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British Journal of Psychology (2020)

www.wileyonlinelibrary.com

Schema and deviation effects in remembering repeated unfamiliar stories

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In today's globalized world, we frequently encounter unfamiliar events that we may have difficulty comprehending – and in turn remembering – due to a lack of appropriate schemata. This research investigated schema effects in a situation where participants established a complex new schema for an unfamiliar type of story through exposure to four variations. We found that immediate recall increased across subsequent stories and that distortions occurred less frequently – participants built on the emerging schema and gradually established representations of parts of the story that were initially transformed. In recall with delays increasing up to 1 month, quantitative measures indicated forgetting while distortions increased. The second focus of this research was on content and order deviation effects on recall. The content deviation, in contrast with previous repeated-event research, was not remembered well and was associated with lower recall; the order deviation had a similar (but expected) effect. We discuss discrepancies between results of this study and previous literature, which had focused on schemata for familiar events, in relation to stages of schema development: it seems that in unfamiliar repeated events, a complex new schema is in the early stages of formation, where the lack of attentional resources limits active processing of deviations.

Two men from Edulac went fishing. (participant's first recall, Bartlett, 1932, p. 66)

Bartlett (1932) demonstrated that parts of an unfamiliar story may become distorted in the process of remembering (see also Bergman & Roediger, 1999; Roediger, Bergman, & Meade, 2000). In one of Bartlett's (1932) experiments, participants were presented with an adapted version of a North American folktale *The War of the Ghosts*, which started with the following line: 'One night two young men from Egulac went down to the river to hunt seals. . .'. Bartlett's participants were then asked to reproduce the story repeatedly with increasing delay. In their reproductions, participants often left out or transformed parts that were most disjoint to their pre-existing knowledge (i.e., parts they had difficulty comprehending; Bartlett, 1932; see also Beals, 1998; Billig, 1990; Edwards & Middleton, 1987). The initial quote shows an example – the participant changed 'hunt seals' into the more familiar 'fishing' and 'Egulac' into 'Edulac'. In today's globalized world, we frequently encounter unfamiliar events that we may have difficulty comprehending due to

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DOI:10.1111/bjop.12449

lack of appropriate schemata. Watching a game of cricket may serve as an example – a first-timer would probably not understand much of what is going on, and if asked to recall the event later, they would likely need to borrow terms they know from different sports, misinterpret certain actions, and overall not remember very much. What if, however, one had a chance to become familiar with the event through exposure to several examples – would we still observe distortions?

Repeated experience leads, through the process of abstracting shared parts of events, to the emergence of a schema, a generic cognitive structure that consists of information about content and temporal order of events (i.e., a script), layout of spaces, and rules or associations between objects (Abelson, 1981; Ahn, Brewer, 2000; Brewer, & Mooney, 1992; Brewer & Treyens, 1981; Ghosh & Gilboa, 2014; Nørby, 2015; Posner & Keele, 1968; Renoult, Davidson, Palombo, Moscovitch, & Levine, 2012; Rumelhart, Smolensky, McClelland, & Hinton, 1986; Schank, 1999; Schank & Abelson, 1975; van Kesteren, Rijpkema, Ruiter, & Fernández, 2013). Repeated-event research from experimental as well as naturalistic settings has investigated various consequences that newly established schemata have on the ability to recall specific details of events that were similar to each other. In general, schemata facilitate memory for what typically happened but are less helpful when the task is to recall details that varied across instances (e.g., Farrar & Goodman, 1992; Fivush, 1984; Freeman, Romney, & Freeman, 1987; McNichol, Shute, & Tucker, 1999; Neisser, 1981; Woiwod, Fitzgerald, Sheahan, Price, & Connolly, 2019). There is an exception to the latter principle, however, when changes in details are so unexpected as to be perceived as outright deviations, in which case these deviations are remembered well (Brubacher, Glisic, Roberts, & Powell, 2011; Connolly, Gordon, Woiwod, & Price, 2016; Greve, Cooper, Tibon & Henson, 2019; MacLean, Coburn, Chong, & Connolly, 2018).

Previous studies, however, typically investigated familiar repeated events such as play activities, tasting sessions, school days, and group meetings and discussions, so new schemata were rather adaptations of old schemata than complex new structures.[1] Given that people experience repeated unfamiliar events in many different contexts (when they travel to countries with a different culture, play a new board game, learn to drive, or switch to a new operation system) and sometimes need to recall details of these events for investigative purposes (e.g., in cases of industrial accidents; Kelloway, Stinson, & MacLean, 2004), we need to gain better understanding of how memory for such events develops and how such events are remembered. In the present research, we used a set of variations of an unfamiliar story in a repeated-event paradigm, and we followed participants' recall using a method of repeated reproduction with increasing delay. This unique combination of methodologies enabled us to examine (1) schema formation for unfamiliar material and effects associated with cultural schemata as well as (2) phenomena specific for repeated events, such as accuracy of recall instances and effects of deviations.

Conventionalization and unfamiliar stimuli

'When cultural material is introduced into a group from the outside it suffers change until it eventually either disappears or reaches a new stable form' (Bartlett, 1932, p. 268). This process of conventionalization illustrates socio-cultural influences on remembering that

[1] *We would like to note that schema establishment for any new human experience, even in the case of unfamiliar events, never occurs from a 'blank slate', because there are always aspects that are familiar (e.g., subjects, objects, and various actions in isolation). In this research, we focus on events that are unfamiliar as a whole and that lead to complex schema adaptations.*

involve assimilation of unfamiliar forms to familiar ones often through processes of rationalization, simplification, and social constructiveness that may result in distortion (Bartlett, 1932; Collins, 2006; Northway, 1940a, 1940b; Saito, 2000).[2]

Transformations (or distortions) as a result of constructive processes apparent in recall have been documented in studies using familiar and unfamiliar material with the method of repeated reproduction. Bergman and Roediger (1999) and Wagoner and Gillespie (2014) replicated Bartlett's experiment using the *War of the Ghosts* story and showed that memory distortions tend to be maintained across repeated tests while accurate recall decreases due to forgetting. Wheeler and Roediger (1992) reported similar results with the use of familiar materials.[3] Bartlett (1932) further mentioned that some distortions only occurred at longer retrieval attempts. This would likely happen in cases where a new schema is still separating from existing schemata. The relative persistence of distortion in delayed recall documented by Bergman and Roediger (1999) and Wagoner and Gillespie (2014) exemplify the conservative nature of stabilized schemata (Collins, 2006; Ost & Costall, 2002).

Remembering repeated events

In everyday life, people form routines, follow procedures, and create preferred ways for completing complex tasks.[4] From this perspective, our lives largely seem a collection of repeated events (Brown, 2016). Two decades of research into children's memory for repeated events and emerging literature on adults' memory for repeated events suggest that people tend to remember the content and structure of how things typically happen (Woiwod *et al.*, 2019). When asked about details of a specific event, participants are often confused about when details occurred, may provide inconsistent reports across repeated interviews, and in turn may seem unreliable (Connolly & Price, 2013; Freeman *et al.*, 1987; Neisser, 1981; Price, Connolly, & Gordon, 2016; Weinsheimer, Coburn, Chong, MacLean, & Connolly, 2017; Woiwod & Connolly, 2017).

The source monitoring framework (SMF; Johnson, Hashtroudi, & Lindsay, 1993; Lindsay, 2008, 2014; Lindsay & Johnson, 2000) is a useful approach that may help us understand why difficulties in remembering details of an instance from a repeated event occur. The SMF is based on the assumption that memory processes at all stages involve multiple systems that work in parallel (Johnson *et al.*, 1993; see also McClelland & Rumelhart, 1985; Rumelhart *et al.*, 1986). During retrieval of a specific detail, these systems give rise to a host of surface-level and generic characteristics that aid the process of attributing the detail to a specific source (Lindsay, 2008). In repeated events, many of these characteristics overlap, which may lead to erroneous attributions (i.e., confusions of details across instances), unless a detail is associated with unique characteristics. There

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[2] *Cole and Cole (2000) elaborated on Bartlett's notion of conventionalization and suggested that it entails transformative as well as generative processes (i.e., that conventionalization involves processes of assimilation of details as well as accommodation of schemata). In this study, we use a narrower interpretation of conventionalization as a transformative and constructive process that is driven by an established schema (e.g., transformation of 'hunting seals' into 'fishing' or recall of 'totem' that never actually occurred in War of the Ghosts; Bartlett, 1932).*

[3] *Gauld and Stephenson (1967) studied conditions that may limit distortions in recall and suggested that strict recall instructions and an opportunity to identify errors in participants' own reproductions have such an effect.*

[4] *Imagine a personalized Monday morning routine of an academic. She enters the office at 9.00 and engages in a brief discussion about the weekend. She then pours coffee that one of her colleagues (who arrives to the office earlier and has a different routine) had made. Until 9.30, she answers emails while sipping coffee. After that, she starts revising slides for an upcoming lecture that she gives at 10.00.*

are two examples of such stronger bounds between details and their source in repeated events: (1) primacy (and sometimes also recency) effects, when recall of the first (and sometimes the last) instance from a repeated event is higher and contains fewer confusions than recall of other instances; and (2) deviation effects, when an instance that was different from others is recalled better than non-deviation instances (Connolly *et al.*, 2016; Greve *et al.*, 2019; MacLean *et al.*, 2018; Roberts *et al.*, 2015; Rubínová, Blank, Ost, & Fitzgerald, 2020). The latter effect is typically associated with a content deviation such as a new activity or an interruption present in one instance and is consistent with literature examining deviation effects presented in a scripted text, where recall of script-interruptive, bizarre, or vivid irrelevant details was found to be similar or better than recall of script-typical details (Davidson, 1994; Davidson, Malmstrom, Burdenand, & Luo, 2000).

An event may also deviate in terms of temporal structure (i.e., when an established arbitrary order of actions changes in one instance), and such deviation seems to have a disruptive effect on recall and source memory of all instances, possibly due to compromising the schematic basis that otherwise aids comprehension (Ohtsuka & Brewer, 1992) and recall (Rubínová *et al.*, 2020).[5] Recent research also suggested that being aware (i.e., remembering) that a deviation occurred may be key to understanding deviation effects: a deviation of content was associated with high deviation awareness and better recall, while a deviation of order was associated with low deviation awareness and poorer recall (Rubínová *et al.*, 2020).

Current study

In the present study, we combined methodologies to answer questions pertaining (1) to schema formation and persistence of memory distortion in repeated unfamiliar events, and (2) to the generalizability of effects found in the repeated-event literature that are based on familiar stimuli. We presented participants with four versions of an unfamiliar story and asked them to recall each story shortly after its presentation (immediate recall), and then again four more times with delays increasing from 10 min to 1 month (delayed recall). In addition, we investigated effects of content and order deviations on delayed recall of unfamiliar stories. For different subsets of participants, in the fourth and final story, we introduced a content deviation (a change in behaviour of the characters),[6] an order deviation (a change in the sequence of actions), or both content and order deviations.

With regard to schema formation, we hypothesized that participants' initial recall of the first story – after their first experience with the unfamiliar material – would be lower than their initial recall of the subsequent stories due to gradual establishment of the schema (e.g., Fivush, 1984; Schank, 1999). Relatedly, we expected that as participants became more familiar with the material and built a new schema, the number of distortions in initial recall would decrease between the first and subsequent stories (i.e., initial distortions would be corrected). We planned exploratory analyses of distortions in

[5] *In the context of an order deviation in a (single) story, Mandler and Johnson (1977) suggested that an apparent order deviation may lead to better recall of the story in the short term. 'However, the longer the delay between telling and recall, the more recall will come to approximate an ideal schema instead of the actual story heard' (p. 132).*

[6] *The content deviation we used would correspond to a vivid schema-inconsistent detail that did not have consequences for the story in terminology used by researchers examining deviation details in scripted stories (e.g., Davidson, 1994), as it involved a change of the ritualistic behaviour enacted by the couple at the end of the story.*

delayed recall to see if occurrence of distortions was stable across time or would show increasing tendencies (Bartlett, 1932).

In delayed recall, based on previous repeated-event research using familiar materials, we should expect (1) primacy and recency effects – higher recall and better source monitoring in Story 1 and Story 4 than in the middle stories (MacLean *et al.*, 2018; Rubínová *et al.*, 2020), (2) positive effects of the content deviation on recall (e.g., Price *et al.*, 2016), and (3) negative effects of the order deviation on recall (Rubínová *et al.*, 2020). Whether these effects are generalizable to repeated unfamiliar events remains to be established and therefore we regarded these analyses as exploratory. Finally, we expected that participants who would be aware that a deviation occurred would have better memory of the stories than participants who would not be aware of a deviation (Rubínová *et al.*, 2020).

Method

Design

This study was a 4 (story: 1/2/3/4) × 4 (session: 1/2/3/4) × 2 (content: typical/deviation) × 2 (order: typical/deviation) mixed design. Content and order were between-subjects factors; story and session were within-subjects factors.

Participants

Sample

One hundred and forty-nine participants took part in this experiment. Participants were recruited through the university undergraduate participant pool and received two research credits for completing the study. We used the following inclusion criteria: age over 18 years, normal or corrected-to-normal vision and hearing, and fluent English-speaking ability. There were 38 males and 111 females aged between 16 and 64 years (M = 20.15, SD = 6.02). Data from one female participant were excluded from the final sample due to familiarity with the materials.[7] Participants were randomly allocated to one of four conditions: there were 37 participants in the typical content and order condition, 39 participants in the changed content condition, 36 participants in the changed order condition, and 36 participants in the changed both content and order condition.

Partially missing data and exclusions

We had complete data from 129 participants and partial data from 19 participants. Partial or complete recall from Session 1 was missing from five participants due to a technical fault. Data from Session 2 and 4 were missing from one participant, two participants did not complete Session 3 and 4, and a further six participants did not complete Session 4. We additionally excluded partial data from Sessions 3 and 4 from five participants whose recall was identical to one of the previous online sessions (i.e., including typos; participants

[7] *The participant was a research assistant of a colleague and was exposed to the story videos on multiple occasions prior to signing-up for the experiment.*

probably saved a record of their recall and copy-pasted it in later sessions). For further details and explanations of data exclusion, see Appendix S1 (OSM, https://osf.io/jhrtc/).

Materials

The stimuli were adapted from Ahn *et al*. (1992, Experiment 2). We simplified and shortened their passage of a Korean Wedding Ceremony (see appendix 1 in Ahn *et al.*, 1992), and varied details and wording of some parts to create four stories depicting the same event (please note that these stories were not labelled as a wedding ceremony; see Table 1 for a list of story-specific details and Appendix 1 for an example story). The stories were presented as videos showing hand-drawn illustrations of the scenes.[8] Each story was read-out by one of four native English speakers (two younger-adult male and female voices and two older-adult male and female voices; for all video examples, see OSM, https://osf.io/jhrtc/). The order of stories was counterbalanced across participants.

Each participant watched four stories. Stories 1–3 were a variation on the same event and served to establish the schema. Depending on the condition, changes were introduced in the fourth story. In the typical content and typical order condition, the final story was another variation on the same event. In the deviation content conditions, the ritualized actions of the main characters at the end of the final story were changed (see Themes 13 and 14 in Table 2). In the deviation order conditions, the actions of the final story remained unchanged, but were revealed in a different order in the middle part of the story (the beginning and ending remained the same; see Table 2). The stimuli were counterbalanced across participants (see OSM, https://osf.io/jhrtc/).

Procedure

Session 1

After participants read the information sheet and signed informed consent, the administrator briefed them about the procedure described below and summarized that the study had three further online parts for which they would receive links 1 day, 1 week, and 1 month later (participants were not told what the purpose of the online parts was, only that they would need approximately 15 min to complete each of them). The whole experiment was administered on a computer with, a paper-based distractor task. After demographic/screening question and basic instructions asking the participants to pay attention to the stories as they would be asked to recall them later, participants watched the first video (Story 1) two times in a row. A 1-min arithmetic filler task followed, after which instructions for immediate recall appeared: 'Now please type in as much as you can remember from Story 1. Try to ensure that your reproduction is as close to the original story as possible, including as many details as you can. Take your time and revise your reproduction until you cannot remember any more. Please do not guess. Once you cannot remember any more, please continue to the next task'. A 2-min dot connecting distractor task followed. The exact same procedure (including watching each story twice) was then repeated for Stories 2, 3, and 4. Participants then completed a 10-min visual-spatial distractor task. The first delayed recall task followed: participants were asked to recall as much as they could remember from each story. The recall task was presented on four

[8] *We decided to present the stories in an audio-visual form (rather than asking participants to read the stories from text) because we believed that this would increase participants' engagement with the materials.*

Table 1. List of story-specific details

	Story			
Detail	1	2	3	4
Female	Barbara	Susan	Linda	Jennifer
Male	Michael	Robert	James	Richard
Go-between	Mrs Smith	Mr Jones	Ms Evans	Mrs Lewis
Relation	Aunt	(Father's) friend	Cousin	Grandmother
Feature	Character	Nature	Personality	Interests
Delay	Two days later	Three weeks later	Twenty days later	The following day
Figure	Psychic	Forecaster	Fortune-teller	Spiritualist
Date	3rd March	12th September	11th January	9th June
Clothes	White blouse and green skirt	White dress	Blue shirt and white skirt	Yellow dress
Refreshments	Cake and fruit	Chocolate cake	Fruit cookies	Lime cake
Context	Standing next to a wooden pillar	Looking at them	Smiling at his wife	Raising glass to propose a toast

Table 2. Changes in story themes according to content and/or order deviations in four conditions

Theme/ Changes	Both typical	Content deviation	Order deviation	Both deviation
1/No	The couple is introduced	[1]	[1]	[1]
2/Order	The go-between visits the girl's family	[2]	[4] The boy's parents visit a 'medium'	[4]
3/Order	The go-between introduces the boy	[3]	[5] The 'medium' provides a date to send a gift to the girl	[5]
4/Order	The boy's parents visit a 'medium'	[4]	[6] The girl receives a gift	[6]
5/Order	The 'medium' provides a date to send a gift to the girl	[5]	[7] The girl receives clothes	[7]
6/Order	The girl receives a gift	[6]	[2] The go-between visits the girl's family	[2]
7/Order	The girl receives clothes	[7]	[3] The go-between introduces the boy	[3]
8/Order	A discussion between the pairs of parents	[8]	[10] The boy bows to the girl's father	[10]
9/Order	The boy wears blue clothes	[9]	[11] The boy gives the girl's father a wooden goose	[11]
10/Order	The boy bows to the girl's father	[10]	[12] Refreshments	[12]
11/Order	The boy gives the girl's father a wooden goose	[11]	[8] A discussion between the pairs of parents	[8]
12/Order	Refreshments	[12]	[9] The boy wears blue clothes	[9]
13/Content	[A] The boy and the girl bow to each other	[B] The boy and the girl sit next to each other	[13 A]	[13 B]
14/Content	[A] The boy and the girl share wine	[B] The boy and the girl sing a song	[14 A]	[14 B]
15/No	The father has a speech	[15]	[15]	[15]

pages entitled with 'Story 1' (page 1, 'Story 2' on page 2, etc.) and illustrations of the boy and the girl as cues (participants could switch between the pages).

Sessions 2 and 3

One day and one week after Session 1, respectively, participants received an online answer form similar to the delayed recall task described under Session 1. Participants completed Session 2 between 0.81 and 5.91 days[9] (M = 1.60, SD = 0.71) and Session 3 between 6.08 and 15.91 days (M = 8.13, SD = 1.67). In both sessions, there were few participants at the late extremes and the smallest interval between Sessions 2 and 3 was 2 days, so we decided not to exclude any data from these sessions.[10]

Session 4

One month after Session 1, participants received another delayed recall online form. Participants completed this part between 27.82 and 68.09 days (M = 29.80, SD = 4.19). There were again few participants at the extreme, so we decided not to exclude any data from this session. After the recall phase, we asked participants to describe any shared elements and any differences they might have noticed between the stories. Finally, we asked participants what they thought the stories were describing.

Measures and coding

Each story consisted of 15 themes, which translated into 76 idea units (these included 11 details that varied across the stories and 4 details that were consistent but changed in the fourth story in the content deviation conditions). From the rich recall data, we created measures of quantity, source monitoring, quality, and recall organization (Sessions 1–4). From the follow-up questions (end of Session 4), we coded any mentions of the occurrence of deviations (i.e., deviation awareness), and a general event representation (i.e., what did the stories describe). Recall quantity was reflected in a coarse-grain measure of themes (maximum 15 per story; Table 2) and a fine-grain measure of idea units (maximum 76 per story; after Mandler & Johnson, 1977), both coded based on the meaning and not verbatim reproduction. Specific details were a measure of quantity that also reflected accuracy of recall (see example below). A total of 15 details were coded: 11 details that varied across stories (Table 1) and 4 details that changed in the content deviation conditions. Source monitoring was reflected in a measure of internal intrusions/source confusions of details (maximum 15 per story). Recall quality was reflected in a measure of distortions of idea units (maximum 76 per story). Recall organization was measured as the sum of pairs of themes that were recalled in the correct order (maximum 14 per story). Deviation awareness reflected participants' mentioning of the content and/or order deviation (yes/no). Participants' descriptions of the stories were categorized and reflected in a measure of general event representation.

Recall of themes was coded as 1 = present, 0.5 = partially present/incomplete, or 0 = absent themes. Recall of idea units was coded as 1 = present or 0 = absent; recall of

[9] *There were two participants who completed Session 2 after 6 and 11 days, respectively, and who did not complete any further sessions. In order to reduce the range of delay in Session 2, we treated these data as answers from Session 3 (see OSM, https://osf.io/jhrtc/).*

[10] *Excluding the participants at the extremes would not change the results.*

details was coded as 1 = correctly recalled or 0 = incorrectly recalled/absent. Details that were attributed to an incorrect story were coded as internal intrusions. For example, the following passage: 'James'[1] family *friend*[2] Ms Evans[3] visited[4] Linda's[5] parents[6] [. . .] and told[7] them about James'[8] education[9] and personality[10,' was coded as 2 themes (Theme 2 and 3 in Table 2), 10 idea units (each marked with a superscript), 2 details (underlined), and 1 internal intrusion (in italics). For statistical analyses, themes, idea units, details, and internal intrusions were converted into a proportion.

Qualitative recall measures reflected five types of recall transformations that were, for the purpose of statistical analyses, combined into a single measure of distortions (see Bergman & Roediger, 1999). (1) Confusions were operationalized as idea units that confused actions or characters in a story (e.g., '*Linda's* cousin told Linda's mum about James'). (2) Conventionalizations were operationalized as transformations of idea units according to Western cultural schemata (Bartlett, 1932; e.g., 'Once they *exchanged vows*, they sang a traditional song together', '. . .she received a *wedding dress*'). (3) Confabulations were mentions of idea units that were not presented in the stories (e.g., 'They had fruit biscuits and *Milk* at the ceremony'). (4) Confusions from multiple sources were details that contained information originating from several other stories and showed, rather than source confusion, blending of details from multiple stories (e.g., 'Mrs Smith who told Barbara's parents about Michael's education, *interests* and *personality*'). (5) Deviation confusions reflected confusions of details that changed in the content deviation conditions with typical details and vice versa.

To measure recall organization, each recalled theme was assigned a sequential number and all correct sequences were summed (e.g., themes ordered as 1, 2, 5, 6, 4, 3 include 2 correct sequences: 1, 2, and 5, 6). In order to make this measure independent of quantity of recall, we calculated a proportion in the following way: we divided the sum of correct sequences by the number of recalled themes deducted by 1 (e.g., the sequence score for the previous example – two out of five correct sequences – would be 0.40, and a completely accurate sequence of any number of themes would gain a score of 1).

For deviation awareness, any mentioning of change of the ritual at the end of the story was coded as awareness of the content deviation (e.g., 'In the last story the boy and girl sat next to each other and sang a traditional song instead of bowing to each other and exchanging three drinks'); any mentioning of the change of story order was coded as awareness of the order deviation (e.g., 'The order of events leading up to the ceremony changed'). Please note that we coded any mentioning of deviation(s) as deviation awareness, including imprecise descriptions or attributions of the changes as (e.g., 'The storyline for the first two were the same; the last two stories changed slightly' was coded as awareness of the order deviation). General event representation was categorized based on participants' descriptions of the meaning of the stories (e.g., 'Arranging some kind of ceremony in which the boy and girl may eventually get married' was coded as 'marriage'; see OSM, https://osf.io/jhrtc/).

All reproductions were coded by E. R. To obtain an estimate of inter-rater reliability, two subsets (a random selection of 15 participants each) were independently coded by two trained raters with resulting high agreement (Cohen's kappa between .72 and .89 for measures of themes, idea units, details, and recall organization). E. R.'s codes were used for statistical analyses. The respective data and coding manual are available in OSM (https://osf.io/jhrtc/).

Statistical analyses

All measures were analysed using linear mixed models with fixed effects of session (1/2/3/4), story (1/2/3/4), content (typical/deviation), and order (typical/deviation) with all interactions, and random intercepts for participants and random slopes for session (Finch, Bolin, & Kelley, 2014). Due to the number of effects in the full model and an associated risk of increasing Type I error, we report analyses relevant for our hypotheses in the main text (i.e., effects and interactions of session and deviation(s) and effects and interactions of story and deviation(s)) and report significant interactions involving session and story in the OSM (we had no theory-based expectations for these effects, and there were just a few of them; https://osf.io/jhrtc/). Deviation awareness analyses, which did not differentiate between deviations, included fixed effects of session, story, and awareness (aware/not aware), and the same random effects as the previous model.

Session was treated as a continuous variable and centred. Story was coded using simple contrasts with Story 1 used as a reference level, so all models included three contrasts between Story 1 and each of Stories 2, 3, and 4. Content and order deviations were coded using simple contrasts, so the main effect of each factor represented a contrast between the typical and deviation levels; deviation awareness was coded using simple contrasts, so the main effect contrasted participants who were and who were not aware of any deviation. All significant higher-order interactions that involved session or story and any deviation were followed up with analyses at the level of stories. We present regression coefficients along with 95% Confidence Intervals in brackets to show the size and range of the effects (Cumming, 2012, 2014). Data and R script are available as OSM (https://osf.io/jhrtc/).

Results

The results section is split into three parts. First, we report immediate recall results bearing on recall quantity (themes, idea units, and details) and quality (distortions) related to schema formation. This is followed by delayed recall findings focusing on general performance differences across the stories, forgetting, and deviation effects. Finally, we report analyses of deviation awareness and its relation to recall.

Immediate recall and schema formation

Figure 1 shows the increase in immediate recall of idea units across the four stories (see Table 3 for other measures). As expected, having encountered a previous example of an unfamiliar story helped participants remember the next example better, although there was not much of a further increase for Stories 3 and 4, suggesting that a new schema may have been established already after the first two instances. Recall of story themes, units, and details increased by 16%, 17% and 19%, respectively, between immediate recall of Story 1 and Story 2, themes: $b = 0.16$, [0.14, 0.18], $t(420) = 16.28$, $p < .001$; units: $b = 0.17$, [0.15, 0.19], $t(419) = 18.30$, $p < .001$; details: $b = 0.19$, [0.16, 0.21], $t(419) = 13.51$, $p < .001$. We do not report further contrasts between Story 1 and Stories 3 and 4 as they both show significant increases. There was one significant three-way interaction between story and both deviations indicating that in contrast with Story 1, recall of Story 3 was lower when both deviations were present. A follow-up analysis of Story 3, however, did not reveal any significant results (highest $t = 1.17$, lowest $p = .25$),

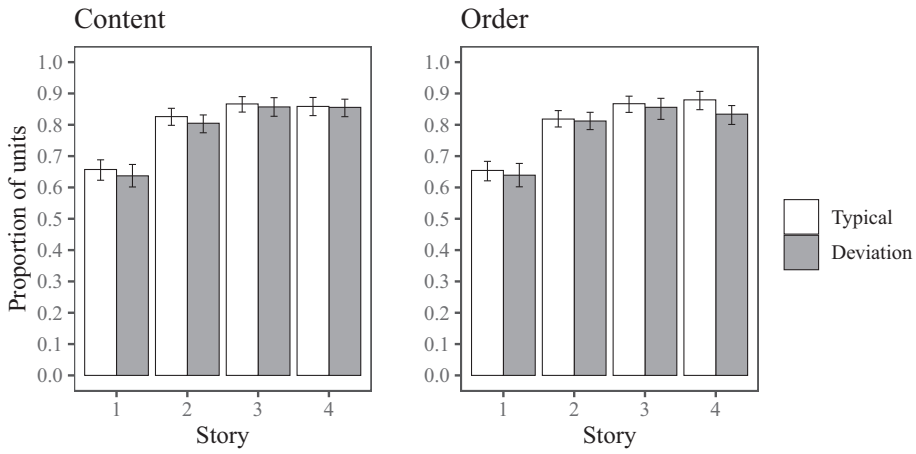

Figure 1. Immediate recall of idea units for typical/deviation content and order conditions. Error bars represent 95% CIs of the means.

which means that the interaction depended on the difference between Story 1 and 3 and not on the deviation effect.

Participants' recall included between 0 and 6 distortions in each story ($M = 0.99$, $SD = 1.13$), and the number of distortions decreased in later stories. The decrease was gradual between Stories 1 and 3 and then levelled off, Stories 1 and 2: $b = -0.26$, $[-0.47, -0.04]$, $t(420) = 2.31$, $p = .02$; Stories 2 and 3: $b = -0.28$, $[-0.48, -0.07]$, $t(141) = 2.62$, $p = .01$; Stories 3 and 4: $b = -0.04$, $[-0.48, -0.07]$, $t(141) = 0.47$, $p = .64$; Table 3. To examine distortions that were in line with Western cultural schemata specifically, we compared percentages of participants whose recall involved conventionalizations across the four stories and found a broadly consistent pattern, although the differences were not significant, Story 1: 10%, Story 2: 7%, Story 3: 6%, and Story 4: 2%; $\chi^2(3, N = 576) = 7.75$, $p = .05$.

In summary, analyses of immediate recall confirmed that participants learned the story schema as they gathered more experience with the material. Participants recalled more details, units, and even whole themes in later stories with most learning occurring between the first two stories. Inversely related to the improvement in the quantity of remembered material was a change in quality – alongside building a new schema for unfamiliar story came a decrease in distortions, and this decrease was more gradual. In

Table 3. Proportion of themes, idea units, and details, and number of distortions in immediate recall

	Story			
Measure	1	2	3	4
Themes	0.71 (0.15)	0.87 (0.12)	0.92 (0.12)	0.91 (0.12)
Idea units	0.65 (0.15)	0.82 (0.12)	0.86 (0.13)	0.86 (0.13)
Details	0.63 (0.19)	0.82 (0.14)	0.84 (0.15)	0.80 (0.16)
Distortions	1.34 (1.37)	1.08 (1.17)	0.80 (0.91)	0.76 (0.95)

Note. Statistics display means and standard deviations.

other words, after repeated examples, participants were able to create representations based on the material rather than deriving them from cultural schemata.

Delayed recall and deviation effects

Themes

The overall analysis showed, as would be expected, that participants recalled fewer themes as delay increased, $b = -0.09$, $[-0.10, -0.07]$, $t(132) = 10.83$, $p < .001$. In addition, there was a significant two-way interaction between story and the content deviation and a significant three-way interaction between story and both deviations. These interactions indicated that in contrast with Story 1, recall of Story 4 was lower when the content or both deviations were present. A follow-up analysis of Story 4, however, did not show a significant effect of any deviation (highest $t = 1.68$, lowest $p = .10$), which again means that the interaction depended on the difference between Story 1 and 4 and not on the deviation effect.

Idea units

Similarly to themes, the overall analysis showed forgetting, $b = -0.05$, $[-0.06, -0.04]$, $t(132) = 7.67$, $p < .001$. In addition, there was a significant effect of story indicating that recall of Story 3 was slightly higher than recall of Story 1, $b = 0.01$, $[0.0003, 0.03]$, $t(1{,}946) = 1.99$, $p = .047$. There were also significant two- and three-way interactions between story and each and both deviations, all indicating that in contrast with Story 1, recall of Story 4 was lower when a deviation was present. A follow-up analysis confirmed that recall of Story 4 was 8% lower in the order deviation conditions than in the typical order conditions, $b = -0.08$, $[-0.16, -0.01]$, $t(141) = 2.28$, $p = .03$; Figure 2. In other words, participants had difficulty recalling Story 4 when the order changed. Table 4

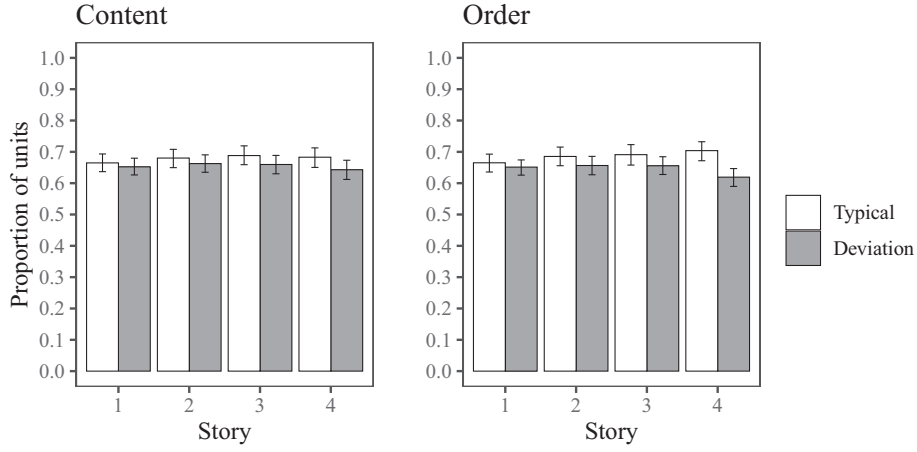

Figure 2. Delayed recall of idea units for typical/deviation content and order conditions collapsed across delay. Error bars represent 95% CIs of the means.

Table 4. Proportion of idea units and details in Story 4 and in all stories split by condition

	Units				Details			
	Story 4							
Session	Both typical	Content deviation	Order deviation	Both deviation	Both typical	Content deviation	Order deviation	Both deviation
1	0.80 (0.23)	0.77 (0.25)	0.72 (0.22)	0.67 (0.24)	0.60 (0.27)	0.57 (0.25)	0.57 (0.25)	0.53 (0.19)
2	0.75 (0.26)	0.72 (0.26)	0.66 (0.25)	0.60 (0.26)	0.42 (0.29)	0.40 (0.26)	0.40 (0.24)	0.35 (0.23)
3	0.69 (0.27)	0.66 (0.28)	0.64 (0.25)	0.56 (0.26)	0.35 (0.29)	0.33 (0.23)	0.32 (0.24)	0.26 (0.25)
4	0.65 (0.29)	0.60 (0.29)	0.54 (0.28)	0.53 (0.25)	0.27 (0.23)	0.26 (0.20)	0.21 (0.19)	0.22 (0.22)
	All stories							
1	0.76 (0.24)	0.72 (0.27)	0.72 (0.22)	0.69 (0.22)	0.58 (0.24)	0.53 (0.26)	0.56 (0.23)	0.52 (0.22)
2	0.74 (0.23)	0.71 (0.25)	0.68 (0.23)	0.68 (0.20)	0.48 (0.25)	0.44 (0.23)	0.46 (0.22)	0.45 (0.21)
3	0.68 (0.27)	0.65 (0.27)	0.63 (0.25)	0.62 (0.22)	0.41 (0.24)	0.38 (0.23)	0.38 (0.23)	0.38 (0.23)
4	0.64 (0.28)	0.58 (0.29)	0.56 (0.27)	0.57 (0.22)	0.33 (0.21)	0.29 (0.20)	0.30 (0.20)	0.30 (0.21)

Note. Statistics display means and standard deviations. Deviation details (and parallel details in typical content conditions) were excluded in the measure of details.

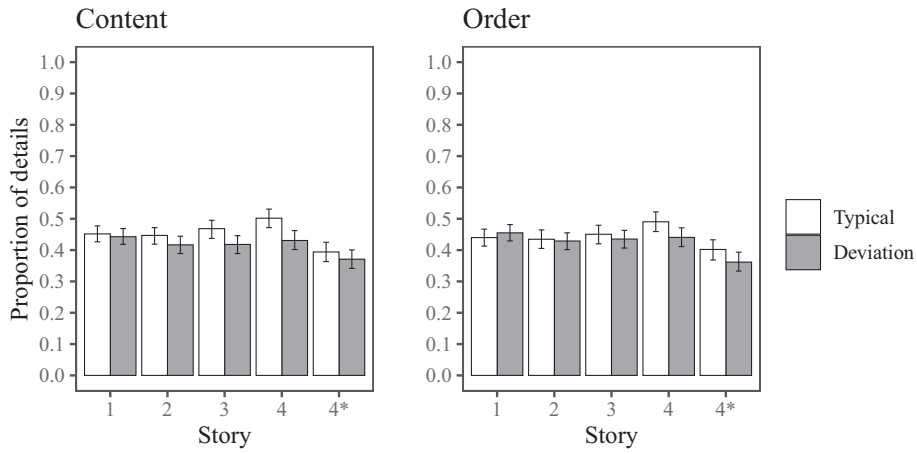

Figure 3. Delayed recall of story details for typical/deviation content and order conditions collapsed across delay. Asterisk indicates measure of details excluding deviation details (and parallel details in typical content conditions). Error bars represent 95% CIs of the means.

displays means and standard deviations for recall of idea units split by experimental conditions.

Details

Similar to the previous measures, the overall analysis showed 8% forgetting between sessions, $b = -0.08$, $[-0.09, -0.07]$, $t(129) = 17.70$, $p < .001$; Table 4. There was some indication of a primacy effect, as recall of Story 2 was significantly lower than recall of Story 1, although the effect was very small, $b = -0.02$, $[-0.03, 0.0009]$, $t(1{,}949) = 2.07$, $p = .04$. Recall of Story 4 was slightly higher than recall of Story 1 ($b = 0.02$, $[0.0006, 0.03]$, $t(1{,}949) = 2.02$, $p = .04$), suggesting a small recency effect. In addition, there were significant two- and three-way interactions between story and each and both deviations in the contrasts between Story 1 and Stories 3 and 4. Follow-up analyses of Story 3 and 4 revealed that recall of Story 4 was 8% lower in the content deviation conditions than in the typical content conditions, $b = -0.08$, $[-0.15, -0.01]$, $t(143) = 2.31$, $p = .02$ (see Figure 3 and Table 4); there were no significant deviation effects analyses of Story 3 (highest $t = 1.79$, lowest $p = .08$).

In order to find out whether the recall disruptive effect of the content deviation in Story 4 was due to participants not reporting the deviation details, we ran a parallel analysis in which we excluded details that deviated in Story 4 in the content deviation conditions and parallel details in the typical content conditions.[11] The results suggested that this was the case: there were no significant differences in recall of Story 4 between the deviation content and typical content conditions after removal of the deviation details, $b = -0.03$, $[-0.10, 0.04]$, $t(143) = 0.94$, $p = .35$; see Figure 3. This pattern of results was contrary to our prediction – we expected the content deviation to be well remembered and to improve recall.

[11] *We re-calculated the measure in the following way: from recall of Story 4 in all conditions, we excluded four details that changed in the content deviation; then, we calculated a proportion of these 11 details.*

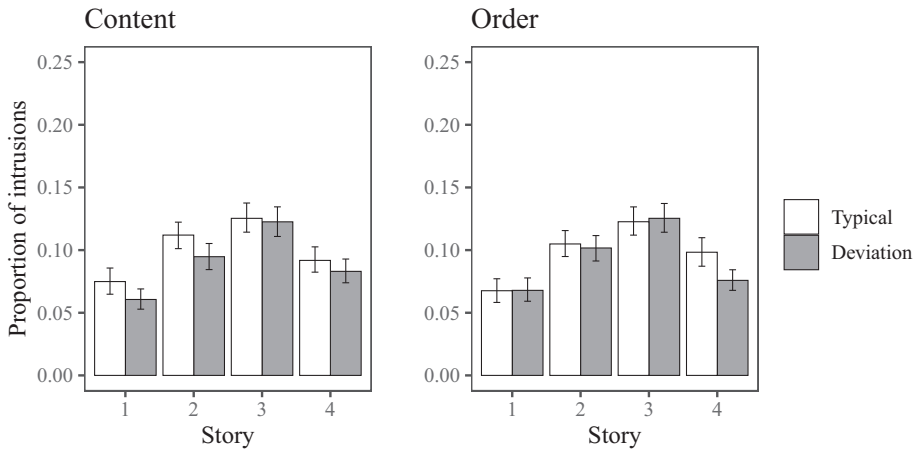

Figure 4. Internal intrusions in delayed recall for typical/deviation content and order conditions collapsed across delay. Error bars represent 95% CIs of the means.

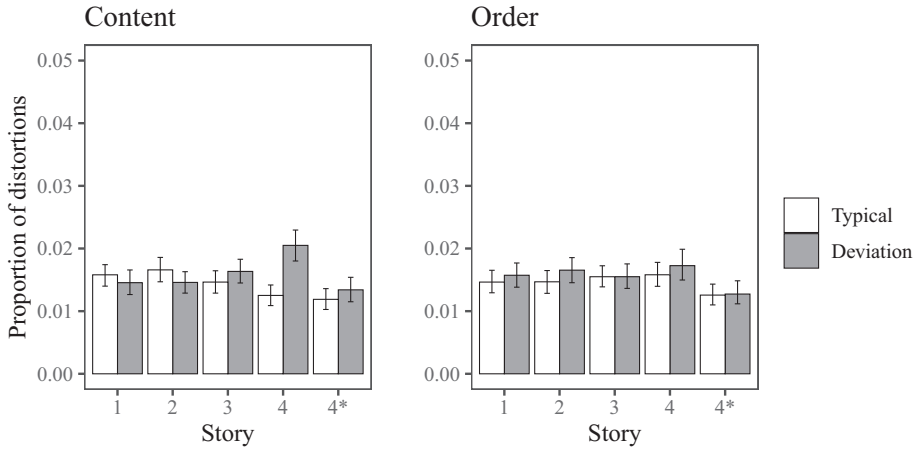

Figure 5. Distortions as a proportion of idea units in delayed recall for typical/deviation content and order conditions collapsed across delay. Asterisk indicates measure of distortions excluding deviation details (and parallel details in typical content conditions). Error bars represent 95% CIs of the means.

Internal intrusions

In each story, there was a maximum of 15 details the source of which could have been confused with another story. Results of the main analysis revealed a non-significant effect of session, indicating that such internal intrusions were relatively stable across delay, $b = 0.0001$, [−0.004, 0.004], $t(141) = 0.01$, $p = .995$. Next, there were main effects of story revealing that participants showed more internal intrusions in Story 2, 3, and 4 than in Story 1, a pattern that shows indirect support for the primacy effect, Story 2: $b = 0.04$, [0.03, 0.04], $t(1,962) = 8.10$, $p < .001$; Story 3: $b = 0.06$, [0.05, 0.06], $t(1,962) = 12.81$, $p < .001$; Story 4: $b = 0.02$, [0.01, 0.03], $t(1,962) = 4.41$, $p < .001$; Figure 4. Finally, there was a significant interaction between story and order indicating that when

contrasted with Story 1, there were fewer internal intrusions in Story 4 when order deviated than when order was typical. A follow-up analysis of Story 4 confirmed this pattern, $b = -0.02$, [−0.04, −0.003], $t(144) = 2.24$, $p = .03$; Figure 4.

Distortions

There were between 0 and 8 distortions in delayed recall. The main analysis showed a significant effect of session: there were more distortions as delay increased, $b = 0.06$, [0.008, 0.12], $t(140) = 2.21$, $p = .03$, although the effect was very small and the most substantive increase occurred between Session 1 and 2 (Session 1: $M = 1.05$, $SD = 1.19$; Session 2: $M = 1.25$, $SD = 1.22$; Session 3: $M = 1.20$, $SD = 1.28$; Session 4: $M = 1.27$, $SD = 1.37$). In addition, a significant two-way interaction between story and content indicated that in contrast with Story 1, more distortions were reported in Story 4 in the content deviation conditions. A follow-up analysis of Story 4 confirmed this pattern, $b = 0.63$, [0.30, 0.97], $t(141) = 3.72$, $p < .001$.

Similar to the analysis of recalled details, we wanted to find out if the increase in recall of distortions in Story 4 associated with the content deviation was driven by participants' distortions of the deviation details. Therefore, we conducted an analysis in which deviation details and parallel details in typical content conditions were excluded from recall of Story 4.[12] The results revealed a non-significant effect of content, $b = 0.002$, [−0.002, 0.005], $t(142) = 0.92$, $p = .36$; Figure 5, suggesting that participants in the content deviation conditions distorted their recall of the Story 4 deviation details in particular.

A focused analysis of conventionalizations revealed a pattern consistent with the general distortion analysis: the percentages of participants demonstrating conventionalizations in recall increased with delay from 4% to 5%, 6%, and 9% across sessions, $\chi^2(3, N = 2{,}276) = 12.91$, $p = .005$, and there were no significant differences across stories, $\chi^2(3, N = 2{,}276) = 3.01$, $p = .39$. Conventionalizations were more frequent among participants in the deviation content conditions than in the typical content conditions (8% versus 4%, respectively, $\chi^2(3, N = 2{,}276) = 20.06$, $p < .001$; there were no significant differences between typical and deviation order conditions, $\chi^2(3, N = 2{,}276) = 1.15$, $p = .28$).

Recall organization

Our main interest in looking at recall organization was to see if any potential decrease in recall due to order deviation (i.e., lower recall of idea units in Story 4) would be paired with lower correct sequencing. The main analysis revealed main effects of session and story showing a decrease in correct sequencing as delay increased, $b = -0.06$, [−0.08, −0.05], $t(130) = 8.04$, $p < .001$, and lower correct sequencing in Stories 3 and 4 than in Story 1, Story 3: $b = -0.03$, [−0.06, −0.01], $t(1{,}952) = 2.36$, $p = .02$; Story 4: $b = -0.08$, [−0.10, −0.05], $t(1{,}952) = 5.31$, $p < .001$. There was also a significant two-way interaction between story and the order deviation indicating lower correct sequencing in Story 4 than in Story 1 in order deviation conditions, which was confirmed in a follow-up analysis of Story 4, $b = -0.16$, [−0.22, −0.09], $t(133) = 4.79$, $p < .001$; Figure 6.

[12] *In order to create a measure that would be comparable across all stories, we calculated distortions as a proportion of units in the following way: we divided the number of distortions by 76 for Stories 1, 2, and 3, and by 72 for Story 4 (deviation details excluded).*

What do analyses of delayed recall tell us overall? All measures of recall quantity showed forgetting with time. Distortions in recall, however, increased with delay – a pattern that may indicate the perseverance of transformations (including those guided by old cultural schema). Next, we found very small direct support for general primacy and recency effects (we will elaborate on three indirect indicators of primacy in the Discussion section, though). With regards to deviation effects, the content deviation impacted recall in the opposite direction than we expected based on previous literature using familiar materials. Participants in the content deviation conditions recalled fewer details and more distortions in Story 4, largely because they failed to report and/or transformed the deviation details. The order deviation, however, showed an expected effect: participants reported (1) fewer idea units from Story 4 and (2) were less able to recall the story according to the sequence it was revealed when the order deviated. We now turn to analyses pertaining to deviation awareness.

Deviation awareness

At the end of the final delayed recall protocol, we asked participants to describe any changes between the stories they might have noticed. Twenty-seven participants mentioned that a change of the ritual that the couple performed occurred, which was coded as awareness of the content deviation (44% of participants in the content deviation conditions), and 25 participants mentioned a that a change in the order of the events in a story occurred, which was coded as awareness of the order deviation (41% of participants in the order deviation conditions).

Awareness of any deviations and recall of themes, idea units, and details

Our main interest in looking at deviation awareness was to see if awareness of any deviation would be associated with better recall. We found that participants in the deviation conditions who reported a deviation recalled 11% more story themes, $b = 0.11$, [0.03, 0.19], $t(92) = 2.76$, $p = .007$, 12% more story units, $b = 0.12$, [0.04, 0.20],

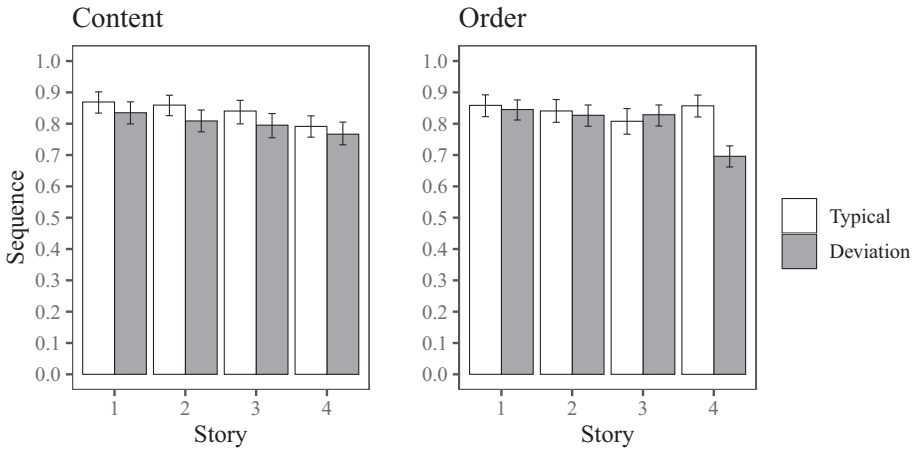

Figure 6. Sequencing in delayed recall for typical/deviation content and order conditions collapsed across delay. Error bars represent 95% CIs of the means.

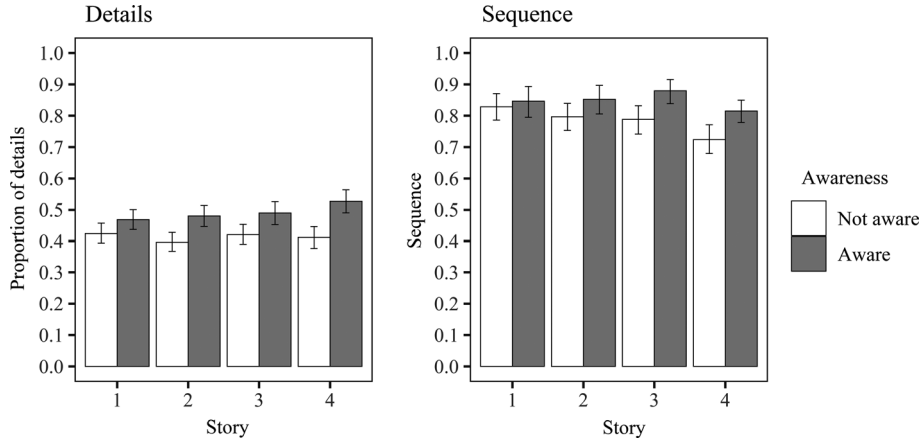

Figure 7. Deviation awareness and recall of detail and sequencing in delayed recall for typical/deviation content and order conditions collapsed across delay. Error bars represent 95% CIs of the means.

$t(92) = 2.96$, $p = .004$, and 8% more details, $b = 0.08$, [0.008, 0.15], $t(92) = 2.18$, $p = .03$, than participants who did not report that a deviation occurred. In addition, for each measure, there were significant interactions between awareness and story suggesting that the effect of awareness was stronger in recall of Story 4 than in Story 1. Follow-up analyses of Story 4 confirmed this pattern for themes, $b = 0.15$, [0.04, 0.26], $t(92) = 2.76$, $p = .007$, idea units, $b = 0.15$, [0.07, 0.24], $t(92) = 3.44$, $p < .001$, and details,[13] $b = 0.12$, [0.04, 0.20], $t(92) = 2.75$, $p = .007$; Figure 7.

Awareness of any deviations and internal intrusions and distortions

Deviation awareness was not associated with significant differences in internal intrusions, $b = -0.006$, [−0.03. 0.01], $t(92) = 0.60$, $p = .55$, and distortions, $b = 0.009$, [−0.31, 0.33], $t(92) = 0.06$, $p = .96$.

Awareness of any deviations and recall organization

The main effect of deviation awareness was not significant, $b = 0.06$, [−0.001, 0.13], $t(92) = 1.92$, $p = .06$, but there was an interaction between awareness and story specifying that in contrast with Story 1 (where there was no difference in sequencing based on deviation awareness), sequencing of Story 4 was higher for participants who reported a deviation than those who did not report a deviation. A follow-up analysis of Story 4 confirmed this pattern, $b = 0.09$, [0.01, 0.17], $t(92) = 2.31$, $p = .02$; Figure 7.

Overall, there were similar – and relatively low – levels of reporting the content and order deviation. This pattern, at least in case of the surprisingly low degree of reporting the content deviation (relative to previous research; Rubínová *et al.*, 2020), complements low recall of deviation details: it seems that participants did not pay much attention to the deviation details (or in general). Analyses of deviation awareness and

[13] *A parallel analysis with details excluding deviation details (and parallel details in typical content conditions) showed a consistent effect (*b = *0.10, [0.01, 0.18],* t*(92) = 2.31,* p = *.02).*

overall recall confirmed this idea: participants who reported that a deviation occurred remembered more than participants who did not report a deviation, and this effect was strongest in Story 4, where deviation awareness was also associated with better recall organization.

Discussion

Imagine a European couple participating in a series of Japanese tea ceremonies or employees in a manufacture adjusting to machine production. In both scenarios, those involved (need to) become familiar with a completely new and perhaps strange environment. Learning would likely entail a series of repeated events and would lead to the emergence of a new knowledge structure – a schema. We aimed to study memory processes in such scenarios by presenting participants with four versions of an unfamiliar story and measuring their learning and delayed recall with delays increasing from 10 min up to 1 month after presentation.

General and schema effects in recall of repeated unfamiliar events

In immediate recall of each story, we found that memory performance improved as participants learned more stories. Improvement was quantitative and qualitative. Quantitatively, participants reported more themes, idea units, and story-specific details in later stories. This pattern suggested that the representation of the first story served as 'scaffolding' for the recall of later stories and as foundation for the building of a new schema (e.g., Brewer & Nakamura, 1984; Ghosh & Gilboa, 2014; Minsky, 1974; Schank, 1999). Qualitatively, distortions of parts of the stories, including conventionalizations that were in line with Western cultural schemata (Bartlett, 1932), occurred less frequently in immediate recall of later stories. This pattern of substituting early distortions with new accurate representations suggested a process of gradual separation of the new schema (emerging through experience with the stories) from old cultural schemata through which participants, at least partly, initially comprehended and interpreted the stories (e.g., Cole & Cole, 2000).

In delayed reproduction, measures of quantity and accuracy of recall indicated forgetting while reporting of distortions slightly increased, which is consistent with results from studies investigating repeated retrieval of a single unfamiliar story (Bergman & Roediger, 1999; Wagoner & Gillespie, 2014). In addition, the perseverance of distortions in recall suggested that old cultural schemata remained blended into the new schema (e.g., mentioning that the couple 'exchanged vows' at the end of the ceremony), where they served a function of conserving memory (Ost & Costall, 2002).

Delayed recall analyses showed, contrary to our expectations, only a limited direct support for primacy and recency effects in the recall of details. Indirectly, however, there were three indicators of a primacy effect. First, comparing Figures 1 (immediate recall) and 2 (delayed recall), we find that recall of Story 1 remained stable (at ~65%), while recall of the other stories decreased by almost 20% on average (themes and details showed similar patterns). Second, analyses of delayed recall of details (reported in OSM) revealed that participants forgot details from Stories 2, 3, and 4 faster than details from Story 1. Third, details of Story 1 seemed to have stronger source links as

more source confusions occurred in the other stories. In brief, the first story was more immune to forgetting than the consecutive stories (see Connolly *et al.*, 2016; MacLean *et al.*, 2018; Roberts *et al.*, 2015; Rubínová *et al.*, 2020), but a direct primacy effect was probably obscured by a concurrent schema-establishment effect (as seen in Figure 1).

Deviation effects and deviation awareness in delayed recall of repeated unfamiliar events

Next, our study investigated the effects of content and order deviations on recall. Previous research using familiar materials indicated that a content deviation may lead to an increase in recall (e.g., Davidson, 1994; MacLean *et al.*, 2018), while an order deviation may lead to a decrease in recall (Rubínová *et al.*, 2020). Our results were, however, only partly consistent with previous findings. Notably, participants had difficulty remembering the content deviation details, and these details became distorted more often than typical details.[14] The order deviation had an expected negative effect on recall, although it was limited to Story 4. This lower recall was accompanied by lower level of recall organization – participants often failed to recall themes of the final story in the sequence in which they were presented, a finding that is in line with previous research (Rubínová *et al.*, 2020). Why were these effects limited to the story in which the deviation occurred, and why did we find an opposite effect of the content deviation? As we will elaborate below, we speculate that due to the use of complex unfamiliar stimuli, schema development in our study may have been at earlier stages than in previous studies.

It is assumed in repeated-event research using familiar materials that new schemata are established with the early instances and that each consecutive instance strengthens the schema (Fivush, 1984). Farrar and Boyer-Pennington (1999; see also Farrar & Goodman, 1992) use 'schema-confirmation' as a term for the first stage of schema development, in which individuals look for a reference that would help them comprehend the experience. In the process of schema-confirmation, schema-typical details receive attention until an appropriate reference schema is found, and the authors emphasize that at this stage, information is remembered only if it is part of the schema, which is unlikely for instance-specific or deviation details (Farrar & Boyer-Pennington, 1999). Only once a reference schema is confirmed, a second stage (termed 'schema-deployment') can follow, during which attention can 'be directed toward the processing of new, and possibly inconsistent, information' (1999, p. 268). Critically, according to the authors, processing may not at all reach the second stage when new schemata are developing due to attention demands (1999; see also Danby, Sharman, Brubacher, & Powell, 2019).

Our findings are consistent with this model and suggest that schema development did not reach the second stage: in delayed recall, deviation details were scarcely reported and often distorted, and participants had difficulty remembering the sequence of a story that unfolded in a different order. In addition, deviation awareness was

[14] *Connolly et al. (Experiment 3, 2016) reported a similar pattern when they compared reports about a deviation between children from two deviation groups. Children from a discrete interruption group reported more incorrect details about the deviation than children from a group in which the interruption lead to a change in behaviour of the main actor for the rest of the event. The nature of this comparison is, however, different from our study, where we compared recall of specific details that were either typical or deviated.*

relatively low (~40% for both content and order deviation). It seems that participants did not have attentional resources that would enable them to process the deviation details or to encode the new sequence – they were only able to maintain information that was consistent with the emerging schema (Farrar & Boyer-Pennington, 1999; Farrar & Goodman, 1992). Findings from previous studies using familiar materials would, in contrast, fit with the second stage of schema development. There, content deviation was associated with high awareness (Rubínová *et al.*, 2020), and content deviation effects were explained through active processing of the deviation and contrasting the deviation instance with typical instances, thus leading to enhanced recall of the deviation details, the whole deviation instance, or all instances in the series (Connolly *et al.*, 2016; MacLean *et al.*, 2018). The order deviation, as reported by Rubínová *et al*. (2020), was associated with low awareness, and the order deviation effects were explained through undermining the newly established simple schema, thus leading to disrupted recall of the whole series of instances.

Finally, our study investigated deviation awareness and its role in recall. In line with our predictions, reporting a deviation was associated with higher recall, and the difference was most apparent in recall of the deviation story (Story 4). This relationship supports the idea that participants who paid more attention to the materials (1) more frequently noticed or remembered that a deviation occurred, and (2) had overall better memory of the stories.

Limitations

This study had two main limitations. First, we administered all stories during one session, which is an unlikely (although not impossible) scenario for repeated events occurring in daily life where instances may be separated by days, weeks, or even months. There were mainly practical reasons leading to this methodological decision – conducting this study across multiple days while maintaining the sample size would not have been feasible for us, so we needed to admit some reduction in external validity. On the other hand, single-session (as opposed to spaced) presentation might have contributed to faster schema development (Price, Connolly, & Gordon, 2006). Second, we only investigated effects of deviations that occurred in the final story. Due to the nature of our study, we wanted participants to gain as much experience with the materials as possible before introducing the deviation. We, therefore, do not know what effects we could expect if deviations were included in one of the middle stories or in the first story.

Conclusion

Our investigation is a step in broadening our understanding of cognitive processes that contribute to autobiographical memory and has potential implications for applied investigative interviewing. People may encounter events that they do not fully comprehend in various contexts. When that happens, they are likely to interpret these events through knowledge they already possess, which may lead to distortions of some pieces of information. It is only with repeated experience that better understanding of what is (and perhaps was) going on is gained and that, at least some, distortions are corrected thanks to the emergence of a new schema. An instance from a repeated event sometimes differs from other instances – there may be changes in what happens and/or in how the event unfolds. Contrary to intuition, such changes may not be remembered at all, especially if the repeated event is unfamiliar and the schema is in the early stages of

development. In investigative settings, when such unfamiliar repeated events become of interest, it seems that, if there is a delay, targeting the first event during an interview may lead to most correct reporting. In addition, investigators should be sensitive to indications that an event differed. Although not many people would notice that an unfamiliar repeated event included a deviation, those who would notice and remember such deviation tend to recall more information overall.

Acknowledgements

The authors would like to thank Liz Saunders, George Burrows, Anthony Groves, Suzy Wise, and Jana Literáková for their help with developing the stimuli; Vanessa Davis for assisting at data collection; Chloe Alexis, Pamela Korsah, and Priyanka Mistry for their help with data management; and Nadine Hawkins de Namor and Ewa Skopicz-Radkiewicz for their help with reliability coding.

Conflicts of interest

All authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are openly available on OSF at https://osf.io/jhrtc/.

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Received 15 February 2020; revised version received 4 August 2020

Supporting Information

The following supporting information may be found in the online edition of the article:

Appendix S1. Results.

Appendix 1:

An example story

'There was a girl named Barbara and a boy named Michael. Mrs Smith, who was Michael's aunt, went to Barbara's house to meet with her parents. Mrs Smith told them about Michael's character, family and education. Two days later, Michael's parents called on the services of a psychic. He chose March 3rd to send a "saju tanja" to Barbara's house. On that day, Barbara's family received a box containing the "saju tanja", on which the hour, day,

month, and year of Michael's birth were written. There was also a white blouse and a green skirt for Barbara. Barbara's parents agreed about the day for the ceremony and told Michael's family. On the day of the ceremony, Michael dressed himself in blue clothes. When Michael and his parents entered Barbara's house, Michael bowed to Barbara's father. Then, Michael gave Barbara's father a wooden goose that he had brought from his house. The company went to a hall. There was a cake, some fruit and a bottle of wine. Michael and Barbara bowed to each other and exchanged three cups of wine. Barbara's father, standing next to a wooden pillar, said: "This is the happiest day of my life"'.