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Contamination or Natural Variation? A Comparison of Contradictions from Suggested Contagion and Intrinsic Variation in Repeated Autobiographical Accounts

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Contradictions and other changes across retellings can result from contamination from others, deception, or natural variation. In this study we used the social contagion paradigm to investigate (a) the relative frequencies and types of contradictions resulting from outside suggestion and from natural variation, and (b) a baseline measure of variation in autobiographical memory accounts across retellings. Participants recalled memories of four personal events. One week later, participants and confederates alternated in describing their own and summarising each other's autobiographical events. The confederates included a contradictory contagion detail in two of the participants' events. The participants then individually recalled their own events. Twenty percent of participants made contradictions due to contagion, but 63% of participants made contradictions due to intrinsic variation. Accounts also exhibited other forms of variation. Concern about negative evaluation and social closeness ratings predicted contradictions due to contagion but not intrinsic variation. We discuss applications to forensic settings.

General Audience Summary

Inconsistencies in certain specific details can affect the perceived truthfulness of a memory account. Contradictions and other changes across memory reports often are interpreted as either contamination from outside suggestion or as a sign of deception. Yet, much research has indicated that memory for experienced events is malleable and thus susceptible to natural variation. In this study we used a procedure called the social contagion paradigm for autobiographical memory to investigate (a) the relative frequencies and types of contradictions resulting from outside suggestion and from natural variation, and (b) a baseline measure of variation in memory accounts of personal experiences across retellings. Participants recalled memories of four personal events. One week later, participants and confederates alternated in describing their own and summarising each other's personal events. The confederates included a contradictory detail in summarising two of the participants' events. The participants then individually recalled their own events. We found that 20% of participants made contradictions due to outside suggestion but that many more (63%) made contradictions that were spontaneous and not due to outside suggestion. We also found that only contradictions due to outside suggestion were influenced by fear of negative evaluation and lower levels of social closeness, whereas contradictions due to other influences were not. Finally we found that participants' freely recalled memories across retellings were generally quite variable. Some contained contradictions, but all contained omissions and additions. Applications to real world settings are discussed.

Keywords: Social contagion, Autobiographical memory, Contradictions, Consistency, Social influence, Forensic, Asylum seeking

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People often are sceptical about the truthfulness of reported memories if there are contradictions in certain details across retellings. We tend to interpret inconsistency as indicating that the entire memory report, rather than just the inconsistent details, is untrustworthy (e.g., Barnier, Temler, & Sutton, 2014; Miller & Armstrong, 2015; Mitchell, 2019). However, this scepticism often is unwarranted. Contradictions in certain details or statements do not indicate overall inaccuracy of an account (Fisher, Vrij, & Leins, 2013). Moreover, there is a temptation to interpret contradictions and other changes as an indication that the memory has been "contaminated" by social influence from an outside source, such as suggestive interviewing or co-witness discussion (Loftus, 2005; Paterson & Kemp, 2006; Wright, Memon, Skagerberg, & Gabbert, 2009). Likewise, there is a temptation to interpret contradictions as an indication that the person is lying (Strömwall & Granhag, 2003). However, we do not know if these interpretations are reasonable because we do not know how variable adults' autobiographical accounts are in the absence of outside suggestion and/or a motivation to deceive. The current study offers a comparison of the relative frequencies and types of contradictions in autobiographical remembering due to outside suggestion versus natural variation across retellings.

Impact of Outside Suggestion on Autobiographical Remembering

Memory changes can occur due to outside suggestion when individuals discuss details of an event together and one person suggests an inaccurate detail, which alters what another later claims to remember. Social contagion (Numbers, Barnier, Harris, & Meade, 2018; Roediger, Meade, & Bergman, 2001) and memory conformity (Gabbert, Memon, & Allan, 2003; Gabbert, Wright, Memon, Skagerberg, & Jamieson, 2012) paradigms examine the effects of social influence on memory and are considered models for real world co-witness discussion. In these experiments, participants are exposed to misleading information (contagion) after viewing slides or videos, either after suggestion from a confederate posing as a peer, or in discussion with another participant who unknowingly viewed a slightly different version of a videorecorded event. Participants are then tested individually in a private setting to examine their memory recall for the original stimuli. The typical finding is that some participants falsely recall contagion items following suggestion. Participants altered details such as types of clothing or objects, and effects were strongest for schematically similar peripheral details (Meade & Roediger, 2002; Paterson, Kemp, & Ng, 2011). Evaluations of social closeness also influenced acceptance of suggestion. Higher likeability ratings, concern for negative evaluation, and quality of social relationship increased susceptibility to accepting contagion (Hope, Ost, Gabbert, Healey, & Lenton, 2008; Wright, London, & Waechter, 2010). Social contagion has been attributed to misremembering due to source confusion (Johnson, Hashtroudi, & Lindsay, 1993).

The social contagion literature implies that memory can be protected by preventing people talking about a previously shared event. But autobiographical memory of real, personally-experienced events is more complex than memory for slides and videos. Further, events that were not experienced together may be discussed. It is worth considering then if social contagion extends to autobiographical memory for personal unshared events. Harris, Barnier, Sutton, and Khan (2017) first asked this question by adapting the social contagion paradigm to autobiographical memory. In their methodology, participants individually wrote four milestone personal experiences (such as 18th birthday) and then one week later described them to a confederate who, in turn, described four (scripted) "memories" of his or her own. The participant and confederate then summarised each other's memories to one another. When summarising participant's memories, the confederate inserted evaluative contagion items (e.g., a positive contagion for the birthday memory was "It was a big turning point in your life"; a negative contagion was "It was no big deal"). Finally after a brief delay, the participant individually and privately wrote down his or her events. Thirty percent of participants made changes in their accounts at rates consistent with social contagion. Although Harris et al. did not specifically examine contradictions, they found a robust social contagion effect. For example, some participants incorporated more negative details after suggestion of the negative evaluative statement. The researchers also noted that the majority of participants made other types of changes to their repeated accounts: they added and omitted details and adopted aspects of the confederate's script. This pattern suggests that in addition to the impact of outside suggestion, autobiographical reports may vary for intrinsic reasons and it is important to chart the baseline of this variation alongside social contagion.

Intrinsic Variation in Autobiographical Remembering

Since autobiographical remembering is a reconstructive (not reproductive) process driven by changing goals and functions (Bluck, Alea, Habermas, & Rubin, 2005; Conway & Pleydell-Pearce, 2000), we should expect intrinsic variation across repeated memory reports. Sharing memories serves the important function of building and maintaining relationships (Barnier, Sutton, Harris, & Wilson, 2008; Bluck et al., 2005; Pasupathi, 2001) and we organise details into narratives that help us better understand and communicate with one another (Fivush, Habermas, Waters, & Zaman, 2011). We often fill gaps in memory with details most congruent with our self-identity and social motivations (Barclay, 1996; Bluck et al., 2005; Conway, Singer, & Tagini, 2004; Echterhoff, Lang, Krämer, & Higgins, 2009). Retellings then naturally vary because autobiographical memories update as goals and functions shift (Bluck et al., 2005; Conway, 2005). Repeated autobiographical recollections should be expected to vary with additions, omissions, and sometimes contradictions (Cameron, 2010; Fisher et al., 2013). Details such as exact times, dates, peripheral descriptions, estimates of frequencies, and evaluations for mental states are particularly vulnerable to change (Bahrick, Hall, & Da Costa, 2008; Cameron, 2010; Offer, Kaiz, Howard, & Bennett, 2000; Strange, Dysart, & Loftus, 2014).

Identifying types and relative frequencies of changes due to outside suggestion versus intrinsic variation is important not only in contexts where eyewitness memory plays a pivotal role

but in other applied settings. For example, in the asylum-seeking context, claimants are expected to report detailed autobiographical narratives of personal experiences across repeated interviews and appeals while adhering to stringent forensic standards of accuracy (Herlihy, Jobson, & Turner, 2012; Holland, 2018). Many have no personal identification or corroborating evidence (Refugee Council of Australia, 2012). Contradictions regarding people, places, times, dates, and travel itineraries may be viewed as deceptive and taken to undermine the credibility of the claimant and the validity of their claim (Cameron, 2010; Herlihy, Gleeson, & Turner, 2010; Herlihy et al., 2012; Van Veldhuizen, Maas, Horselenberg, & Van Koppen, 2018). In Australia, more than 2000 asylum seekers are grouped in detention with others who have experienced different yet similar types of events (Australian Department of Home Affairs, 2019; AHRC, 2017). Memory changes may occur when asylum seekers share similar stories with one another. In these situations, it is unclear whether the source of contradictions is contamination, deception, or intrinsic variation.

The Current Study

More research is needed to understand the parameters of variation across repeated retellings of autobiographical events, especially the relationship between outside suggestion and intrinsic variation. In the present study, we measured and compared relative frequencies and types of contradictions in memory reports due to outside suggestion versus intrinsic variation. We also measured additions and omissions to enrich our picture of the baseline for autobiographical variation in the context of social influence. To do this, we extended Harris et al.'s (2017) autobiographical version of the social contagion paradigm. We asked participants to provide autobiographical accounts for four events across two occasions one week apart. For some events a confederate suggested contradictory contagion details. Consistent with past social contagion findings, we expected that some participants would accept the social contagion into their memory accounts. But we expected even more would change details spontaneously, reflecting natural variation in autobiographical remembering across retellings. Finally, since relationship factors have been shown to influence the uptake of memory contagion (Hope et al., 2008; Pasupathi, 2001), we expected that the perceived quality of the social interaction between the participant and confederate—including concerns about likeability and feelings of social closeness—might influence the type or degree of variation across retellings.

Method

Participants and Design

Fifty second-year psychology undergraduate students from Macquarie University volunteered to take part in the experiment for partial fulfilment of a course requirement. Eight men and 42 women participated ($M_{age} = 20.80$ years, $SD = 3.35$, age range: 18–36 years). Data for one participant was excluded as she did not return for the second session of the experiment.

We based our procedure on Harris et al.'s (2017) autobiographical adaptation of the social contagion paradigm. We used a within-participants design, manipulating the type of contagion items (sensory or contextual) and exposure to suggested contagion (contagion or no contagion) within participants. Contradictions due to suggested contagion and contradictions due to intrinsic variation were the primary dependent variables. We also measured additions and omissions in memory accounts as well as evaluations of the social interaction with the confederate.

Materials

Events. Participants described four autobiographical events that we later used as targets for social contagion. These events were recent (approximately 2 years old) and personally significant for the selected sample and included first date, high school certificate (HSC) exam, high school formal, and 18th birthday. If the participant was older than 19 years of age or could not vividly remember their 18th birthday, they described their most recent memorable birthday (i.e., 21st, 25th or 30th birthday). In cases where participants had not experienced any of these events or reported having a very poor memory of an event, they wrote about alternative autobiographical events such as first day of university or first day at most recent place of employment.

Contagion. The contagion items were either sensory or contextual concrete details. Each participant received one sensory contagion item and one contextual contagion item. The sensory contagion item was a detail that described the clothing that a person wore at the event. If participants did not provide clothing details then another sensory detail (e.g., hair style) was suggested that matched the type of sensory detail provided by the participant. The contextual contagion item was a detail specifying location or other spatial information (e.g., building where their HSC exam took place). We chose these contagion items because (a) they are similar to the types of details used in traditional social contagion type experiments, and (b) earlier studies indicated sensory and contextual details were most likely to be spontaneously elicited across repeated autobiographical memory accounts (Temler, 2015).

For each event, contagion items were details that directly contradicted details mentioned during initial elicitation of participants' autobiographical memories. Participants' report of personal memories of unshared events made it impossible to choose identical contagion items across every single person. For example, if we chose "black shirt" as our contagion item across all participants and some participants reported "black shirt" at final individual recall, we would not know if the report represented a contradiction or addition unless the participant explicitly divulged a contradictory detail at initial recall (e.g., white shirt). To overcome this obstacle as best as possible, we specifically chose details as contagion items that contradicted details elicited at initial recall. The contagion items suggested were therefore different for each participant. Although this methodological decision affected consistency, it increased the reliability and ecological validity of our test of social contagion.

Scripts. Generic scripted autobiographical events were drawn from Harris et al. (2017). The scripts mirrored the length

Table 1
Confederate Script.

First Date
I was extremely nervous. I kept thinking that we weren't going to have anything to say or that I might do or say something stupid. I made sure that I looked good for my date. I wore a black shirt and jeans/I wore a black dress and silver heels. I picked her up from her house (he picked me up from my house). When I saw my date I got even more nervous, I could hardly say 'hi'. From my (her) house we went for a movie. After the movie we went to a restaurant where we had some Italian food, which was delicious. I paid for her even though she insisted that I didn't (he paid for me even though I insisted that he didn't). We found it a little difficult to make conversation at first, but then slowly we both got more comfortable with each other and we ended up having lots of things to talk about. Considering how nervous I was, I think that it ended up being a good night.

and experiences of participants' events. Table 1 provides a sample first date script.

Additional materials. During the experiment we used the Trail Making Task (Reitan, 1958) as a filler task and the Social Closeness Scale drawn from the Multidimensional Personality Questionnaire (Tellegen, 1982). This consists of 22 true and false questions. High scorers describe themselves as sociable, liking people, taking pleasure in and valuing close interpersonal ties, warm and affectionate, and turning to others for comfort and help. We also asked participants three questions about their perceived social interaction with the confederate: (a) On a scale from 1 to 10, where 1 means not at all and 10 means very much, how connected did you feel to the other participant who took part in this study? (b) On a scale from 1 to 10, where 1 means not important and 10 means very important, how important was it to you that the other participant liked you? (c) On a scale from 1 to 10, where 1 means not comfortable and 10 means very comfortable, how comfortable did you feel telling your memories to the other participant?

Procedure

Confederate training. Two women and two men (three final-year students and one recent graduate) were recruited as confederates. They were selected on the basis that they spoke English fluently and presented with good interpersonal skills. The confederates memorised scripts of all seven autobiographical events referred to in the materials section. Confederates received training to ensure that their verbal and behavioural responses were consistent with the experimental protocol. Confederates were matched for gender with participants. One female confederate was the confederate for the 42 female participants. Although using one female confederate increased potential for confederate-specificity, it decreased confounding factors of poorly memorised scripts. One male confederate was the primary confederate for six male participants and another male confederate was the reserve confederate for two male participants.

Experiment. The experiment was conducted over two sessions. Session 1 lasted 30 minutes. Session 2 lasted 60 minutes and was held seven days after Session 1. All participants were tested individually in Session 1. All participants were tested individually with a single confederate in Session 2. At the beginning of the experiment, participants were told that we were examining individual differences in autobiographical remembering. There were five phases: individual recall, description, summary and contagion, filler task, and final individual recall.

Session 1. *Individual recall phase.* Participants wrote detailed accounts of four autobiographical events. They were asked to think about what they remembered happened from beginning to end, their sensory impressions, where and when the event took place, how they felt and what they thought, and any social interactions they had with others. These cues reflect the qualities of experiences (Johnson et al., 1993) and were the same cues used by Harris et al. (2017). Participants had 5 minutes to write about each autobiographical event. The four events were introduced separately throughout the session and were randomised across participants.

Session 2. *Description phase*. One week later the participant and confederate (apparent participant) alternated in recalling their own memories. These memories were the same ones that the participant wrote about in Session 1. The experimenter told the participant and confederate to pay close attention to what the other person said as they would be asked to summarise the other person's memory. They were given booklets and instructed to write down the six most important details of the other person's memories in their summaries. The confederate always began first. After the confederate finished describing his or her first autobiographical event (the memorised script), the participant described his or her first autobiographical event. This pattern of turn taking took place until the confederate and participant finished describing all four events to each other.

Summary and contagion phase. The participant and the confederate then alternated summarising each other's memories of each of the four events. The participant always began summarising first. For two of the four events, the confederate included the sensory or contextual contagion item when summarising the participant's memories. The contagion item was always the third of the six details mentioned by the confederate in his or her summary of the participant's autobiographical memories. The confederate did not have to memorise the contagion items as the experimenter wrote contagion items in the confederate's booklet used by the confederate during the description and summary phases of the experiment.

When possible, the sensory detail was changed in the "first date event" and the contextual detail was changed in the "high school certificate event." To exclude possible primacy and recency effects, social contagion always was provided for the second and third events that participants described during the description phase of the experiment. The order of sensory and contextual contagion items was counterbalanced. For the first and fourth event where social contagion was not provided the confederate simply summarised the participant's experiences without offering any changed details.

Filler task. After the participant and confederate summarised all events to each other, the experimenter separated them. The experimenter then gave the participant the Trail Making Task (Reitan, 1958) and told him or her that the task assessed

Table 2
Types of Contradictions.

Contradiction	Description	Example
Sensory	Discrepancies in what the participant saw, heard, smelled, tasted, and/or touched.	Participant 5 described her first date event. In Session 1 she reported she was wearing "denim shorts." Then in Session 2 she reported she was wearing "a black skirt."
Contextual	Discrepancies in location or spatial contextual details. This includes mode of travel and any location information.	Participant 8 described her high school formal event. In Session 1 she reported, "A friend picked us up to go to the after party." Then in Session 2 she reported, "A friend gave us a lift home. We didn't go to the after party."
Temporal	Discrepancies in exact times, temporal experiences, or order of events.	Participant described her first date event. In Session 1 she reported, "We went to the restaurant then to the movies." Then in Session 2 she reported "We went to the movies first and then got something to eat."
Quantity	Discrepancies in numerical differences in items or people.	Participant 8 described her first date event at a skating rink. In Session 1 she reported, "There were only a few people there." Then in Session 2 she reported, "There was only one couple there."
Evaluation	Conflicting retrospective evaluation of mental states of the event or episode.	Participant 4 described her 18th birthday event. In Session 1 she reported, "The food looked and tasted good." Then in Session 2 she reported, "The food was average though."
Action and people	Discrepancies in specific performed actions or discrepancies in people who performed the actions.	Participant 18 described his first date event. In Session 1 he reported, "They smoked and drank." Then in Session 2 he reported, "We smoked and drank."

perceptual ability and they had 5 minutes to complete it. The confederate left the laboratory at this point in the experiment and did not complete the filler task or any of the final recall tasks. The experimenter left the room every 5 minutes to give the impression that the confederate was undertaking an identical procedure.

Individual final recall phase. After the filler task, the participants individually wrote detailed accounts for four autobiographical events just as in Session 1. They were again asked to think about what they remembered happened from beginning to end, their sensory impressions, how they felt and what they thought, where and when the event took place, and any social interactions they had with others. After participants wrote down all four events, they completed the Social Closeness Scale and answered the three questions measuring perceptions of the social interaction with the confederate.

Post-experimental inquiry. Participants gave reasons as to why they did or did not accept the contagion items. The experimenter thanked participants for their involvement in the experiment. Post-experimental inquiry indicated that no participants were suspicious that the other participant actually was a confederate.

Definitions and Coding

Contradictions were coded as either being due to suggested contagion or intrinsic variation. All contradictions were defined and coded with the forensic high stringent standard for accuracy (e.g., Herlihy et al., 2012; Simon, 2012).

Suggested contagion. Contradictions due to suggested contagion were coded when participants recalled the specific contagion item in Session 2 that opposed an original detail recalled in Session 1. The contagion item was either a falsely suggested sensory or contextual detail. Participants could receive a score of 0, 1.0, or 2.0. Inter-rater reliability was very high. The experimenter and independent coder agreed 100% on contradictions due to suggested contagion.

Intrinsic variation. Coders were instructed to identify what they perceived as "direct discrepancies in details or ideas between Session 1 and Session 2 accounts that happened spontaneously and were not due to anything the confederate said." All of the participants' written accounts from Session 1 and Session 2 were reviewed and scored by two raters. Inter-reliability agreement was very high ($\kappa = .943$, $p < .0005$).

Coders then coded contradictions by category. Table 2 shows the six types of contradictions due to intrinsic variation coded and identified. The categories of the types of contradictions were developed across a series of experiments by Temler (2015). Inter-reliability was high ($\kappa = .813$, $p < .0005$).

Finally, data were coded for other changes across retellings that were not direct contradictions. Coding instructions for these other changes are included in the supplementary material and results section.

Results

One hundred and ninety-six events were elicited over each of the two sessions. A total of 392 written accounts of these events were gathered across the two sessions. Most participants generated memories for the four main autobiographical events ($n = 49$ for birthday; $n = 44$ for first date; $n = 37$ for first HSC exam; $n = 43$ for formal). Participants also generated memories

Table 3
Observed and Expected Distribution of Participants Who Made Contradictions Due to Social Contagion.

Suggested contagion	Observed	Expected	Residual
Yes	10	14.7	−4.7
No	39	34.3	4.7

Table 4
Observed and Expected Distribution of Participants Who Made Contradictions Due to Intrinsic Variation.

Intrinsic variation	Observed	Expected	Residual
Yes	30	10	−20.0
No	18	38	20.0

for the substitute events ($n = 16$ for first day at university; $n = 7$ for first day of first employment). Events containing contagion items were $n = 35$ for first date, $n = 22$ for HSC exam, $n = 17$ for birthday, $n = 14$ for formal, $n = 9$ for first day of university, and $n = 1$ for first day of employment. Primary analysis of data focused on (a) contradictions due to suggested contagion, and (b) contradictions due to intrinsic variation, while secondary analysis focused on the relationship between contradictions and (c) other changes across accounts (additions and omissions), and (d) social closeness and evaluation of the social interaction ratings.

Contradictions Due to Suggested Contagion

Frequency. Twenty percent of participants recalled at least one of the two suggested concrete details from the confederate that directly contradicted their own elicited concrete details in Session 1. No participants accepted both contagion details. The data were analysed nominally (as whether participants reported any contagion or not). A chi-square goodness-of-fit test was performed to test whether the distribution of contradictions due to suggested contagion was different from the expected 30% frequency based on previous social contagion findings (e.g., Harris et al., 2017). Table 3 shows the observed and expected values. Although lower than expected, our sample distribution was not significantly different, χ^2 (1, $N = 49$) = 2.147, $p = .143$, and therefore consistent with expected social contagion distribution.

Type. Twelve percent accepted sensory contagion and eight percent accepted contextual contagion items suggested to them. There were no instances where a participant recalled both their original detail and the contradictory contagion item or where the participant recalled a contagion item in an event different from the target event. All ten participants who accepted contagion reported their contradictions as plausible when it was pointed out by the experimenter. For example, Participant 9 said, "I either wear my hair in a pony tail or bun" when describing why she accepted the contagion item for having her hair in a bun. Participant 16 said, "I remember the location of my classes but I don't pay attention to the names of the buildings" when explaining why she accepted a contagion item for a different building. Participant 5 said, "I was just guessing both times, I really don't remember what colour shirt he was wearing" when explaining why she accepted a contagion item for a white shirt when she originally said a black shirt.

Contradictions Due to Intrinsic Variation

Frequency. Overall, 62.5% of participants contradicted themselves in details during Session 2 final recall when no contagion was introduced for the contradicted details. Eighteen participants made no contradictions, 14 participants made 1 contradiction, 8 participants made 2 contradictions, 4 participants made 3 contradictions and 4 participants made 4 contradictions across their four accounts. A Wilcoxon signed-rank test found no significant difference in the number of contradictions due to intrinsic variation in the contagion and control events ($Z = -0.771$, $p = .441$). A chi-square goodness-of-fit test was performed to examine if the distribution of participants who made contradictions due to intrinsic variation differed significantly from the distribution of participants who made contradictions due to suggested contagion. Data were collapsed and analysed nominally (as whether participants made any contradictions due to intrinsic variation or not). Table 4 shows the observed contradictions due to intrinsic variation and expected values (based on distribution of contradictions due to suggested contagion). The distribution was significantly different, χ^2 (1, $N = 48$) = 50.53, $p < .0005$, indicating participants were much more likely to make contradictions due to intrinsic variation than suggested contagion.

A chi-square test of independence was performed to examine the relationship between contradictions due to intrinsic variation and contradictions due to suggested contagion. As can be seen by the frequencies cross-tabulated in Table 5, the relationship between these variables was not significant, χ^2 (1, $N = 48$) = .034, $p = .854$. This indicates that there is no evidence of a relationship between these contradictions.

Type. A total of 58 contradictions were coded. Participants contradicted themselves in terms of type of clothing (dress versus shirt), food eaten (chicken versus beef), mode of travel (cab versus limo to formal), times and days (2:00 am versus 3:00 am), (Thursday versus Saturday), quantity (there were 5 of us versus there were 6 of us), evaluation (food was good versus food was average), and action and people (we left after we won versus we left after we lost; we drank versus they drank). Figure 1 shows the percentage of different types of coded contradictions due to intrinsic variation that all participants made across repeated autobiographical events.

Table 5
Cross-Tabulation of Contradictions Due to Intrinsic Variation and Contradictions Due to Suggested Contagion.

	Intrinsic variation		
Suggested contagion	Yes	No	Total
Yes	6	4	10
No	24	14	38
Total	30	18	48

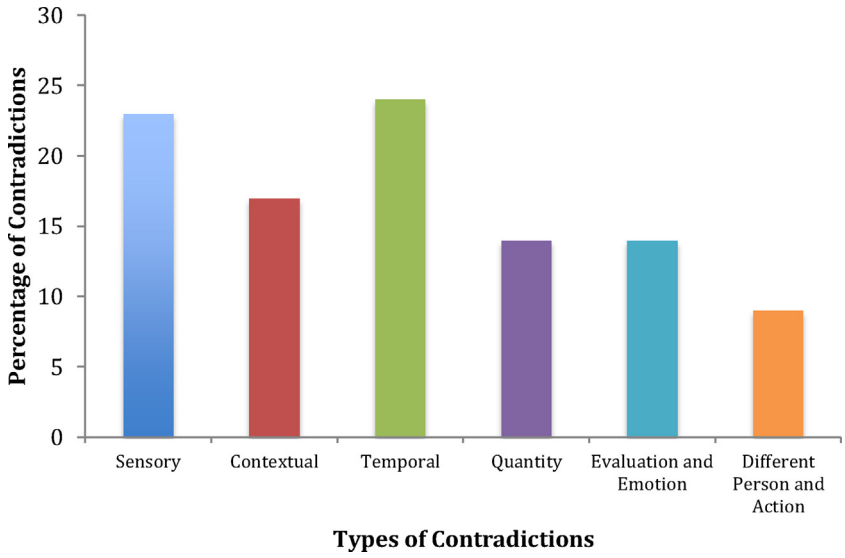

Figure 1. Percentage of types of contradictions due to intrinsic variation across four events.

Other Changes Across Accounts

We examined other changes in accounts besides contradictions across the two retellings. One hundred percent of participants added ($M = 8.45$, $SD = 3.60$) and omitted ($M = 9.86$, $SD = 3.35$) details across their accounts. Further, 86% of participants added details or gist that mimicked the confederate's own memorised script (e.g., "When I saw my date I got even more nervous"). This demonstrates other forms of variation across participants' autobiographical accounts.

Contradiction relationship with other variables. We next explored whether uptake of contagion was influenced by aspects of the social interaction and by other variations across retellings. We performed a binary logistic regression analysis with contradictions due to suggested contagion as the dependent variable and additions, omissions, Social Closeness Scale, and the three questions on the perceived social interaction with the confederate ("How connected did you feel to the other participant?"; "How important was it to you that the other participant liked you?"; "How comfortable did you feel telling your memories to the other participant?") as predictor variables. In total, 47 cases were analysed and the full model was significant ($\chi^2 = 26.51$, $df = 8$, $p = .001$). This model accounted for between 43.1% and 66.9% of variance in acceptance of contagion, with 97.3% of participants who did not accept contagion correctly predicted and 70% of participants who did accept contagion correctly predicted. Overall, 91.5% of predictions were accurate. Table 6 gives the coefficients and the Wald statistics and associated degrees of freedom and p-values for each of the predictor variables. This shows that only ratings on the Social Closeness Scale and evaluations of perceived likeability reliably predicted acceptance of suggested contagion. Specifically, an increase in ratings on the Social Closeness Scale was associated with a decrease in odds of contradictions due to suggested contagion by a factor of 0.593 and an increase in ratings to the question "how important to you was it that the other participant liked you" was associated with an increase in the odds of contradictions due to suggested contagion by a factor of 3.80.

We likewise explored whether contradictions due to intrinsic variation were influenced by aspects of the social interaction and by other variations across retellings. We performed a Poisson regression analysis, with the number of contradictions due to intrinsic variation as our dependent variable and additions, omissions, Social Closeness Scale, and the three questions on the perceived social interaction with the confederate (age and gender included as control) as our predictor variables. Our analysis failed to reveal a significant model and did not adequately fit the data ($\chi^2 = 10.45$, $df = 8$, $p = .235$). However, we note that there appears to be some evidence that our control variable age influenced the number of contradictions due to intrinsic variation ($B = -.175$, $p = .03$), although the evidence is relatively weak and therefore cannot be interpreted.

Discussion

The aim of this study was to examine consistency across retellings of personally experienced events. We used the social contagion paradigm for autobiographical memory to examine relative frequencies and types of contradictions from outside suggestion and contradictions from intrinsic variation. We gained baseline information on autobiographical variation across retellings.

Outside Suggestion

After hearing confederates falsely summarise details, participants incorporated suggestions into their own retellings of personally experienced events. Twenty percent of participants accepted at least one of the contagion items. Although the relatively low uptake may reflect the more personal, owned nature of targeted memories, the frequency is comparable to other social contagion experiments (Harris et al., 2017; Meade & Roediger, 2002) and demonstrates the impact of outside suggestion. Participants made contradictions due to contagion in specific details

Table 6
Suggested Contagion and Relationship with Other Variables.

Predictor variable	*B*	S.E.	Wald	df	*p*	Exp(*B*)
Additions	−0.229	0.202	1.290	1	.256	0.795
Omissions	0.556	0.297	3.506	1	.061	1.744
Social Closeness Scale	−0.522	0.235	4.926	1	.026	0.593
How connected did you feel to the other participant?	−0.701	0.475	2.175	1	.140	0.496
How important to you was it that the other participant liked you?	1.335	0.582	5.252	1	.022	3.800
How comfortable did you feel telling your memories to the other participant?	−0.580	0.449	1.667	1	.197	0.560

Age and gender included as control and found to be insignificant.

similar to those identified in previous experiments examining contamination from social influence for shared simple material (Paterson et al., 2011; Roediger et al., 2001; Wright & Stroud, 1998). They judged reported contagion details as plausible and aligned with their memory accounts. This is consistent with previous work showing that the more similar confederates' statements are to original information, the stronger the social contagion effect (Meade & Roediger, 2002). We also found that aspects of the social interaction influenced acceptance of contagion. Participants who were more concerned about whether the confederate liked them and who reported lower levels of social closeness were more likely to accept outside suggestion. Although we expected that higher social closeness scores would predict acceptance of contagion (based on Hope et al., 2008), our result may instead suggest that people who fear negative evaluation from others are more likely to accept contagion (Tainaka, Miyoshi, & Mori, 2014; Wright et al., 2010). Finally, our research extended Harris et al.'s (2017) results to freely recalled autobiographical memories, highlighting both the reliability and ecological validity of these kinds of adaptations to memory paradigms designed to capture the impact of outside suggestion.

Intrinsic Variation

Despite the uptake of outside suggestion by 20% of participants, many more people (62.5%) made spontaneous contradictions due to intrinsic variation. This pattern provides a fresh perspective on the often-cited conclusion from the social contagion literature that memory changes occur because of contamination. This finding also contextualises and highlights the importance of extending accuracy-driven paradigms focused on simple memory material to autobiographical memory. Our findings are consistent with research that illustrates that contradictions should be expected across retellings and can occur for a range of other reasons besides outside suggestion (Cameron, 2010; Fisher et al., 2013; Hyman & Loftus, 1998). Contradictions predominantly were in sensory, contextual, and temporal details that are important for supporting the social narrative and are vulnerable to change due to shifting goals and functions of autobiographical memory (Barclay, 1996; Bluck et al., 2005; Conway et al., 2004). Not only were there more contradictions due to intrinsic variation, but these appeared to be independent of suggested contagion. Further, in contrast to uptake of contagion, social closeness ratings and perceived evaluations of the social interaction with confederate did not predict the number of contradictions due to intrinsic variation, further supporting the apparent difference between these types of contradictions.

Autobiographical Memory Variation Baseline

Although participants generally made few contradictions, all made numerous additions and omissions and many adopted details and narrative structure from the confederate's script when there was no motivation to lie. Our findings are consistent with earlier work showing that inconsistency across memory accounts is normal and influenced by a range of factors besides direct outside suggestion (Barnier et al., 2008; Bond & Smith, 1996; Cialdini & Goldstein, 2004; Fisher et al., 2013; Harris et al., 2017; Koriat, Goldsmith, & Pansky, 2000; Pasupathi, 2001; Skowronski & Walker, 2004).

Natural variation must be considered when interpreting results from controlled laboratory-witnessed events, particularly when applying conclusions to real-world forensic situations where the stakes are high. Although misremembering does not usually cause significant problems in everyday life, the same processes govern our autobiographical memory legal settings.

Our research has limitations. First, like most experimental work across different research traditions, our study was conducted in an everyday rather than forensic context. Nevertheless, previous research has demonstrated that participants make contradictions in similar types of details even when forensically framed (Strange et al., 2014). Second, although gender effects were insignificant in our modelling, it is not possible to exclude gender differences due to the small number of men in our sample. There is much research and debate about the degree to which women are encouraged in many cultures to be more alert to social cues and relationships (Carli & Bukatko, 2000). It is plausible that this factor would play a role in shaping social influence on memory. Third, participants were drawn from a student sample whereas forensic samples may vary in background and age. By offering data on the natural instability of autobiographical remembering, our findings help to fill an important gap in our knowledge of memory consistency and inconsistency with and without outside suggestion. Future research should continue to investigate how individual and social factors influence variation in autobiographical reports. Such adaptations of powerful laboratory paradigms can continue to extend accuracy-driven investigations to everyday situations of repeated retelling, increasing both the ecological validity and the contribution of memory research in applied settings.

Conflict of Interest Statement

The authors declare no conflict of interest.

Author Contributions

All the authors conceived and designed the experiment. Temler performed the experiment and analysed and interpreted the data. Temler primarily wrote the paper, with comments from all other authors. Sadly, Doris McIlwain passed away before completion of this manuscript. Her family has given permission to have her included as an author.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jarmac.2019.12.001.

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