)=0.55$, $MS_e=834$, $p>.05$ between 4^{th} grade children and adults recalling events from grades 1 to 3).

To further investigate this ambiguous finding, two independent judges evaluated the event clusters as clustered or non-clustered according to the criteria given for what constitutes an event cluster (i.e., the two events must be causally related, nested, or part of a larger event). If two events could feasibly be clustered, they were coded as such. Conversely, if two events were clearly not clustered, they were coded as non-clustered. This provided a conservative estimate of non-clustered events. The concordance rate between the two judges was 83%. On average, 42% of the event pairs were judged as clustered. The 15% difference between children's reports (57%) and judges' reports (42%) indicated that the prevalence of event clusters reported by children might be inflated.

To investigate this possibility, we examined the event relations used by children and adults in Phase 3 of the event cueing paradigm. Table 1 compares the percentage of relations (conditionalized on clustered events) by 4th grade children recalling events from grades 1 to 3 and young adults recalling events from grades 1 to 3 and high school, respectively. Overall, the results suggest that children may not understand or interpret the task in the same way as adults.

Table 1.
Percentage of Event Relations between Clustered Pairs for 4th Grade Children Recalling Events from Grades 1 to 3 (Gr. 1-3) and Young Adults Recalling Events from Grades 1 to 3 and High School, Respectively.

	Cueing Event Periods		
	Adults (Gr. 1-3)	Adults (High School)	Children (Gr. 1-3)
Events within Same Year	67%	83%	75%
Feature Overlap[1]	89%	89%	95%
Same People	71%	72%	79%
Same Activity	51%**	51%**	68%
Same Location	47%***	46%***	74%
Causally Related	61%	59%*	70%
Nested	54%**	54%**	75%
Hierarchical	62%*	66%***	49%
Other	47%	44%	54%

[1]*Feature Overlap includes shared People, Activities, and Locations.*

*$p<.05$; **$p<.01$; ***$p<.001$

In comparison to adults, children relied on all three classes of feature overlap – people, activities, and locations; whereas adults predominantly used people as relational cues. Nonetheless, overall, children used feature similarity to a comparable degree as adults for relating clustered events, that is, 95% of the time as compared with 89% of adults recalling clustered events from high school ($\chi^2(1, N = 650) = 3.13, p > .05$) and 89% of adults recalling events from grades 1 to 3 ($\chi^2(1, N = 534) = 3.42, p > .05$). The only difference was that children relied on all three classes of similarity (people, activities, locations), while adults tended to use only one.

To begin, of the feature overlap relations, clustered events shared the same people most frequently by both children and adults. Children reported the same people in clustered pairs 79% of the time versus adults recalling high school events (72%, $\chi^2(1, N = 526) = 2.55, p > .05$) and adults recalling events from grades 1 to 3 (71%, $\chi^2(1, N = 433) = 2.64, p > .05$). Second, children reported more shared activities within event clusters (68%) than adults did from high school (51%, $\chi^2(1, N = 385) = 9.94, p < .01$) and grades 1 to 3 (51%, $\chi^2(1, N = 322) = 9.16, p < .01$), respectively. Lastly, children reported higher proportions of shared locations between clustered events (74%) than adults did from high school (46%, $\chi^2(1, N = 362) = 26.30, p < .001$) and grades 1 to 3 (47%, $\chi^2(1, N = 306) = 24.28, p < .001$).

More important to the examination of clustering rates were the relations used to determine an event cluster. First, children judged more events to be causally related (70%) than adults recalling events from high school (59%, χ²(1, *N* = 439) = 4.21, *p*<.05) and grades 1 to 3 (61%, $\chi^2(1, N = 372) = 2.92$, *p*>.05). Second, children tended to predominantly nest events within one another (75%), judging events to be a part of other related events much more frequently than adults recalling events from high school (54%, $\chi^2(1, N = 412) = 15.38$, *p*<.001) and grades 1 to 3 (54%, $\chi^2(1, N = 344) = 14.60$, *p*<.001), respectively. Finally, hierarchical relations showed the reverse pattern and were under-represented when compared to adults. Children judged 49% of related event pairs to belong to the same broader event, whereas adults considered 66% of the events from high school ($\chi^2(1, N = 459) = 9.34$, *p*<.01) and 62% of the events from grades 1 to 3 ($\chi^2(1, N = 359) = 5.59$, *p*<.05) to belong to the same broader event. The differential post-hoc judgments for relating event pairs may account for the inflated proportion of event clusters reported by children as compared with adult judges. Overall, children tended to relate clustered events more generally than adults.

Additionally, it is worth noting that there were no significant differences in children's and adults' judgments of time and other relations between clustered events. Children reported that 75% of the clustered events occurred within one year of each other as compared with 83% of events recalled by adults from high school ($\chi^2(1, N = 595) = 3.67$, *p*>.05) and 67% of events recalled from grades 1 to 3 ($\chi^2(1, N = 406) = 2.72$, *p*>.05). Further, children reported that 54% of the clustered event pairs were related in some other way (i.e., a way that was not listed in the relation menu). Similarly, 44% of clustered events recalled by adults from high school were judged to be related in some other way ($\chi^2(1, N = 329) =$

3.01, $p > .05$) and 47% of clustered events from grades 1 to 3 were judged to be related in some other way ($\chi^2(1, N = 285) = 1.56, p > .05$).

The percentage of direct retrievals for clustered events was comparable across children and adults. Children reported 63% of clustered events as being directly retrieved, whereas adults reported 69% from high school and 57% from grades 1 to 3, respectively. This further supports the possibility that direct retrieval may be a good index of event clustering across the lifespan.

Additionally, direct retrievals were retrieved faster than generative retrievals. Although children's back-transformed mean response times were greater than adults' and showed more variability, the pattern between direct (8.18 s, $SE = 0.05$) and generative retrieval (15.21 s, $SE = 0.22$) times remained constant ($t(205) = 15.12, p < 0.01$). This suggests that direct retrieval is implicated in the recall of event clusters regardless of age.

In sum, Experiment 2 found that children reported a comparable amount of event clusters (57%) as adults (63%) when event age was held constant. Additionally, children reported a similar proportion of event clusters (57%) as adults (51%) from the same time period (i.e., grades 1 to 3). Two adult judges indicated the opposite pattern – children's events were judged to be less clustered (42%) than adults' in both conditions. Further, children reported differential post-hoc judgments in relating event pairs than adults. This difference indicated that children may not have understood the relation-coding task in the same way as adults, and may have interpreted event relations differently than adults. This, in turn, may have inflated children's cluster rates.

Taken together, we suspect that the frequency of event clusters as they have been operationalized are, indeed, diminished in childhood as compared with adulthood. The implications of our findings for theories of autobiographical memory development and dealing with the limitations imposed by testing children are discussed next.

General Discussion

Experiment 1 replicated Brown's (2005) finding that events cluster less from childhood than high school. It also extended this finding by adding an intermediate condition as a comparison group (i.e., junior high school). There was no difference in the proportion of event clusters from junior high and high school, disconfirming the hypothesis that simple forgetting wholly accounts for the reduced proportion of event clusters in childhood. Experiment 2 found that 4^{th} grade children displayed comparable levels of clustering as adults when event age (1 to 3 year old events) and lifetime period (grades 1 to 3) were held constant. Further analyses by independent adult judges, as well as comparisons of child and adult interpretations of event relations, suggested that cluster rates were, in fact, reduced in childhood. Taken together, our results provide an unexpected finding – in comparison to adults, 4^{th} grade children retrieve event clusters less frequently, yet judge events as being clustered more frequently.

There is an alternate explanation than the one we have proposed which could account for the observed reduction in clustering (Experiment 1), as well as the comparable prevalence of event clusters recalled by children (Experiment 2). Event clusters may be just as common in childhood as they are in adulthood. It may be that events cluster regardless of age and subsequently lose their inter-event cohesion with the passage of time. That is, events may initially be encoded and stored within event clusters. However, inter-event relations may get weaker with time, resulting in higher frequencies of isolated, non-clustered, remote events. Examining the cluster rates of older adults recalling events from high school could test this possibility. If the cluster rates were reduced when recalled from later adulthood, it would provide support for this explanation. However, our results fail to support this possibility. For one, since the junior high and high school clustering rates were comparable, it suggests that inter-event cohesion does not diminish over time. Further, the evaluations made by the independent adult judges indicate that children cluster events less than adults, and less than children report. Finally, a comparison of the Phase 3 event relations suggests that children and adults use different criteria for relating events. If event clusters disintegrate over time, these lines of evidence would be difficult to explain.

Another important consideration for interpreting the results of this study is the fact that it has been based on a priori assumptions about the types of relations that exist between clustered events. Granted, there may be other types of relations, as well. The finding that the direct retrieval of clustered events is consistent across various time periods suggests that direct retrieval may be a better index of event clustering. This could be explored by adopting a process-approach to the investigation event clusters. By conditionalizing on direct retrievals, the qualities and relations between clustered events could be determined without a priori assumptions and operational limitations. This is left to future research.

There are several limitations that should be heeded when interpreting the results of this study. One is the degree to which we can trust children's self-reports. Not only do demand characteristics, such as desirable responding, threaten the validity of any research, the sample size in Experiment 2 was less than ideal. More critically, however, the event cueing paradigm relies on participant's post-hoc judgments to determine cluster status. Because children may not understand the task in the same way as adults, and their interpretations of event relations may not be comparable, it is difficult to draw definitive conclusions about the prevalence of cluster rates in children. Given that adults may understand the task and judge event relations differently than children, it is a challenge to determine which judgments to trust. If viewed from the perspective of adult evaluations, event clusters are not yet fully established in middle childhood. If viewed from the perspective of children's judgments, event clusters are comparable in childhood and adulthood. It would be helpful for future research to investigate whether blind judgments of adult clustermates also decrease. Nonetheless, because it is believed that children's cognitive abilities develop over time and because science is based on adult evaluations of truth, we tentatively base our conclusions on the judgments of adults. We conclude that children understand and interpret event relations differently than adults, and that event clusters as they have been operationalized are reduced in childhood as compared with adulthood.

Our findings suggest several ways in which event clusters might impact the development of autobiographical memory. Regardless of whether event clusters are adequately determined by the types of relations suggested, several insights may be gained from the differences observed between children's and adults' post-hoc relational judgments. These differences suggest that autobiographical memory is not fully formed by middle childhood.

First, 4th grade children appear to over-generalize event relations. For example, the finding that children use all three classes of feature overlap for relating events (i.e., people, activities, locations) may be explained by a developmental shift that occurs in conceptual classification. Denney (1974) found that children between the ages of 6 to 9 shift from making complementary categorizations (i.e., categorizing things according to functions or themes) to making similarity-based categorizations that remain stable into adulthood. This (over) dependence on similarity features may be an artifact of the developmental shift that occurs at this stage, as well as overgeneralizations that are typical in the categorical learning process, such as overgeneralizations of word meanings in language acquisition (Clark, 1973). This implies that event relations are not understood in the same way, or are as stable, as they are in adulthood.

Second, the differences between children's and adults' event relations may comment on the ways event clusters are formed. It may be that the formation of event clusters is not restricted to associations demonstrated when people are prompted for a related event (e.g., the cued events in Phase 2), but may also be influenced by post-hoc judgments (e.g., explicit relational judgments made between event pairs in Phase 3). This dual process may be implicated in the formation of narratives, in general, including event clusters, event narratives, self narratives, and life narratives.

Third, an unexpected finding that has implications for theories of cognitive development is the degree to which children considered events to be a part of other events. The majority of events were considered to be a part of one another, while there was a relative paucity of hierarchical relations between events. For example, one event pair included, *going to the Valley Zoo with my class* and *seeing the monkeys at the zoo*. While the two events were judged as being a part of each other, they were not considered to be a part of a single, broader event, such as *a school fieldtrip*. This may be similar to children's categorical thinking. Children tend to consider category names at a single level of classification. For example, *bird* and *duck* are often considered to be contrastive classes, rather than superordinate-subordinate classes (Murphy, 2002).

This finding is particularly interesting in light of the developmental literature that suggests coherence in self narratives is not fully established until adolescence (Habermas & Bluck, 2000; Habermas & de Silveira, 2008). Narrative coherence is derived from two types of relations: (1) relations between individual parts, and (2) relations between each part and the whole (Linde, 1993). Our results may disentangle what is happening in the formation of narrative coherence abilities. Children of 9 to 10 years of age appear to liberally relate one event to another, seeing connections between several disparate parts.

However, children of this age still seem unable to fully conceive of events as being a part of a single broader event; that is, of relating individual parts to the whole. This may be the next step for establishing coherence in the self narratives observed in adolescence.

Overall, event clusters provide insight into the development of autobiographical memory. As narrative-like memory structures, event clusters may be contemporaneous components of the narratives found in autobiographical memory. Further, the formation of event clusters, and hence, narratives, may depend on a dual process. One may be associative (as in the retrieval of related event memories), the other rule-based (as observed in post hoc evaluations of event relations). In the end, we surmise that children cluster events to a lesser degree than adults, and that event clusters are an accomplishment in the development of autobiographical memory.

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