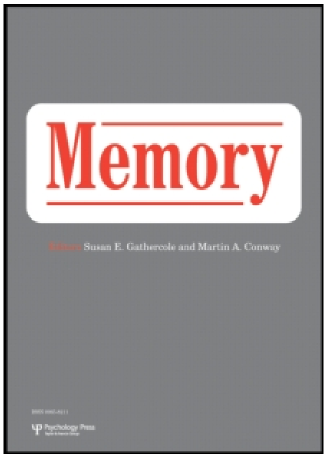

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Children's memory for complex autobiographical events: Does spacing of repeated instances matter?

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Children's memory for complex autobiographical events: Does spacing of repeated instances matter?

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Often, when children testify in court they do so as victims of a repeated offence and must report details of an instance of the offence. One factor that may influence children's ability to succeed in this task concerns the temporal distance between presentations of the repeated event. Indeed, there is a substantial amount of literature on the ''spacing effect'' that suggests this may be the case. In the current research, we examined the effect of temporal spacing on memory reports for complex autobiographical events. Children participated in one or four play sessions presented at different intervals. Later, children were suggestively questioned, and then participated in a memory test. Superior recall of distributed events (a spacing effect) was found when the delay to test was 1 day (Experiment 1) but there was little evidence for a spacing effect when the delay was 1 week (Experiment 2). Implications for understanding children's recall of repeated autobiographical events are discussed.

When children testify in court they often do so as alleged victims of a repeated offence. Legally, children may be required to report details of one instance from a series of many similar instances in order to provide the defendant with enough particular information to raise a defence—e.g., the specificity principle, affirmed in *R.* v. *B.(G.)*, 1990. For children who experience several similar versions of an event, the task of accurately attributing details to a particular occurrence is cognitively challenging (Connolly & Price, 2006; Powell & Roberts, 2002). However, the extant repeat event research has inconsistently varied the temporal distance between repeated instances, which leads to the question of whether the differential spacing of repeated instances will similarly influence repeat event children's recall. In the present research, we explored children's memory for a unique event versus an instance of a repeat event in which the temporal distance between instances of the repeat event varied.

THE SPACING EFFECT

We are unaware of any research that has specifically investigated the effect of the temporal distance between instances of a repeated event on children's memory for a particular instance. However, there is research on the spacing effect with other stimuli (e.g., word lists, Braun & Rubin, 1998; Greene, 1989; foreign language vocabulary, Bahrick & Phelps, 1987). Generally, memory for repeatedly presented stimuli is superior if repetitions are distributed (i.e., greater temporal distance) rather than massed (i.e., smaller temporal distance). Although some research has explored the spacing effect with

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children (Rea & Modigliani, 1987; Toppino, 1991; Toppino & DeMesquita, 1984) and found similar patterns of learning, the focus has been on list-like presentations of pictures, words, or facts, not personal events.

As the most obvious theoretical framework through which to explore the effect on memory of varying temporal spacing of repeated instances, the spacing effect literature is discussed here. However, as detailed in the discussion, there are methodological differences in studies of the spacing effect and studies of children's memory for repeated complex autobiographical events that may qualify the application of the former to the latter. Despite these limitations, there are important concepts that can be derived from the spacing literature and examined in the context of children's memory for repeated events. Specifically, there are two broad classes of theories that are most commonly called upon to explain the spacing effect: encoding (or contextual) variability theories and diminished (or deficient) processing theories.

Encoding variability theories contend that a larger temporal spacing between repeated presentations of the same material leads to a greater opportunity for encountering different encoding conditions, and thus a higher probability that the material can be recalled under a variety of retrieval contexts. An example of this is Bellezza and Young's (1989) chunking hypothesis which assumes that, in addition to the requirement that subsequent presentations of information retrieve the memory code of the previous presentations, the encoding context of the subsequent presentation must be sufficiently different (i.e., encoding variability) from the previous presentations so that it not only retrieves but also expands the previous memory codes (i.e., the codes are "chunked" together). One way in which encoding can be varied is by increasing the time between presentations (Bellezza & Young, 1989), thus leading to a spacing effect. The chunking hypothesis is based on the assumption that information that is identified as *similar* but not *identical* is compiled to form one memory code (what Bellezza and Young refer to as a "composite code"). The chunking hypothesis may also apply to strongly related information, rather than only to the repetition of the same information in different contexts. If this is the case, as long as two presentations are recognised as highly similar and a composite code can be developed, the spacing effect should apply. Importantly, the magnitude of the spacing effect may depend on the delay between the presentation of the stimuli and recall. According to encoding variability theory, massed presentation will enhance recall at short retention intervals because the recall context will be highly similar to the encoding contexts (which themselves will be highly similar to one another; see Pavlik & Anderson, 2005). However, because massed presentation involves highly similar encoding contexts, at a longer retention interval the recall context will vary from the encoding contexts, thus making recall more difficult than with distributed presentation. Conversely, distributed presentation allows for exposure to more diverse contexts, which allows for better recall of the stimuli, even after a substantial delay. Therefore, the relative success of massed versus distributed presentation (i.e., superior recall of distributed presentation) should be enhanced at a longer delay to recall.

Diminished processing theories assert that with repeatedly presented stimuli, subsequent presentations receive less attention than early presentations if presented at short intervals, while this effect is less pronounced, or absent, at longer intervals. An example of such a theory is offered by Jacoby (1978; Cuddy & Jacoby, 1982) who likens encoding to problem solving. The first time a problem is presented, the level of processing required is likely to be extensive. If the same problem is presented again, the level of processing required to reach the same solution will be reduced. The greater the period of time between two presentations of the same problem, the more extensive the processing required to solve the problem the second time because the ability to rely on memory of the previous solution to solve the current problem is reduced (or absent). Extended to the processing of stimuli, as retention between presentations increases, the level of processing required to encode the second presentation of an item or to retrieve what is recalled from the first presentation also increases. The increased level of processing should lead to a stronger memory—that is, a spacing effect. Diminished processing theories predict that with minimal processing between massed presentations of stimuli and the resulting poorer recall of the stimuli compared to distributed presentations, memory should decay for the stimuli relatively quickly (Cuddy & Jacoby, 1982). Therefore, similar to encoding variability theory, the poor recall ability after massed presentation is enhanced at a longer delay to recall.

REPEATED EVENTS

Using particular measures of memory strength (reports of experienced and non-experienced details) empirical research has demonstrated that instances of repeated events are recalled differently from unique events (e.g., Hudson, 1990). The suggestibility paradigm is often employed in the study of children's memory, specifically regarding forensic applications. Generally, this paradigm involves three phases: presentation of a target (to-be-remembered) event, presentation of erroneous suggestions, and a memory test (Bruck & Ceci, 1999). A suggestibility effect is observed when children report that suggested details occurred during the target event. It has been frequently demonstrated that, under particular circumstances, children will incorporate information that they have only heard into reports of their experiences (Bruck & Ceci, 1999; Ceci & Bruck, 1993). The *memory trace strength theory* proposes that weaker memories are more susceptible to suggestions than stronger memories (e.g., Pezdek & Roe, 1995). This implies that the size of the suggestibility effect can help to inform us about the strength of a memory trace. However, this theory has only been tested with memory for unique events; it may not apply to memory for repeated events. Research examining the effect of repeated experience on children's suggestibility for particular kinds of information has produced differing results. Three studies have reported a heightened suggestibility effect for variable details in children who repeatedly experienced an event compared to children who experienced an event once (Connolly & Lindsay, 2001; Connolly & Price, 2006; Price & Connolly, 2004). Others have reported inconsistent effects (e.g., Powell & Roberts, 2002; Powell, Roberts, Ceci, & Hembrooke, 1999).

In addition to suggestibility, children's repeated-event memory research usually includes two other measures of recall. First, children's reports of details that occurred during the target instance are, of course, correct responses that are indicative of clear memory for a target instance. Generally, children report more correct details after experiencing an event once than if it is one in a series of several similar events (e.g., Connolly & Price, 2006), perhaps because there is less interference from the other similar instances. Second, children's reports of details that were experienced during the sequence of similar events, but not in the target instance, are coded as internal intrusion errors. Internal intrusion errors are evidence of confusion between instances, and thus strong memory for the target instance should lead to reports of fewer internal intrusions. Experimental explorations of children's recall of an instance of a repeat event consistently find that children are more precisely accurate when recalling a single event than an instance of a repeat event, although many of the errors made by children in repeat event conditions are internal intrusion errors (e.g., Connolly & Lindsay, 2001; Powell & Roberts, 2002; Powell et al., 1999; Price & Connolly, 2004).

At least two theories, script theory and fuzzy-trace theory, also support the contention that memory of an instance of a repeat event differs from that of a single event. Script theory asserts that, with repeated experience, a cognitive representation of what typically occurs leads to expectations of what will transpire in the future (Nelson, 1986). This general representation, or script, has been used to explain the oft-cited phenomenon that individual instances of a repeat event are difficult to access. Very few events recur in exactly the same way: some details change across instances. Sometimes, the change is predictable, as with the food you order at a restaurant. Details that vary in a predictable way are called "variable details". Variable details are said to be represented as dynamic list-like sets of experienced options that are not tightly associated with any one instance, and that provide expectations about what will occur in the future (Fivush, 1984). New details that are consistent with expectations (i.e., script-consistent) are easily integrated into this "list". Thus, compared to children who experience an event once, there should be heightened suggestibility for variable details that are script consistent (e.g., ordering food at a restaurant) among children who experience several similar instances of the event. Further, over time memory becomes more script-like (e.g., Myles-Worsley, Cromer, & Dodd, 1986). This means that the longer the retention interval from an event to recall, the more likely a rememberer is to report general details of an event rather than specific instance details, which should also lead to greater suggestibility for plausible details, fewer reports of correct instance details, and more frequent reports of internal intrusion errors.

Fuzzy-trace theory may also be used to explain the findings that memory for instances of repeat events is different from memory for unique events. According to fuzzy-trace theory (e.g., Brainerd & Reyna, 2002; Reyna, Holliday, & Marche, 2002), two independent memory traces are formed each time an event is encountered: A verbatim trace that contains the precise details of the event and a gist trace that contains the general meaning of the event. When several similar instances of an event are encountered, each individual experience will lay a unique verbatim trace but each will also activate the same gist trace. This leads to gist memory that is relatively stronger than any of the individual verbatim traces and so is more likely to be retrieved during subsequent interviews about the target event. Moreover, verbatim memory fades more quickly than gist memory (Brainerd & Reyna, 1998). Hence, memory for the particular details of individual instances of a repeat event will be more difficult to access than memory for the gist of the event, particularly after a delay. Conversely when experiences are encountered once, the consequent gist memory will be correspondingly weaker than when events are encountered repeatedly and, thus, less likely to be retrieved during post-event interviews. If, during a suggestive interview and subsequent recall test, participants access verbatim memory for the target event, then they have all of the information needed to reject the suggestion and to report experienced details, even if suggestions are gist consistent. However, if gist memory is retrieved, as is more likely to be the case after a delay and when an event is repeated (compared to unique), suggestions that are gist consistent may be readily accepted as plausible. Thus, the result will be heightened suggestibility and poorer recall of target details, for instance of repeat events compared to unique events, especially after a delay.

REPEATED EVENTS AND THE SPACING EFFECT

The above explanations for the spacing effect may help us to predict children's recall of an instance of a repeated event that is presented in a massed or distributed fashion. When each individual instance is encountered, previous instances are also activated, which should result in the formation of a composite code. The spacing condition that promotes the development of a stronger composite code should evince more correct recall, fewer internal intrusion errors, and a greater suggestibility effect because suggestions, at least those that are gist consistent, can be integrated into the composite code easily (for a similar argument see Connolly & Price, 2006).

Importantly, these effects may vary depending on the time delay between the presentation of the target instance and recall. As mentioned above, according to both script theory and fuzzy trace theory as well as some other autobiographical memory work (e.g., Brewer, 1986; Fivush, 1997; Hudson & Nelson, 1983; Myles-Worsley et al., 1986), memory becomes more general and less specific over time. This may be particularly so in recall of instances of repeated events; Powell and Thomson (1997) found that memory for a single event declines at a slower rate than memory for an instance of a repeated event. Accordingly, when studying memory for instances of repeated events after a delay, memory for target instance details may become more difficult to retrieve and as such unavailable either to provide correct information or to reject suggestions. This could occur regardless of whether the instances are presented in a massed or distributed fashion. In other words, for repeated autobiographical events, the benefits attributable to the distributed spacing of instances may diminish or disappear over time.

Conversely, expectations developed from the spacing literature on the influence of retention interval on recall predict precisely the opposite pattern of recall. As reviewed above, both diminished processing and encoding variability theories predict that the spacing effect will be enhanced after long retention intervals, meaning that the advantage of distributed over massed presentation would actually increase over time. However, an important consideration is that much of the previous work (including the works cited here) on the spacing effect has been based on a delay to recall of no more than a few minutes. This represents a particular difficulty for the present research when one considers that most of the research on children's recall of an instance of a repeated event has involved delays of days to weeks (e.g., Connolly & Price, 2006; Powell & Roberts, 2002). However, there is other spacing-related research that has explored longer delays (see Bahrick, 2000), and found that the spacing effect is enhanced when recall tests are delayed over a long period (up to many years).

THE PRESENT RESEARCH

In the present research we manipulated the spacing of repeated instances to examine children's recall of an instance of a repeat event compared to a unique event. In Experiment 1, children participated in a single play session, four play sessions in 1 day, or four play sessions in 4 days, and were interviewed 1 day later about the target session. We selected a 1-day delay to recall to allow for a balance between the most common spacing-literature delays (minutes) and the repeated event literature delays (days to weeks). Spacing theories suggest that a longer delay to recall provides a greater opportunity to observe a spacing effect (Bahrick, 2000) and we wanted to maximise the chance of finding a spacing effect, if one was present. With a delay from target instance to recall of 1 day, we anticipated that a spacing effect would be observed such that children in the distributed condition would be more accurate, more suggestible, and less likely to confuse details across instances than children in the massed condition. In Experiment 2, we explored the boundaries of the spacing effect by adding an additional spacing condition (four sessions in 10 days) and increasing the delay to recall to 1 week.

EXPERIMENT 1

Method

Participants. A total of 45 children (aged 7–8 years, $M = 7.82$ years, $SD = 0.78$ years) were recruited from university science camps. Children were enrolled in the camp for 1 week at a time. Each week of the camp was randomly assigned to one play session, four play sessions in 1 day, or four play sessions in 4 days (equal *n*s per condition). Age and gender distributions were equal in all conditions ($ps > .60$).

Children aged 7–8 years were selected for participation based on the finding from a prior study indicating that older children may be better able to recognise the relationship between similar experiences than younger children (6–7- versus 4–5-year-olds; Connolly & Price, 2006), a skill likely required for the formation of a composite code across multiple experiences.

Design and procedure. The study was a 3 (sessions: single, 4-in-1 day, 4-in-4 days) $\times 2$ (details: suggested, control) mixed factorial design, with sessions manipulated between subjects and details a within-subjects factor.

Play sessions. Play sessions were conducted by the same male experimenter and with all children registered in the camp each week (20–25 children per week). Each play session was approximately 15 minutes in duration and involved four activities, each with two critical details, for a total of eight critical details. For each critical detail in the repeat event condition a different "option" (i.e., way the critical detail was presented) was presented during each of the four play sessions (options are presented below in parentheses). For each critical detail there were five categorically linked options (where appropriate, we used category members from Price & Connolly, in press), four that would be presented across the four play sessions, and one that served as a suggested/control detail (see Table 1 for a sample set of options). The order of the four activities was the same each day: play a pretend game (baseball, tennis, soccer, hockey, or bowling) while the experimenter wore a special nametag and asked the children to call him by that name during the play session (Jesse, Pat, Alex, Ricky, or Dale); colour a sticker (car, aeroplane, truck, motorcycle, or scooter) while thinking of a special

TABLE 1
Activities and variable details presented to half of the children

	1	*2*	*3*	*4*	*5*
1. Pretend game	Baseball	Tennis	Soccer	Hockey	Bowling
2. Special nametag	Jessie	Pat	Alex	Ricky	Dale
3. Colour a sticker	Car	Aeroplane	Truck	Motorcycle	Scooter
4. Think about	Red	Green	Orange	Purple	Pink
5. Draw a picture	House	Shack	Cottage	Apartment	Cave
6. Lucky number	2	4	10	3	5
7. Hide under a cup	$20.00	$10,000	$1.00	$100.00	$10.00
8. Decorate	Foggy	Clear	Lightning	Windy	Sunny

colour (red, green, orange, purple, or pink); draw a picture (house, shack, cottage, apartment, or cave) while the experimenter held a lucky number (2, 4, 10, 3, or 5); and find something hidden under one of three cups ($20, $10,000, $1, $100, or $10) while the experimenter decorated the room with a picture of weather (fog, clear, lightning, wind, or sun). The experimenter brought each critical detail to the attention of the children by repeatedly naming each option. The target (to-be-remembered) session was identical across conditions and was the final session for the repeat-event children and the only session for the single-event children. The target session was distinguished by having the experimenter wear a silly moustache.

The critical details were partially counterbalanced; half of the children in each session's condition received one of two random orders of options and suggested details. Table 1 presents a list of activities (two successive cells in the first column represent an activity) and associated options (columns labelled 1 to 5). Referring to the top row of Table 1, half of the repeat-event children experienced details 1, 2, 3, and 4 on days 1, 2, 3, and 4 and, for details assigned to be suggestive, were biased with detail 5. The remaining children experienced details 4, 1, 5, and 2 on days 1, 2, 3, and 4, and were biased with detail 3.

Biasing interview. Only children with parental permission participated in the interviews. The biasing interview was conducted with each child individually on the morning of the day after the target session. The interviewer (one of three trained individuals blind to the children's condition) began by establishing rapport with the child and explaining that s/he wanted to learn what happened during ''Moustache Playtime'' because s/he was not there. Once the target instance was identified (i.e., the child accurately described the silly moustache) and the child appeared to understand that all questions concerned that instance only, the interviewer continued with a scripted set of questions. Children were asked one question about each of the eight critical details. Questions were grouped by activity and asked in the activity order experienced during the play session. One question from each pair was a control question; the other was a suggestive question. The suggested/control variable was counterbalanced such that each detail served as a suggested detail for half of the children and a control detail for the other children. Each pair of questions was introduced with a reminder of the target activity and was followed by three presentations of each suggestion, once or twice in the reminder of the activity and the remaining presentation(s) in the question itself. The suggestions were details the children had not experienced during any of the play sessions, and were embedded in questions that did not require the child to acquiesce to the suggestion in order to answer (e.g., ''During Moustache Playtime you pretended that you were bowling. I really like to go bowling, do you?''). The control question did not present any specific information about the target detail (e.g., ''During Moustache Playtime, you pretended that you were something unusual. Do you like to play pretend games?'').

Final interview. After a minimum 2-hour delay, children participated in a final memory interview. The three persons who conducted these interviews also conducted the biasing interviews, but no child received the same interviewer for both interviews. Procedures for rapport building and identification of the target session were the same as those used in the biasing interview. The interview began with free recall wherein children were asked to recall everything they could about what happened during ''Moustache Playtime''. Next, three non-directive prompts were asked (e.g., ''Can you tell me anything else about Moustache Playtime?''). Then the interviewer named the four activities in the order experienced by the child and asked the child what s/he could recall about each activity. One non-directive prompt followed each child's response (i.e., ''What else can you tell me about that?'').

The interview then progressed to cued recall. The interviewer reminded the child that s/he did not know what took place during ''Moustache Playtime'' and wanted to understand what happened. Children were told that it was okay to say ''I don't know'' if they did not know the answer to a question. They were also told that they may be asked questions about things that they had already discussed, and that this did not mean that they were wrong the first time, the interviewer simply had to ask all of the questions on the sheet. Cued recall comprised eight direct questions, one for each critical detail (e.g., ''What did you pretend to be during Moustache Playtime?''). All questions were asked in the same order as the activities were experienced.

Final interviews were transcribed and responses were coded into one of three responses:

1. Correct response: experienced critical detail.
2. False suggestion: reported detail was a suggested detail.
3. Internal intrusion error: detail was experienced, but not in the target session.

If a child reported more than one detail for a single activity and was unable to narrow it down to the detail experienced on the target day, each response was coded independently. For example, if a child said that he played a pretend game of bowling and hockey, and bowling was experienced on the target day, while hockey was experienced on a non-target day, the child would be scored as having reported one correct response and one internal intrusion. Thus, there is not a consistent denominator for the number of total possible responses. Intercoder agreement was 89.9%, based on coding 10% of transcripts. We have focused on coding only critical details because the vast majority of children's comments in free recall were related to the critical details, and also so that we are assured knowledge of baseline accuracy of the coded details.

Results

Free and cued recall analyses. Correct responses were analysed with a 3 (sessions) $\times 2$ (details) analysis of variance (ANOVA) for free and cued recall responses separately. When children report a suggested detail to a question about a detail for which no suggestion had been presented (i.e., a control item) the response reflects the likelihood of guessing a suggested detail. Given that, in the present research, there was an extremely low level of such guessing (see Table 2) and the resulting cell means for control items is extremely low, we analysed suggested responses with a one-way (sessions) ANOVA. Internal intrusions in the single-event condition reflect mere guessing, and as can be seen in Table 2, guessing did not occur with notable frequency. As such, internal intrusions in the single-event condition are not analysed. All tests were two-tailed and alpha levels were set to .05. Descriptive statistics for all responses are provided in Table 2.

Correct responses. In free recall, there was a main effect of sessions, $F(2, 42) = 11.11$, $p < .001$, $\eta^2 = .35$: LSD (least significant difference) post hoc tests indicated that children in the single-event condition reported more correct responses

TABLE 2
Means (SD) of free and cued recall responses in Experiment 1

		Single	*4-in-1 day*	*4-in-4 days*
Free recall				
Correct	Suggested	2.20 (0.86)	0.80 (0.78)	1.00 (0.85)
	Control	2.00 (1.00)	0.73 (1.10)	1.47 (1.06)
Suggestion	Suggested	0.13 (0.52)	0.13 (0.35)	0.53 (0.99)
	Control	0.00 (0.00)	0.07 (0.26)	0.00 (0.00)
Internal	Suggested	0.00 (0.00)	1.07 (0.80)	0.27 (0.80)
intrusion	Control	0.07 (0.26)	1.20 (1.08)	0.33 (0.72)
Cued recall				
Correct	Suggested	2.80 (0.41)	0.93 (1.03)	1.67 (1.29)
	Control	2.60 (0.91)	1.00 (0.93)	2.07 (0.88)
Suggestion	Suggested	0.20 (0.56)	0.33 (0.62)	1.13 (1.06)
	Control	0.00 (0.00)	0.20 (0.41)	0.07 (0.26)
Internal	Suggested	0.00 (0.00)	1.40 (1.06)	0.27 (0.46)
intrusion	Control	0.00 (0.00)	1.87 (0.99)	1.00 (0.93)

($M = 4.20$, $SD = 1.66$) than children in the 4-in-4 days ($M = 2.47$, $SD = 1.46$) and 4-in-1 day ($M = 1.53$, $SD = 1.60$) conditions. No other differences were significant. In cued recall, there was a main effect of sessions, $F(2, 42) = 23.83$, $p < .001$, $\eta^2 = .53$. LSD probes indicated that children in the single-event condition reported the most correct details ($M = 5.40$, $SD = 1.12$), followed by children in the 4-in-4 days ($M = 3.73$, $SD = 1.49$), and 4-in-1 day conditions ($M = 1.93$, $SD = 1.49$). All pairwise comparisons in cued recall were significant.

False suggestions. In free recall, no effects were significant. In cued recall, there was a main effect of sessions, $F(2, 42) = 5.72$, $p < .001$, $\eta^2 = .21$ (Figure 1). LSD post hoc tests indicated that children in the 4-in-4 days condition reported significantly more false suggestions ($M = 1.20$, $SD = 1.08$) than children in the 4-in-1 day condition ($M = 0.53$, $SD = 0.74$) and children in the

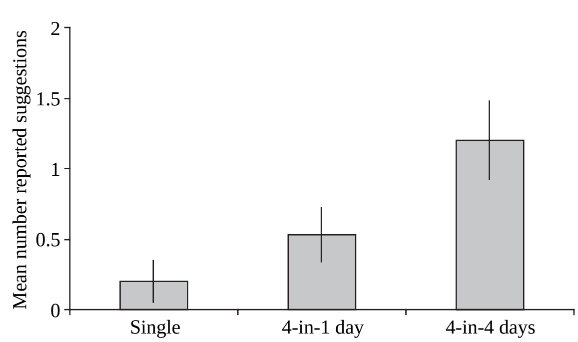

Figure 1. Mean number of suggested responses in cued recall as a function of event spacing in Experiment 1. Error bars show one standard error above the mean.

single-event condition ($M = 0.20$, $SD = 0.56$). No other comparisons were significant.

Internal intrusion. In free recall, there was a main effect of sessions, $F(1, 28) = 9.33$, $p < .01$, $\eta^2 = .25$: children in the 4-in-1 day condition reported more internal intrusions ($M = 2.27$, $SD = 1.62$) than children in the 4-in-4 days condition ($M = 0.60$, $SD = 1.35$). In cued recall, there was an effect of details, $F(1, 28) = 12.26$, $p < .01$, $\eta^2 = .31$; children reported more internal intrusions to control ($M = 0.83$, $SD = 0.99$) than suggested ($M = 1.43$, $SD = 1.04$) details. There was also an effect of sessions, $F(1, 28) = 13.15$, $p < .01$, $\eta^2 = .32$; children in the 4-in-1 day condition reported more internal intrusion errors ($M = 3.27$, $SD = 1.83$) than children in the 4-in-4 days condition ($M = 1.27$, $SD = 1.10$).

Discussion

If the spacing effect applies to memory for repeatedly experienced complex autobiographical events, we anticipated that children would report more correct and suggested details, and fewer internal intrusion errors when the events were more distributed in time. Children's responses were consistent with a spacing effect. In cued recall, when comparing repeat event conditions, children in the 4-in-4 days condition reported more correct information than children in the 4-in-1 day condition. Children who experienced only a single event reported significantly more correct information than children in either repeat event condition. This latter finding is consistent with the expectation that single-event children would best recall the target event (e.g., Connolly & Price, 2006; Nelson, 1986; Powell & Roberts, 2002). Children were also most suggestible when they had experienced repeated distributed events (4-in-4 days) than massed events (4-in-1 day). Thus, we found support for our hypothesis that a more distributed presentation of *highly similar* events provides a greater opportunity for the detection of similarity between experienced instances, and thus, the development of a composite code. Finally, children in the 4-in-4 days condition also reported significantly fewer internal intrusions than children in the 4-in-1 day condition. This indicates that children in the massed condition were more confused as to what occurred during the target instance than children in the distributed condition.

Given that there was clear evidence for a spacing effect in complex autobiographical events in Experiment 1, we were interested in further exploring the boundaries of the spacing effect in two ways. First, we added an even more distributed spacing condition (4-in-10 days) to the conditions from Experiment 1. Verkoeijen, Rikers, and Schmidt (2005) caution that, although some forgetting between repeated presentations of information is essential to many explanations of the spacing effect (e.g., due to the extra processing required; Cuddy & Jacoby, 1982), once the spacing between presentation reaches a certain distribution the forgetting may be so great that larger spacing is no longer a benefit, but rather an impediment. That is, the spacing effect may only apply until a certain point, at which time recall of widely distributed information should be no better than information presented in a more massed fashion. It has been suggested that extending the delay from the last presentation of stimuli to recall may in fact have a similar impact as distributed spacing of repeated instances (i.e., improve recall; see Cuddy & Jacoby, 1982). Thus, in Experiment 2 we also extended the delay from target instance to recall from 1 day to 1 week. We implemented the extended delay to explore further the boundaries of the spacing effect and also to examine whether or not a spacing effect could be found after a delay that is more comparable to that used in the study of repeated autobiographical events. As discussed in the introduction, the autobiographical memory literature and the spacing effect literature predict opposite patterns of findings with an extended delay to recall. Autobiographical memory work predicts that memory becomes more general over time, and thus memory for target instance details will be more difficult to recall after a delay. On the other hand, the spacing literature predicts that a long delay will enhance the spacing effect and memory for the target instance will improve. Because there is little empirical guidance to predict the relative influence of the spacing effect versus the generalisation of autobiographical memory over time, we did not develop specific hypotheses for Experiment 2.

EXPERIMENT 2

Method

Participants. A total of 77 children (aged 7–8 years, $M = 7.82$ years, $SD = 0.61$ years) were recruited from classes in private elementary schools in the Vancouver area of British Columbia. Each class of children was randomly assigned to engage in either one play session ($N = 20$), four play sessions in 1 day ($N = 20$), four play sessions in 4 days ($N = 18$), or four play sessions in 10 days ($N = 19$). Unfortunately, due to last-minute scheduling challenges, ages were not equal in all conditions in this experiment, $F(3, 62) = 34.08$, $p < .05$ (some ages were not provided), although no average difference between conditions was greater than 1 year. Post hoc LSD probes indicated that single-event children and children in the 4-in-4 days condition were younger than 4-in-1 day and 4-in-10 days children (single event: $M = 7.46$ years, $SD = 0.54$; 4-in-4 days: $M = 7.25$, $SD = 0.27$; 4-in-1 day: $M = 8.39$, $SD = 0.30$; 4-in-10 days: $M = 8.17$, $SD = 0.28$). No other differences were statistically significant. Gender distribution was equal in all conditions ($p = .89$).

Design and procedure. The study was a 4 (sessions: single, 4-in-1 day, 4-in-4 days, 4-in-10 days) $\times 2$ (details: suggested, control) mixed factorial design, with sessions manipulated between subjects and details manipulated within subjects. Play sessions, biasing, and final interviews were all conducted as in Experiment 1, with three exceptions. First, instead of referring to the target session as ''Moustache Playtime'', the play session leader (a female in Exp. 2) wore a special bowtie and the target session was called ''Bowtie Playtime''. Second, a fourth spacing condition was added in which children participated in four play sessions over the course of 10 days. Finally, the timing of the interviews differed from Experiment 1. In Experiment 2, children participated in a biasing interview 1 week after the final (or only) play session. One day later, children participated in a final interview. Interviews were coded with the same protocol as Experiment 1.

Results

Free and cued recall analyses. Correct responses were analysed with a 4 (sessions) $\times 2$ (details) ANOVA for both free and cued recall. For reasons described in Experiment 1 (and see Table 3 for descriptive statistics), children's false suggestions were analysed with a one-way (sessions) ANOVA and single-event children were excluded from the analyses of internal intrusion errors. All tests were two-tailed and alpha levels were set to .05. Because of the significant age differences between some spacing conditions, we also ran analyses with age as a covariate. The results from the ANCOVAs did not change any of the conclusions in the present study, so the ANOVA results are reported here.

Correct responses. In free recall, there was a main effect of sessions, $F(3, 73) = 14.58$, $p < .001$, $\eta^2 = .38$: LSD post hoc tests indicated that children in the single-event condition reported

TABLE 3
Means (SD) of free and cued recall responses in Experiment 2

		Single	*4-in-1 day*	*4-in-4 days*	*4-in-10 days*
Free recall					
Correct	Suggested	1.25 (0.85)	0.45 (0.61)	0.06 (0.24)	0.11 (0.32)
	Control	0.95 (0.89)	0.40 (0.50)	0.33 (0.49)	0.32 (0.67)
Suggestion	Suggested	0.40 (0.82)	0.45 (0.61)	0.72 (0.90)	0.37 (0.60)
	Control	0.05 (0.22)	0.05 (0.22)	0.06 (0.24)	0.00 (0.00)
Internal intrusion	Suggested	0.05 (0.22)	0.85 (0.93)	0.72 (0.75)	0.26 (0.65)
	Control	0.00 (0.00)	0.90 (1.17)	0.61 (0.78)	0.37 (0.50)
Cued recall					
Correct	Suggested	1.65 (1.23)	0.95 (1.00)	0.33 (0.49)	0.42 (0.69)
	Control	1.80 (0.89)	1.10 (0.91)	0.72 (0.67)	1.26 (1.20)
Suggestion	Suggested	0.60 (1.00)	1.20 (1.01)	1.50 (1.04)	1.37 (1.21)
	Control	0.00 (0.00)	0.05 (0.22)	0.11 (0.47)	0.00 (0.00)
Internal intrusion	Suggested	0.15 (0.37)	1.50 (1.57)	1.39 (1.20)	0.74 (0.93)
	Control	0.05 (0.22)	2.35 (1.87)	1.50 (1.10)	1.47 (1.43)

more correct responses ($M = 2.20$, $SD = 1.47$) than children in the 4-in-1 day ($M = 0.85$, $SD = 0.88$), 4-in-10 days ($M = 0.42$, $SD = 0.69$), and 4-in-4 days ($M = 0.39$, $SD = 0.61$) conditions. No other differences were significant. In cued recall, there was a main effect of details, $F(1, 73) = 8.75$, $p < .001$, $\eta^2 = .11$; children reported more correct information for control ($M = 1.23$, $SD = 1.00$) than suggested ($M = 0.86$, $SD = 1.04$) details. There was also a main effect of sessions, $F(3, 73) = 9.33$, $p < .001$, $\eta^2 = .28$: LSD post hoc tests indicated that children in the single-event condition reported more correct responses ($M = 3.45$, $SD = 1.70$) than children in the 4-in-1 day ($M = 2.05$, $SD = 1.61$), 4-in-10 days ($M = 1.68$, $SD = 1.45$), and 4-in-4 days ($M = 1.06$, $SD = 0.87$) conditions. The only other significant difference was between the 4-in-1 day and the 4-in-4 days conditions, wherein the 4-in-1 day children reported more correct information than the children in the 4-in-4 days condition.

False suggestions. In free recall, no effects were significant. In cued recall, there was a main effect of sessions, $F(3, 73) = 3.02$, $p = .04$, $\eta^2 = .11$ (Figure 2); LSD probes indicated that children in the single event condition reported fewer false suggestions ($M = 0.60$, $SD = 0.99$) than children in the 4-in-10 days ($M = 1.37$, $SD = 1.21$) and the 4-in-4 days ($M = 1.61$, $SD = 1.09$) conditions. No other comparisons were significant.

Internal intrusions. In free recall, there was a main effect of sessions, $F(2, 54) = 3.55$, $\eta^2 = .12$: LSD post hoc probes indicated that children in the 4-in-1 day ($M = 1.75$, $SD = 1.68$) condition reported more internal intrusions than children in the 4-in-10 days condition ($M = 0.63$, $SD = 0.90$); children in the 4-in-4 days condition did not differ from either condition ($M = 1.33$, $SD = 1.24$). In cued recall, there was a main effect of details, $F(1, 54) = 8.79$, $\eta^2 = .14$; children reported more internal intrusions to control ($M = 1.79$, $SD = 1.54$) than suggested ($M = 1.21$, $SD = 1.29$) details.

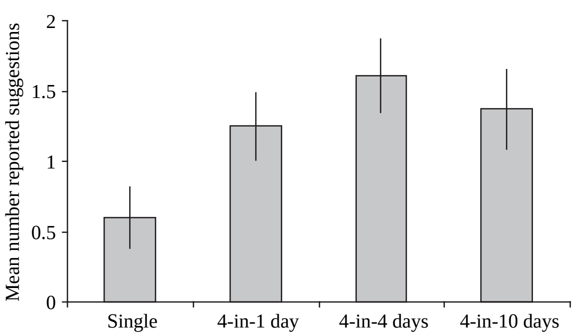

Figure 2. Mean number of suggested responses in cued recall as a function of event spacing in Experiment 2. Error bars show one standard error above the mean.

Discussion

In Experiment 2, one finding was consistent with a spacing effect: internal intrusion errors were more common among children who had experienced the most massed (4-in-1 day) versus the most distributed (4-in-10 days) presentation. This indicates that children who experienced the most massed condition were confused between repeated instances, and thus had a poorer memory of the target instance. Interestingly, however, children in the 4-in-4 days condition did not differ significantly from either of the other repeat event conditions in their reports of internal intrusions, while in Experiment 1, the 4-in-1 day children were more likely to report internal intrusions than the 4-in-4 days children. As discussed below, the variable retention intervals in Experiments 1 and 2 may have contributed to this finding.

There was little other evidence of a spacing effect in Experiment 2. In the reporting of suggestions, we once again found that children who experienced the most distributed events (4-in-4 days and 4-in-10 days), although not different from other repeat event conditions, reported more suggestions than children in the single-event condition. Also, children's pattern of responses for correct details were partially consistent with their responses in Experiment 1: Children who experienced only one play session reported more correct details than children who experienced the event repeatedly. These findings are consistent with a growing body of literature indicating that under some conditions, children who experience several similar instances of an event are more suggestible and have more difficulty recalling the details from a target instance than children who experience a single event (e.g., Connolly & Lindsay, 2001; Connolly & Price, 2006; Price & Connolly, 2004). However, the spacing effect would predict that within the repeat event conditions, the more distributed conditions would evince heightened suggestibility and more correct responding, compared to a massed condition. This was not the case. As discussed further in the General Discussion, the different delays from the target session to test between Experiments 1 and 2 may help to explain the pattern of results.

GENERAL DISCUSSION

Experiments 1 and 2 examined the influence of the temporal spacing of repeated instances on children's recall of an instance of a repeat event versus their recall of a single event. There were three consistent findings. First, children who experienced a single event reported more correct details than children who experienced a repeat event, regardless of the temporal spacing of the repeat event. Second, children who experienced a repeat event were frequently more likely to report suggestions than children who experienced a single event. Third, children who experienced the repeat event presented in a massed fashion (4-in-1 day) were consistently more likely to report internal intrusions than some children who experienced the repeat event presented in a more distributed manner. Our conclusion from this pattern of data is that children had difficulty accessing one instance from a series of many similar instances. This is an important finding because it indicates that, across three different spacing formats, this same general principle applies to the relationship between repeated and unique events.

We proposed that evidence for a spacing effect would involve greater recall of correct and suggested responses and fewer reported internal intrusions after experiencing more distributed than massed presentation of experiences. Based on the spacing effect literature, we would have anticipated that the spacing effect would be more prominent when the delay to recall is extended. This expectation is based on research indicating that after several years (see Bahrick, 2000) the spacing effect continues to facilitate retention of acquired information (i.e., the advantage of distributed over massed presentation increases over time). Strong evidence of a spacing effect was found in Experiment 1. In Experiment 2 the evidence was modest. Why would the spacing of presentations matter with a 1-day delay to test, but not with a 1-week delay to test?

The most complete explanation for the differential findings rests on the autobiographical memory research which finds that memory becomes more general over time (e.g., Myles-Worsley et al., 1986). When memory is general, recall of specific details is less likely. In order to observe a spacing effect, specific details must be recalled. If we proceed on the assumption that the spacing effect is more likely to be evident when memory is specific (compared to general), it is reasonable to expect that as memory becomes more general and less specific, the spacing effect may be reduced. That is, as memory becomes more "script-like" or "gist-like" over time, the advantage of distributed over massed presentation of repeated instances of a complex event may be reduced. Both script theory and fuzzy-trace theory propose that memory for repeated events becomes more general over time. Script theory describes this process as a scripting of memory over time: the development of a schema or general framework for the basic structure of an event (Nelson, 1986). Fuzzy-trace theory asserts that verbatim (specific) traces fade faster than gist (general) traces, and therefore, over time, recall of general information is more likely than recall of specific information (Brainerd & Reyna, 2004). Thus, both theories support the proposition that children's memory in Experiment 2 would have been more general and less specific than children's memory in Experiment 1. Despite the powerful influence of the spacing of presentations on memory for specific instances, it may not have had as substantial an effect on autobiographical memory that was more general.

The influence of the spacing of presentations on autobiographical memory may also have been affected by our specific selection of stimuli. In much of the research on the spacing effect, exactly the same target stimuli have been presented repeatedly. However, with respect to repeated complex autobiographical events, it is probably the case that no two instances will be identical, thus memory for details that change across instances was the focus of this study (e.g., Connolly & Lindsay, 2001; Powell et al., 1999; Price & Connolly, 2004). Importantly, repeated presentation of similar or related information may not operate under the same principles as repetition of the *same* information. As discussed earlier, however, Bellezza and Young's (1989) conception of a composite code allows for the repetition of highly similar information to lead to a spacing effect. Unfortunately, there is little empirical guidance for the level of similarity required to develop a composite code. Perhaps the level of similarity between instances in the present experiments may simply not have been strong enough to observe the benefit of a spacing effect after a longer delay.

It is also possible that the spacing effect does not apply to memory for complex autobiographical events, although this is less likely given that a spacing effect was observed in Experiment 1. There are some methodological differences in studies of the spacing effect and studies of children's memory for repeated complex autobiographical events that may limit the application of the former to the latter. First, in research that has previously observed the spacing effect, information is often effortfully learned to a pre-established criterion. However, in children's repeat event research, children simply engage in events and are asked to recall them later during an unexpected memory test (see Challis, 1993, for an examination of learning intentionality and the spacing effect). Second, much of the research examining the spacing effect has explored the effect using word lists or other similar types of stimuli. There may be important differences in the recall of word lists and personally experienced events, such as interest in the stimuli, which may influence memory (e.g., Jacoby, 1978). These limitations may explain some of the difficulties in the present experiments of applying the literature on the spacing effect to children's memory for complex events.

A final limitation of the present work is that it did not involve a direct comparison between retention intervals. In retrospect, it would have been more helpful to have included a delay manipulation in Experiment 2 so we could compare the effect of delay to recall on children's reports. Such a comparison would have allowed for a direct test of our conclusion, based on prior empirical work, that the differences between the two experiments may have been a result of the process of memory becoming more general over time. This comparison, as evinced in the present results, could have substantial implications for children's recall and would be an excellent comparison for future research.

Conclusion

The present exploration of the impact of event spacing on children's recall of a personally experienced event is unique and may help us to understand children's memory for repeated autobiographical experience. The results of these experiments also have practical implications. Although these are only the first experiments to explore the impact of temporal spacing of events on children's recall of a complex repeat event, these findings highlight the need to consider event spacing when evaluating children's recall of and suggestibility for repeated events. Particularly because these results run counter in some ways to what one might expect, further research must be conducted that will help elucidate the influence of event spacing on children's recall of personally experienced events.

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