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Social Transmission of False Memory in Small Groups and Large Networks

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Abstract

Sharing information and memories is a key feature of social interactions, making social contexts important for developing and transmitting accurate memories and also false memories. False memory transmission can have wide-ranging effects, including shaping personal memories of individuals as well as collective memories of a network of people. This paper reviews a collection of key findings and explanations in cognitive research on the transmission of false memories in small groups. It also reviews the emerging experimental work on larger networks and collective false memories. Given the reconstructive nature of memory, the abundance of misinformation in everyday life, and the variety of social structures in which people interact, an understanding of transmission of false memories has both scientific and societal implications.

Keywords: False memory; Collective memory; Collaborative memory; Social contagion; Memory distortions

1. Introduction

Remembering is often a social experience. We share with others our past experiences, our highs and lows, as well as news and gossip. Such interactions are undoubtedly rich sources for valuable, veridical information. These interactions are also opportunities for

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developing and transmitting information that can be erroneous, distorted, or false. Because social interactions are embedded within larger social networks, false memories that develop in small-scale settings such as those consisting of friends, partners, and other small groups can propagate across larger and increasingly complex networks. Social transmission of false memories is a relatively new topic in cognitive-experimental research, but it is not a peculiar phenomenon. In many ways, it is an expected outcome because individual memory is known to be fallible and malleable, misinformation is widely available in our environment, and the psychological processes involved in the social sharing of memory are conducive for such transmission.

As memory is a process of reconstruction rather than verbatim recollection, individuals routinely exhibit forgetting and distortions (Bartlett, 1932; Roediger, 1996; Roediger & McDermott, 2000). While everyday memory distortions are usually innocuous, errors such as misremembering an innocent individual as a perpetrator creates serious harm. Furthermore, malleability of memory not only can lead people to report inaccurate memories of real events, but people can also report false recall of events that are entirely fabricated and never happened (Gallo, 2006; Loftus, 2005).

Memory distortions and errors that arise from the malleable nature of memory can be amplified by misinformation in our environment. From textbooks (Hubisz, 2003) and encyclopedias (Giles, 2005) to social media and hoax news sites, misinformation is abundant. Social propagation of such misinformation gives rise to false beliefs as well as false memories. While the two are distinct phenomena, they are also related. False beliefs develop when people remember the information correctly but the information itself is false, for example, when someone learns information from an erroneous textbook or believes a fake news article. Exposure to such misinformation can also contaminate previously accurate memories and, as a result, give rise to distorted or false memories. As online outlets and social media proliferate, the ability to create, share, and receive content on such large-scale platforms has potentially increased the possibilities for memory distortion.

Furthermore, the social transmission process itself can contribute to false memory and memory distortion. In Bartlett's (1932) seminal studies on the reconstructive nature of memory and social transmission of memory, he described substantial changes in memory when individuals relayed information from one to another in a social chain. Using such chains, Bartlett (1932) reported one of the earliest demonstrations of the transmission of memory errors and distortions, including the loss, insertion, or altering of information. In this vein, a growing body of recent research on collaborative remembering shows how processes unique to collaboration, such as disrupting, error-correction, or augmenting mutual memories can reshape memories.

In brief, false memories can be a consequence of the malleability of memory, exposure to misinformation, and the social transmission of information. With respect to social transmission, whether it is through a friend accidentally sharing inaccurate news in a conversation or on his or her social media, or in a group of co-workers together falsely remembering the details from a meeting, false memories can emerge across a variety of social contexts. False memories develop within individuals and groups, propagate across social networks through everyday interactions, and reshape personal and collective

memories. In turn, collective memory of groups can impact collective behaviors and decisions of the individuals who are influenced by these social connections (Christakis & Fowler, 2009; Luhmann & Rajaram, 2013, 2015). Such phenomena make it important to study social transmission of false memories for both its scientific and societal relevance. As with the goals to identify methods that can counter misinformation effects on memory (Lewandowsky, Ecker, & Cook, 2017; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012), a better understanding of how false memories emerge through social interactions can aid in efforts to reduce propagation of inaccurate memories.

The aim of this review is to highlight several key findings from cognitive-experimental research on the social transmission of false memories. First, we make a very brief note of the substantial research on false memories in individual remembering. Then, we turn to social remembering studies and review two social paradigms in which false memories can be socially transmitted in small groups. These are contexts where false information is introduced by social sources, and contexts where false memories arise as a result of collaborative remembering. Next, we examine recent empirical approaches taken to investigate propagation of false memories in larger networks. We conclude with some implications for the emergence of collective false memories.

2. False memories when remembering alone

The general public as well as psychological scientists have been long fascinated by the phenomenon of false or distorted remembering. In an impressively large body of research on individual memory, which we only very briefly note here, an array of experimental approaches has been developed to study these phenomena. One such approach focuses on the misinformation effect. Here, individuals who are exposed to misinformation following an event later misremember details of the original event by reporting the misinformation as a part of the original event (Loftus, Miller, & Burns, 1978; see Loftus, 2005; Pickrell, Bernstein, & Loftus, 2016, for reviews on the misinformation effect). Another approach uses the well-known Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). In this widely reported, robust paradigm, individuals perform a simple task of retrieving associated words that were presented to them, for example, words such as *haystack, thread, prick*. Interestingly, they also frequently report a related word *needle* that was never presented (see Gallo, 2006, 2010; Roediger & Gallo, 2016, for reviews of DRM findings). False memories also emerge in the context of recalling richer personal memories. For example, false memories of autobiographical events such as falling sick after eating ice cream or getting lost at the mall in childhood can be implanted in individuals by introducing explicit misinformation and exploiting suggestibility (Bernstein, Laney, Morris, & Loftus, 2005; Loftus & Pickrell, 1995). Another striking phenomenon shows that false retrieval is not limited to memory but also occurs in the retrieval of knowledge, for example, when people learn misinformation from fictional sources and answer general knowledge questions incorrectly, including cases where individuals possessed prior accurate knowledge (Fazio, Barber, Rajaram, Ornstein, &

Marsh, 2013; Marsh, Meade, & Roediger, 2003; see Marsh, Cantor, & Brashier, 2016, for a review).

As this range of experimental approaches shows, the focus of past work has been largely on how false memories emerge when remembering alone, irrespective of the social influences that can shape this phenomenon. Against this backdrop, we focus on false memory errors people make in response to influences of social interactions.

3. Social transmission of false memories in small groups

False information can spread in daily social interactions; for example, a co-worker describes a news article, unaware of some of its inaccuracies, to a colleague. This colleague, despite having read accurate reports firsthand, now recalls and shares a distorted version of the story with others. In this recalling, this person might include both the accurate information and inaccuracies transmitted by the co-worker, and also perhaps adding his or her own embellishments. This example illustrates how the availability of misinformation as well as its social transmission can distort accurate memories of the recipient, and how the reconstructive nature of memory can further bring about errors in memory representation. In this section, we focus on the findings on transmission of false memories in small groups.

3.1. Social contagion

Similar to the misinformation effect in individual remembering where false information introduced later can make memory for the original episode erroneous, social sources can also alter memory. Social contagion errors have been studied, using two well-known paradigms that share features with the misinformation paradigm, namely the *social contagion paradigm* (e.g., Meade & Roediger, 2002; Roediger, Meade, & Bergman, 2001) and the *memory conformity paradigm* (e.g., Gabbert, Memon, & Allan, 2003; Wright, Self, & Justice, 2000). Both paradigms include a phase where misinformation is introduced through a social source. In the memory conformity paradigm that stems from the eyewitness memory tradition, experimenters often simulate real-world crime experiences in the laboratory, for example, by using crime-related study material (e.g., crime scene films, eyewitness narratives) (Gabbert & Hope, 2013; Gabbert, Wright, Memon, Skagerberg, & Jamieson, 2012). The social contagion paradigm combines the conformity paradigm of Asch (1956) and the misinformation paradigm of Loftus (1979), and it typically uses materials such as household scenes or word lists to create study episodes (Meade & Roediger, 2002; Roediger et al., 2001).

These paradigms typically include a sequence of three stages—participants first study some materials (e.g., household scenes or a film), next retrieve studied information at which point misinformation is introduced through a real or ostensible social source, and finally recall the studied material alone. Misinformation is introduced in different ways across studies. One, a confederate discusses or takes turns with the naïve participant in a

dyadic conversation to interject both accurate and inaccurate details related to the studied material (Gabbert & Hope, 2013; Roediger et al., 2001; for a similar procedure using autobiographical memories, see Harris, Barnier, Sutton, & Khan, 2017). Two, indirect social interactions occur where a naïve participant reviews information—purportedly from a social source such as another participant or an eyewitness—that includes misinformation (Gabbert, Memon, Allan, & Wright, 2004; Meade & Roediger, 2002). Three, collaboration takes place between two naïve participants who studied information that, unbeknownst to them, is only partially shared between them. This arrangement makes it possible for unique information to transmit between them, for example, when participants view the same scene that differ in the camera perspective and as a result are each exposed to some unique information, or when participants together watch different films while wearing polarizing glasses that block the other film (Gabbert & Hope, 2013; Gabbert et al., 2003; Garry, French, Kinzett, & Mori, 2008; Mori, 2003). Despite variations in how misinformation is socially delivered, it is often erroneously recalled when participants later retrieve the original study material individually.

The social contagion effect has been explored widely, with studies also documenting conditions that enhance or reduce this effect. People are more susceptible to social contagion when misinformation or false items are schema-consistent with a scene (Meade & Roediger, 2002; Roediger et al., 2001), when study information is presented for shorter durations (Roediger et al., 2001), or when individuals are less confident in their own memory, such as when considering partners to be advantaged by having received more study time (Gabbert, Memon, & Wright, 2007; Wright & Villalba, 2012).

Factors that reduce social contagion include variations in experimental procedures as well as social/interpersonal factors. With regard to experimental procedures, additional study opportunities following collaboration attenuate social contagion (McNabb & Meade, 2014) and an initial cued-recall test promotes more accurate source monitoring (Huff, Davis, & Meade, 2013). Receiving warnings about potential inaccuracies in their partner's responses or being told not to include information from poststudy experiences also reduces social contagion errors (Bodner, Musch, & Azad, 2009; Echterhoff, Hirst, & Hussy, 2005; Hirst & Echterhoff, 2012; Meade & Roediger, 2002) as does giving strict instructions to recall accurate items (Wright, Gabbert, Memon, & London, 2008). Furthermore, emotional information can be more resistant to social contagion compared to neutral information, presumably because it receives more elaborate processing (Kensinger, Choi, Murray, & Rajaram, 2016).

One variable that could be critical for influencing social contagion is one's partner's retrieval accuracy. But extant evidence is unclear as to whether participants actively assess partner accuracy during collaboration (Jaeger, Lauris, Selmeczy, & Dobbins, 2012; Numbers, Meade, & Perga, 2014). Numbers et al. (2014) found no differences in the magnitude of social contagion if partner's responses consisted of 33%, 66%, or 100% errors, suggesting that participants assume their partners are accurate and do not necessarily evaluate it unless they are explicitly told or given an opportunity to observe it. For instance, social contagion does not change when participants observe partner's low performance on a *related* memory task, but it does attenuate after participants observe the

partners' poor performance on the *same* task on which they would later collaborate (Numbers et al., 2014).

Certain social and interpersonal factors do influence social contagion. For instance, source credibility plays a role. Findings show that individuals are less likely to incorporate misinformation from an older adult (Davis & Meade, 2013; Kwong See, Hoffman, & Wood, 2001), a child (Skagerberg & Wright, 2009b), or an out-group member (Andrews & Rapp, 2014), presumably because of perceived low credibility. In contrast, participants rely on information more from partners with whom they have a prior relationship (e.g., friends or romantic partners) than from strangers (French, Garry, & Mori, 2008; Hope, Ost, Gabbert, Healey, & Lenton, 2008), presumably because of perceived reliability. Perception of power also plays a role; for example, individuals are more likely to incorporate information received from those perceived to have more power in certain relationship dynamics (Skagerberg & Wright, 2009b; but see Carol, Carlucci, Eaton, & Wright, 2013; Skagerberg & Wright, 2009a), those with a competitive rather than cooperative mindset (Park, Son, & Kim, 2016), those who speak first (Gabbert, Memon, & Wright, 2006; Hewitt, Kane, & Garry, 2013; Wright & Carlucci, 2011), and those asserting more confidence (Allan & Gabbert, 2008; Wright et al., 2000). Finally, personality and emotional factors such as social avoidance (Wright, London, & Waechter, 2010), increased openness, extraversion, and neuroticism are associated with reduced social contagion, whereas increased agreeableness is associated with greater social contagion (Doughty, Paterson, MacCann, & Monds, 2017). Given the potential for their applied significance, these are intriguing variables for future investigations.

The social contagion effect demonstrates that individuals are susceptible to incorporating misinformation they receive from social sources into their memories (Gabbert et al., 2003; Meade & Roediger, 2002; Roediger et al., 2001; Wright et al., 2000). This consequence has critical implications because we receive an overwhelming amount of information—as well as misinformation—from social interactions and the Internet, and we subsequently share it with our social connections (Choi, Blumen, Congleton, & Rajaram, 2014). For instance, even when we might have read or watched accurate reports of breaking news event, it is possible for us to incorporate related misinformation that a colleague later mentions in conversation. As reviewed earlier, this can happen if we do not actively assess the accuracy of information because of reasons such as perceived or actual expertise, reliability, or confidence of the social source (e.g., Andrews & Rapp, 2014; Davis & Meade, 2013; Hope et al., 2008; Numbers et al., 2014; Wright et al., 2000). Future research on conditions that promote the ability to separate fact from fiction is particularly relevant and timely in this Internet age of rapid and vast dissemination of information and misinformation.

3.2. Collaborative false remembering

As the review in the previous section shows, individuals are clearly susceptible to social contagion memory errors. But does false information feature in group memory if misinformation is not systematically introduced (e.g., by a confederate or through an

experimental procedure), but instead simply arises as a part of conversational remembering? The findings for this question provide a more detailed picture about the ways social dynamics propagate or curtail false memories. These conditions are important to understand because the social environments where we engage with others vary in interpersonal and communication dynamics, and these insights can help us understand errors across different communication contexts such as in-person or online platforms.

A bulk of the evidence on the emergence of false memories in groups comes from research using the collaborative memory paradigm. Introduced in the 1990s, the collaborative memory paradigm has motivated a resurgence of interest in Bartlett's (1932) classic work for exploring differences between group and individual remembering (Basden, Basden, Bryner, & Thomas, 1997; Basden, Basden, & Henry, 2000; Basden, Basden, Thomas, & Souphasith, 1997; Finlay, Hitch, & Meudell, 2000; Weldon & Bellinger, 1997; Weldon, Blair, & Huebsch, 2000). This experimental approach offers ways to investigating cognitive processes that underlie group remembering and its consequences. Though the paradigm was not designed specifically to elicit false memory phenomena, studies using this paradigm nonetheless present an opportunity to assess conditions where false memories are introduced in the course of collaborative remembering.

The collaborative memory paradigm typically includes a study phase, a delay period, and one or more recall phases. Studies have used word lists, pictures, and films as study materials, and also DRM word-lists when exploring social false memory. In the recall phase, participants typically complete a memory test either individually or collaboratively in dyads or triads. Considerable research has focused on a counterintuitive and well-documented outcome called collaborative inhibition (Basden, Basden, Bryner, et al. 1997; Weldon & Bellinger, 1997), where collaborating groups recall less studied information than the baseline groups. This baseline consists of nominal groups or groups in name only, where the same number of participants (as in a collaborative group) individually recall the studied information and the items they recall are summed by removing the overlapping items to calculate the baseline recall score (see Marion & Thorley, 2016; Rajaram & Maswood, 2017; Rajaram & Pereira-Pasarin, 2010; for reviews and theories). The downstream consequences of collaboration are assessed after collaborative remembering, by asking all participants to provide an individual account of items presented in the original study episode (e.g., Blumen & Rajaram, 2008, 2009; Choi, Blumen, Congleton, & Rajaram, 2014; Choi, Kensinger, & Rajaram, 2017; Congleton & Rajaram, 2011, 2014).

Our interest here is on the question of whether the context of collaborative remembering produces false memories. Early evidence was inconclusive and primarily came from studies where group remembering was compared to individual remembering, and not to the more suitable nominal group baseline (Perlmutter, 1953; Perlmutter & De Montmollin, 1952; Stephenson, Wagner, & Brandstatter, 1983; Yuker, 1955). Later studies using the collaborative memory paradigm (e.g., Basden, Basden, Bryner, et al. 1997; Weldon & Bellinger, 1997) also reported mixed effects of group recall on the production of false memories. Collaborative groups sometimes produced more intrusions than

nominal groups (B. H. Basden, Basden, Bryner, et al. 1997; Exp. 1–3), whereas other evidence showed no significant difference (Weldon & Bellinger, 1997).

More recent studies have clarified that false recall by groups can depend on the method of collaboration. Instructions for group interactions in collaborative memory studies have commonly focused on one of two methods of collaboration: *free-for-all* or *turn-taking*. In free-for-all collaboration, members freely interact with one another to discuss and recall what the members studied earlier. They receive minimal instructions on how to collaborate or resolve any disagreements that may arise and are typically not required to reach consensus on what they recall (Rajaram & Pereira-Pasarin, 2010; Thorley & Dewhurst, 2007; Weldon & Bellinger, 1997). In turn-taking, collaborators sequentially take turns to recall a studied item on each turn, either up to a set amount of time or until each member has consecutively failed to recall a word (Basden, Basden, Bryner, et al. 1997; Basden, Basden, Thomas, et al. 1997; Thorley & Dewhurst, 2007). These collaboration methods result in different interaction dynamics that, in turn, have a different impact on the information produced.

During collaboration, a turn-taking environment allows limited interaction and fewer opportunities for error correction, and brings greater social pressure to recall due to the expectations to retrieve on each turn without aid. These conditions can promote recall of incorrect information. In a free-for-all environment, the degree of interaction is high, allowing opportunities for discussion and error pruning, and as a result, fewer false memories are likely to survive in the group recall report. A study directly comparing these two methods of collaboration using the DRM word lists supported these predictions (Thorley & Dewhurst, 2007). False recall was greater in turn-taking groups compared to both the free-for-all and nominal groups, whereas the latter two groups did not differ. Since accurate memory was comparable for free-for-all and turn-taking groups, the degree of interaction specifically affected reports of false memories.

The curtailing of false recall through the free-for-all method has been reported in other studies as well when examining groups consisting of strangers (Maki, Weigold, & Arellano, 2008; Exp. 1; Takahashi, 2007; Exp. 3; Weigold, Russell, & Natera, 2014; but no difference in Takahashi, 2007; Exp. 1) or friends (Takahashi, 2007; Exp. 2), or when comparing recall of collaborating groups with that of single participants who report comparable levels of false recall (Maki et al., 2008; Exp. 1,2; Weigold et al., 2014). Evidence is relatively sparse regarding the persistence of false memories in individual recall that occurs after collaboration (Basden, Reysen, & Basden, 2002; Peker & Tekcan, 2009; Thorley & Dewhurst, 2007, 2009), but it appears that only turn-taking members retained similar levels of false memories as their former group, whereas free-for-all members recalled fewer false memories compared to their earlier group recall (Thorley & Dewhurst, 2007). These findings suggest that both explicitly introduced/experimentally-manipulated misinformation (as in the social contagion studies reviewed earlier) as well as false memories arising naturally during group collaboration persist downstream, and contaminate individual memory after collaboration. We discuss the interaction dynamics again later for their implications for real-world phenomena.

Other experimental variables that can influence transmission of false memory include type of study materials, size of the collaborating groups, and type of memory task, although this evidence is limited at present. For type of materials, findings first showed that collaborating groups falsely recall critical, nonstudied exemplars from categorized lists more than do nominal groups (Basden, Basden, Thomas, et al. 1997; Exp. 2). This pattern was attributed to the hierarchical relationships between category names and exemplars and the availability of strong retrieval cues. This pattern of greater false remembering in collaborative groups did not occur for DRM word lists (Exp. 1). But later evidence shows that DRM lists with higher associative strength increase false remembering in collaborating groups (Thorley & Dewhurst, 2007), suggesting that the qualities of study material may contribute to group false memory production (Basden, Basden, Thomas, et al. 1997; Thorley & Dewhurst, 2007). With respect to group size, recall of dyads, triads, and quartets was examined for the DRM stimuli, and results showed that false recall increased with group size (Thorley & Dewhurst, 2007, 2009). This effect was observed when using the turn-taking or the free-for-all collaboration methods (Thorley & Dewhurst, 2007) with the former method promoting more errors than the latter, both in recall and on a later test of recognition memory (Thorley & Dewhurst, 2009), demonstrating that as more people interactively remember the past, their interactions escalate false recall when remembering information (here, the DRM stimuli that facilitate false remembering). Finally, with respect to the effects of retrieval tasks, collaborative groups report more false memories than nominal groups on recognition tests consisting of DRM words. This outcome was attributed to group members using strong, recall-based arguments to persuade members about the falsely recalled items (Thorley & Dewhurst, 2009) since DRM critical lures are typically remembered with high confidence (Clark, Abbe, & Larson, 2006; Clark, Hori, Putnam, & Martin, 2000; Roediger & McDermott, 1995).

3.3. Theoretical explanations

Several explanations have been considered for social contagion of memory errors. The source-monitoring framework (Johnson, Hashtroudi, & Lindsay, 1993) is a prominent explanation offered for how memory errors arise following social interactions. According to this view, social contagion errors reflect a failure in source monitoring as misinformation may be inaccurately attributed to the study material (or the original experience of the rememberer) instead of the social source (Gabbert & Hope, 2013; Gabbert et al., 2012; Meade & Roediger, 2002; Roediger et al., 2001). Since misinformation from partners or confederates is introduced shortly after the encoding experience or when recalling the study material, source-monitoring errors can increase due to the proximity of these contexts or their temporal sequence. Source monitoring errors can also increase when the original information and the socially introduced errors share some characteristics, such as when misinformation is schema consistent (incorporating a toaster in a kitchen) than when it is less schema consistent (Gabbert et al., 2007, 2012; Meade & Roediger, 2002; Roediger et al., 2001). Also, when participants are warned or instructed to be accurate,

inducing more careful source monitoring, social contagion errors reduce (Bodner et al., 2009; Meade & Roediger, 2002).

Another explanation of social contagion concerns normative and informational routes of influence (Deutsch & Gerard, 1955; Gabbert et al., 2012; Wright et al., 2010). Normative influences involve considering the need for agreeableness when processing others' input, to balance the cost of disagreeing with the benefits of conforming. In contrast, informational influences come into play when people exhibit a desire for accuracy and therefore rely more on others' memories, for example, when they believe others to have better memory or to be more confident than themselves (Gabbert & Hope, 2013; Gabbert et al., 2012; Wright et al., 2000).

Two other explanations offered to account for social contagion errors in collaborative recall are retrieval criterion shift and error-pruning. As we described earlier, in collaborative recall procedures turn-taking produces more memory errors than the free-for-all method. According to the retrieval criterion shift explanation, higher pressure to recall in the turn-taking method likely promotes the use of a lax retrieval criterion, thereby allowing for errors and false memories. By contrast, free-for-all collaboration, where the pressure to recall is lower and social risks of making errors may seem higher, likely promotes the use of a conservative retrieval criterion, thereby reducing false memories (Basden, Basden, Thomas, et al. 1997; Thorley & Dewhurst, 2007). A speculative extension of the retrieval criterion shift account posits that when group members experience disruption to their own retrieval strategy (because of interruptions from others' recall), they turn greater attention to their own memories, evaluating it with stricter source monitoring and criterion shifts (Takahashi, 2007).

The error-pruning explanation is separate from the criterion shift explanation, although the two can be related. According to this view, false memory production in groups relates to the level of interaction among members and the opportunities for error pruning (Maki et al., 2008; Pritchard & Keenan, 2002; Rajaram & Pereira-Pasarin, 2010; Ross, Spencer, Blatz, & Restorick, 2008; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004; Weigold et al., 2014). In turn-taking, interaction is limited during exchange of information and the information shared is not followed up with discussion or assessment. Consequently, erroneous information introduced during recall is included in the group recall product by default. By contrast, the error-pruning process operates more effectively in free-for-all groups where members interact and engage freely, and errors that are introduced can be discussed, assessed, and rejected by the group. Weigold et al. (2014) examined this possibility with free-for-all groups and found evidence for error-correction. While most studied words discussed were included in the group recall product, false memories brought up by the group were associated with lower confidence and more than half were ultimately rejected during the collaboration process, resulting in fewer false memories recalled than nominal groups. Error pruning has been also reported in studies on jury deliberation where errors initially made by individuals were corrected after discussions with others more often than for those not collaborating (Pritchard & Keenan, 2002). In studies where memory for household items was tested in couples, false memories were reduced with collaboration (Ross et al., 2004, 2008) and incorrect information was responded to with

more doubt or rejection (Ross et al., 2008). Collaborative memory studies using word list stimuli, although not designed to elicit false memories, have also reported benefits of error pruning (Blumen & Rajaram, 2008, 2009; Finlay et al., 2000; Experiments 2 and 3; Harris, Barnier, & Sutton, 2012a,b; Hyman, Cardwell, & Roy, 2013; Johansson, Andersson, & Rönnberg, 2000, 2005; Pereira-Pasarin & Rajaram, 2011; Takahashi & Saito, 2004; Weldon & Bellinger, 1997; Wessel, Zandstra, Hengeveld, & Moulds, 2015; Yaron-Antar & Nachson, 2006). Similarly as with free-for-all collaboration, a requirement to reach consensus prior to recalling information also reduces intrusions since it encourages error correction and discussion (Harris et al., 2012a).

The studies we just reviewed provide growing evidence that opportunities for error correction can protect against spread of false information. These findings are useful for assessing the emergence of false memories in everyday settings such as classrooms, meetings, and parties where conversational remembering varies in the communication dynamics and goals. For example, if we compare large lecture classes versus small seminars, the former offers fewer opportunities than the latter for discussions and joint construction of what students learn from the course materials. Available findings are also useful for assessing false memory contagion on the Internet and social media platforms that are popular modes for social communication. Some platforms offer numerous avenues to interact, communicate and provide feedback (e.g., Twitter, Facebook, Reddit) or require reaching consensus (e.g., Wikipedia). Other online platforms can place restrictions and limit interaction; for example, not enabling comments on news sites, blogs, and such platforms simulate conditions where errors can go uncorrected.

Taken together, the reviewed literature shows that false memories emerge in small groups across a variety of contexts. When individuals receive misinformation socially, they incorporate it into memory and report it later. Furthermore, even when a systematic stream of misinformation (e.g., from a confederate) is absent, false memories nonetheless emerge in the natural course of collaborative remembering. In light of the parallels, we have noted between these methodologies and everyday social contexts for communication, findings observed with these paradigms have widespread implications for everyday memory errors.

Findings from small group interactions have real-world implications for another prevalent reason; small groups are typically embedded within a larger network of social connections. As a result, memory contagion in small groups can have an impact beyond the group on the larger social network, and this provides an impetus for examining the emergence of false memories in large social settings.

4. Social transmission of false memories in social networks

Small group interactions are ubiquitous in daily life and they are also embedded within larger social networks. Social networks represent how people are connected through the relations and interactions among individuals. For example, the connections we have in our social network include both immediate (e.g., friends) and distant (e.g., friends of

friends) relations. Such networks can also contain cliques, with individuals within each clique who are directly connected to each other, and thereby facilitate connections across cliques, and so on. Such direct and indirect connections among members inhabiting social networks make the members susceptible to a wide-range of influences. As such, information exchanged within smaller social settings—including misinformation and false memories—can have cascading effects on their social connections across larger networks within which the smaller groups are embedded, both by influencing memories, and possibly also behaviors and decisions across connections (Christakis & Fowler, 2009; Luhmann & Rajaram, 2013, 2015). Current experimental evidence mainly speaks to false memory transmission in small groups made up of dyads or triad, whereas investigations on the far-reaching effects of false memories in social networks are still in infancy, leaving many questions unanswered. We describe a few, emerging studies that tap into aspects of social network structures to assess social transmission of false memories.

A classic example of information transmission in a social network is the serial reproduction chain used by Bartlett (1932) that we noted earlier. In this type of network, an individual receives, reconstructs, and passes down information from a previous individual in the chain. This type of network is often considered a proxy for how information, culture, and collective memories are shared in societies (Bartlett, 1932; Bietti, Bangerter, & Mayor, 2017; Mesoudi & Whiten, 2008). Several studies have used this network structure to investigate cognitive biases including biases in function learning (Kalish, Griffiths, & Lewandowsky, 2007), stereotype propagation (Lyons & Kashima, 2003), and memory biases for the propagation of certain information. For instance, negative events from a story persisted more than positive events across the transmission chain, suggesting a bias for the propagation of negatively valenced information (Bebbington, MacLeod, Ellison, & Fay, 2017). A bias for sharing socially interesting information across serial reproduction chains has also been reported, with reports showing that gossip (e.g., information about individuals involved in an affair) and information about nongossip social interactions (e.g., a social interaction involving asking for directions) transmit more than nonsocial information (e.g., description of a physical environment, or an individual in an everyday situation such as being late to class) (Mesoudi, Whiten, & Dunbar, 2006).

In contrast to the indirect transmission of information in Bartlett's (1932) work, Tan and Fay (2011) investigated whether information transmission differed across serial reproduction chains where participants were allowed to interact and communicate directly compared to those who were not. In noninteractive chains, information was transmitted indirectly to participants in that they received the information via audio recordings, whereas in interactive chains information was communicated directly where participants freely discussed it in face-to-face interactions. An expected, loss of information across participants was observed in both types of chains. However, as the interactive chains allowed opportunities for clarification, backchannel responses, and questions, their transmitted information was more accurate than in the noninteractive chains. This effect on interactivity is particularly interesting as it relates to the small group studies reviewed earlier where free-for-all interactions led to fewer memory errors than in turn-taking where interactions were reduced. Together, these findings show that interaction and

communication play a protective role in reducing memory distortions in both small groups and larger social networks.

The serial reproduction chain has been also used to investigate the transmission of false memories specifically. In a recent study, DRM word lists were presented to participants using a novel and efficient design to examine the fate of information when produced serially across individuals compared to a repeated recall condition (Roediger, Meade, Gallo, & Olson, 2014). Participants in the serial reproduction chain studied and reproduced the output of a previous individual, except for the first individual in each chain who studied the original set of DRM word lists. Each participant recalled the material four times, with only the first recall-output serving as study material to be transmitted to the next participant in the chain. Participants in the first position in a chain constituted the repeated recall or the control condition, to examine the effects of serial reproduction across participants. Relative to the original study material, recall decreased across the four individuals in the serial reproduction chain, whereas it remained stable across repeated recall within individuals. Additionally, the proportion of false memories in relation to accurate recall increased across individuals in serial reproduction. In line with Bartlett's (1932) findings, this study showed forgetting of accurate information, emergence of false memories, and distortions in recall as information transmitted serially across individuals.

Another report examined error correction during information transmission using a variation of the serial reproduction chain (Ditta & Steyvers, 2013) All participants studied the same set of DRM lists, but instead of the recall output of the participant from the previous node in the chain serving as study material, participants were instructed to edit the recall output of the previous participant. This procedure served as an indirect form of collaboration, similar to collaborative platforms online such as Wikipedia where other individuals can edit the entries. Across eight nodes, participants were more likely to add correct information than incorrect information, with incorrect information (e.g., critical lures, intrusions) being quite low at every node. Furthermore, while deletions were infrequent relative to insertions, participants were more likely to delete correct words than incorrect words.

Moving beyond single chains, another common feature of social networks is the series of interactions we engage in with different groups of individuals across time, for example, family members, co-workers, or friends. Recently, this type of social network was created in the laboratory to study the propagation of information consisting of word lists (Choi et al., 2014, 2017). In both studies, three individuals first collaboratively recalled studied items, then separated to collaborate with a new set of partners who had already collaborated with other individuals. As a result, four proximal partners and four distant partners (i.e., proximal partners' previous partners) could potentially influence a given individual within this network over the course of two interactions. This type of diverse network was compared to an insular network where the same three individuals collaborated twice together; thus, only two partners potentially influenced any given individual (Choi et al., 2014, 2017).

Findings relevant to false memory transmission come from Choi et al. (2017) where, in addition to varying network structures, exposure to information was also varied such that all group members had been exposed to some information (shared), only two group members saw the information (partially shared), or only one member saw the information (unshared). In this way, partially shared and unshared information were false memories for those collaborating participants who had not originally seen it themselves. The emotional valence of words was also manipulated though it did not influence the false memory effects. But the network structure did. Findings showed greater availability of false information in diverse networks compared to insular groups. Yet those who collaborated in insular groups had formed more collective false memories than those in diverse structures and were also more confident in their individual false recognition of nonstudied information (Choi et al., 2017).

These recent studies show that modes of transmission and network structures have consequences for the transmission of information and emergence of false memories. In this context, research from other social sciences shows that connections in a social network—both immediate (e.g., friends) and distant (e.g., friends of friends)—can influence a variety of behaviors as well, including health-related behaviors and emotional states (e.g., smoking, drinking, happiness, or loneliness) (Christakis & Fowler, 2009). Furthermore, recent modeling work in cognition suggests that transmission and sharing of information within social networks could serve as possible bases for such behavior contagion (Luhmann & Rajaram, 2013, 2015). As such, larger network structures are also a fruitful area for future research because the transmission of information in these contexts, including memory distortions and false memories, potentially have significant scientific and societal implications.

5. Implications for the emergence of collective false memories

We conclude this review by briefly considering how the process of social transmission in small groups and social networks can give rise to the emergence of *collective false memories*, resulting in shared false or inaccurate memories among members of a group or a community. As we noted in the Introduction, this phenomenon is related to, but can be distinguished from, shared or collective false beliefs where the latter refer to cases when several individuals come across the same hoax news story and believe it. In this case, their memories for what they heard or read could be accurate, but it can lead to false beliefs because the information itself was a hoax. As observed with the popularity and sharing of various types of misinformation or unverified information such as conspiracy theories (Bessi et al., 2015), rumors, and urban legends (Allport & Lepkin, 1945; Cotter, 2008; DiFonzo & Bordia, 2007; Heath, Bell, & Sternberg, 2001), widely shared false beliefs can emerge. The process of acquiring and sharing false beliefs is important to understand not only in and of itself but also because this process can distort memories that were accurate before. This process is similar to the way exposure to incorrect information can impair general knowledge that was accurately known before (Fazio et al.,

2013). This distinct yet close relationship between false beliefs and false memories is useful to keep in mind as we briefly explore collective false memories of wildly distorted, inaccurate, or unreal events and information.

Collective memory typically refers to a body of knowledge or recollections that a group of people shares and that is implicated in the formation of their collective identity and values (Bodnar, 1992; Cole, 2001; Halbwachs,1980; Hirst & Manier, 2008; Roediger & Abel, 2015; Wertsch & Roediger, 2008). In experimental studies, collective memory denotes the individually recalled memories that people come to have in common following collaborative remembering (e.g., Congleton & Rajaram, 2014; Cuc, Ozuru, Manier, & Hirst, 2006; Stone, Barnier, Sutton, & Hirst, 2010).

The emergence of collective false memories and memory distortions has implications for large-scale groups and communities since false memories and misinformation grow rapidly and widely at a societal scale (Baumeister & Hastings, 1997; Kammen, 1995; Roediger & Wertsch, 2015). Large-scale groups, including communities, nations, and cultures, develop collective memories of past historical or personal events as well as bodies of knowledge (Roediger & Abel, 2015), and recent reports show that collective memories of the same event can have striking differences for nations and generations (Wertsch, 2002; Zaromb, Butler, Agarwal, & Roediger, 2014). Conflicting collective memories of past events can emerge because of differences in goals, norms, and values of different peoples, and motivate the question as to what circumstances lead groups of people to recollect events that are extremely distorted, drastically inaccurate, or that did not occur. Though experimental research on such phenomena is only just gaining attention, the phenomenon of collective false memories has received much attention in the general public. For example, following the death of Nelson Mandela in 2013, several accounts online reported confusion and recollections of Mandela dying in prison in the 1980s despite evidence of Mandela's life since he left prison in 1990. As a result, an online community was formed and it coined the term *The Mandela Effect* to refer to similar collective false memories or "alternate memories," attributing the phenomenon to paranormal rather than cognitive effects. Questions for future empirical research include understanding collective false memory as a function of whether an entirety, a majority, or subsets of members of a community have such false memories in common and the roles of different histories, goals, norms, and values in giving rise to conflicting collective memories of past events across different communities.

6. A concluding note: Broader societal implications

People constantly engage in a variety of social interactions both face-to-face and online. The general public would benefit from information about conditions that are likely to introduce false memories, conditions such as navigating questionable information and content from internet sources, social media platforms, and face-to-face social interactions, or conditions where different interaction methods promote or reduce the spread of false memories. The effects of misinformation are difficult to reduce and eliminate, and as

progress has been made to identify effective techniques to debunk misinformation (Lewandowsky et al., 2012), research on the social transmission of false memories can also aid in providing recommendations for combatting fake news and misinformation, and protecting people from acquiring false memories (e.g., Choi et al., 2017). A better understanding of social transmission of false memories also has practical implications for eyewitness memory and jury decision-making. More broadly, awareness about the social transmission of false memory can aid in promoting a well-informed public and in preventing behaviors that arise because of misinformation.

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