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Features of Successful and Unsuccessful Collaborative Memory Conversations in Long-Married Couples

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Abstract

While we often engage in conversational reminiscing with loved ones, the effects of these conversations on our memory performance remain poorly understood. On the one hand, Wegner’s transactive memory theory predicts that intimate groups experience benefits from remembering together. On the other hand, research on collaborative recall has shown costs of shared remembering in groups of strangers—at least in terms of number of items recalled—and even in intimate groups there is heterogeneity in outcomes. In the current research, we studied the effects of particular communicative features in determining the outcomes of collaborative recall in intimate groups. We tested 39 older, long-married couples. They completed a non-personal recall task (name all the countries in Europe) and a personal recall task (name all your mutual friends), both separately and together. When they collaborated, we recorded their conversation. We coded for specific “communication variables” and obtained measures of “conversational style.” Overall, we found two clusters of communication variables positively associated with collaborative success: (a) cuing each other, responding to cues, and repeating each other; and (b) making positive statements about memory performance and persisting with the task. A negative cluster of behaviors—correcting each other, having uneven expertise, and strategy disagreements—was associated with less interactive, more “monologue” style of collaboration, but not with overall recall performance. We discuss our results in terms of the importance of different conversational processes in driving the heterogeneous outcomes of group remembering in intimate groups, suggesting that a focus on recall output alone limits our understanding of conversational remembering.

Keywords: Collaborative recall; Collaborative processes; Transactive memory

1. Introduction

We often remember with others. Most often, such social remembering occurs with our romantic partners, families, and friends: those people with whom we share many experiences about which to reminisce (Harris, Barnier, Sutton, & Keil, 2014; Pasupathi, 2001; Sutton, 2008; Sutton, Harris, Keil, & Barnier, 2010). We reminisce with others in order to build a sense of intimacy and of group identity, to teach others, to empathize with others, to verify our recollection and gain different perspectives, and because it is enjoyable (Alea & Bluck, 2003; Harris, Rasmussen, & Berntsen, 2014; Pasupathi, Lucas, & Coombs, 2002; Wade & Garry, 2005). However, in addition to these social and emotional benefits, there is an increasing interest in the possible cognitive benefits of joint remembering (Blumen, Rajaram, & Henkel, 2013): Can remembering with others benefit memory performance?

Such questions have been addressed in philosophy, using concepts such as group mind, extended mind, and distributed cognition (Barnier, Sutton, Harris, & Wilson, 2008; Sutton, 2015; Sutton et al., 2010). There has also long been interest in collaborative memory benefits in domains where enhancing memory performance is the goal, such as in gerontology (e.g., Dixon, 1999, 2011, 2013; Kemper, Lyons, & Anagnopoulos, 1995; Rauer, Riediger, Schmiedek, & Lindenberger, 2011) and child development (Kulkofsky, 2011; Nelson & Fivush, 2004; Sutton, 2015). In cognitive psychology, Daniel Wegner's pioneering theory of "transactive memory" (Wegner, 1987; Wegner, Erber, & Raymond, 1991; Wegner, Giuliano, & Hertel, 1985), which aimed to make "group mind" empirically tractable and predicted benefits of joint remembering, has had slow uptake (Barnier, Klein, & Harris, 2018). Developed separately, the experimental "collaborative recall" paradigm provided a strict method for quantifying the influence of a group on how much is remembered (Weldon & Bellinger, 1997), and research in this domain typically finds that collaboration reduces recall productivity (see Marion & Thorley, 2016 for a review). However, collaborative recall experiments typically have focused on groups of strangers and not groups in which benefits of shared remembering might be expected, such as intimate groups in which group members know each other well and have a long-shared history (Barnier, Klein, et al., 2018; Harris, Keil, Sutton, Barnier, & McIlwain, 2011). In the current research, motivated by transactive memory theory's emphasis on intimacy and effective communication as leading to memory benefits, we extended the robust methodology of collaborative recall to focus on intimate groups and their communication styles, examining the features of successful collaboration in long-married older couples (see also Harris, Barnier, Sutton, Keil, & Dixon, 2017; Harris, Barnier, et al., 2014; Harris, Rasmussen, et al., 2014)

According to transactive memory theory, as members of groups become familiar with each other and experience events together, they can develop an efficient system for sharing the encoding, storage, and retrieval of information (Barnier, Klein, et al., 2018;

Wegner et al., 1985; Wegner, 1987). Wegner suggested that such systems rely on the individual memory systems of the group members, an accurate shared meta-knowledge about “who knows what,” and effective communication or “transactions” which allow the group as a whole to access the information stored by all individuals (Wegner, 1987; Wegner et al., 1985). In developing transactive memory systems, groups become capable of “memory feats” beyond that of a single individual (Wegner, 1995, p. 1). In the current research, we focus on these theorized benefits of group remembering in intimate groups and the role of effective communication in bringing them about. A handful of studies have yielded findings consistent with transactive memory theory, suggesting that couples can remember together more effectively than strangers. For instance, intimate couples recall together more effectively than pairs of strangers, but only when they do not have an external system for dividing responsibility imposed (Wegner et al., 1991). Additionally, Hollingshead found that couples collaborated more effectively than pairs of strangers, but only when they used implicit, non-discussed systems for organizing their recall (Hollingshead, 1998a), and only when communicating face-to-face (Hollingshead, 1998b). However, these studies typically compare collaborating couples to collaborating pairs of strangers, so it remains unclear whether collaborating improves couples’ joint performance relative to their individual performance.

Two aspects of transactive memory theory are critical in motivating the current research. First, transactive memory systems develop with time and with group experience: the longer that individuals have been members of a group, and the more experienced the group is at sharing memories, the more effective and accurate their transactive memory system is likely to be (Barnier et al., 2014; Harris et al., 2011, 2017). Second, transactive memory systems are only as good as the communication strategies of their members (Harris et al., 2011). That is, any benefits of transactive memory should be associated with a profile of successful communication.

However, as noted above, these theorized benefits of shared remembering are at odds with the findings of a large cognitive experimental literature on “collaborative recall.” Collaborative recall research has quantified the costs and benefits of remembering with others, by comparing recall output of collaborative groups and “nominal groups.” Nominal groups are “groups in name only.” Nominal group recall is calculated as the pooled performance of separate individuals, in order to index what group output should look like if groups were simply a combination of the individuals within them (Basden, Basden, Bryner, & Thomas, 1997; Weldon & Bellinger, 1997). Typically, collaborative recall studies demonstrate that groups of strangers recalling word lists, from dyads to larger groups, show costs of collaboration: collaborative groups recall less than nominal groups (for reviews see Harris, Paterson, & Kemp, 2008; Marion & Thorley, 2016; Rajaram & Pereira-Pasarin, 2010)

However, there are a handful of studies indicating that, in certain kinds of groups, collaboration can lead to benefits for memory rather than the typical costs. For example, Johansson, Andersson, and Rönnerberg (2005) found that while older couples in general showed collaborative costs, a subset of couples reversed this effect to instead show collaborative benefits. These successful couples were characterized by high self-reported

division of responsibility in their day-to-day life as well as high agreement about this division, consistent with emphasis of transactive memory theory on division of cognitive labor and shared meta-memory (Johansson et al., 2005). Johansson et al.'s (2005) findings introduce the possibility that there are individual differences in the development of effective transactive memory systems, such that even in intimate groups like couples not all groups remember effectively together. Thus intimacy alone may not be sufficient for developing transactive memory systems, which may explain why studies comparing collaborative recall in intimate and non-intimate groups have often failed to identify any differences between them (e.g., Gould, Osborn, Krein, & Mortenson, 2002; Harris, Barnier, & Sutton, 2013).

Subsequent studies have offered further insights into the kinds of groups that might be able to collaborate successfully and show collaborative benefits. Harris et al. (2011) found overall collaborative costs when long-married older couples collaborated to remember the names of their social club members. However, there were strong individual differences in the costs versus benefits of collaborative recall, and these were largely explained by specific features of the conversation that couples had when they remembered together. Harris et al. (2011) identified three clusters of communication strategies that couples used during collaborative recall: a “group-enhancing” cluster, including cuing, response to cues, and repetition; a “group-diminishing” cluster, including corrections, nominating an expert, and strategy disagreements; and a “filler” cluster, including acknowledgments and extraneous elaborations. The group-enhancing factor was associated with better collaborative recall, whereas the group-diminishing and filler factors were associated with worse collaborative recall (Harris et al., 2011; see also Meade, Nokes, & Morrow, 2009, for the role of communication in collaborative facilitation in expert pilots). Consistent with transactive memory theory, these findings suggest the crucial importance of specific, effective communication strategies in bringing about collaborative benefits, and that such communication strategies are not universally adopted even in very intimate groups. However, this coding was developed and analysis conducted using a small sample of 12 older couples. In the current research, we aimed to replicate and extend these findings in a larger sample of older couples.

In the current research, we analyzed the processes of collaborative recall in 39 older couples, recorded as they participated in a larger study of the costs and benefits of collaborative remembering. The outcomes of this study with a fuller range of tasks and measures are reported elsewhere by Barnier, Harris, and Morris (unpublished data). In the analysis reported here, we conducted detailed coding and analysis of the transcripts taken from the recorded collaborative recall of these 39 couples, to examine the features of successful and unsuccessful collaborative recall. The couples completed a range of memory tasks, both individually and together, and we focus our analysis in this study on two of them: a non-personal memory task (“list all the countries in Europe”) and a personal memory task (“list the names of your mutual friends”). These tasks were motivated by previous findings of Harris et al. (2011) that at least some couples showed marked memory benefits when collaborating on a similar personal memory task. In using these tasks, Barnier, Harris, et al. (unpublished data) aimed to compare non-personal and personal

memory tasks, while still using list-based tasks to enable pooling of nominal performance (see also Harris et al., 2011). Barnier, Harris, et al. (unpublished data) reported overall memory benefits when these couples remembered together on both non-personal and personal memory tasks: on average, couples remembered more when they collaborated than they did separately. There were individual differences in the extent of these benefits and stronger benefits on the more personal task.

In the current analysis, we aimed to determine the features of collaborative recall that resulted in these reported memory benefits. Barnier, Harris, et al. (unpublished data) scored each collaboration for whether the couple used an explicit strategy to coordinate their recall or not. They reported that the use of explicit strategies developed with repeated testing and was more common in more personally relevant tasks, but that there was a limited association between categorically coded strategy use and memory benefits. In this study, we aimed to follow up this categorical analysis with a more detailed content analysis of the processes of collaboration by couples remembering together.

Since Harris et al. (2011) found that certain clusters of communication variables were associated with collaborative success, we aimed to replicate the findings of Harris et al. (2011) as well as to extend them by adding additional communication variables and by examining any associations with other aspects of conversational style. Therefore, we scored conversations in two ways. First, we examined the features of the collaboration by coding “communication variables” within the collaborative recall. We additionally characterized “conversational style,” by measuring the contribution of the individuals in terms of the amount each spoke within the collaboration, the similarity or difference in their contributions, and the degree to which they engaged in rapid back-and-forth turn-taking. We examined how these communication variables and conversational style might be associated with the benefits of collaboration for memory.

2. Method

2.1. Recruitment and participants

Participants were 78 individuals, aged 68–90 years ($M = 74.74$, $SD = 5.10$). These individuals made up 39 older male-female married couples (39 women, 39 men), married for 13–65 years ($M = 49.46$, $SD = 8.78$). Participants were a subset of those involved in the Australian Imaging Biomarkers and Lifestyle Study of Ageing (AIBL; Ellis et al., 2009). All had been classified by AIBL as cognitively healthy (i.e., no cognitive impairment) based on AIBL’s testing, and confirmed on the day of our testing via a Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975). The AIBL study has run since 2006 and involves over 1,100 individuals, who are tested every 18 months with respect to biomarkers, cognitive characteristics, and health and lifestyle factors, to track factors that predict the development of cognitive impairment and Alzheimer’s disease. From within this large sample, we identified 47 couples who were eligible to participate in our research, with the criteria that both individuals were cognitively healthy according

to their classification in the AIBL database and both had agreed to be contacted for additional research participation beyond the AIBL testing itself. We contacted these 47 couples by mail and then by phone to invite them to participate. This recruitment resulted in the 39 couples who were tested for the current research (see also Barnier, Harris, et al., 2018).

2.2. Materials and procedure

Sessions were conducted in participants' homes by two experimenters (one male, one female). In two sessions a week apart, participants completed a range of memory tasks and a range of questionnaires, of which a subset are reported here (for more details, see Barnier, Harris, et al., 2018). Recall 1, completed within the first session, was individual, with the two members of the couple recalling separately in separate rooms. The recall output of the two individuals was pooled to form "nominal group" scores for each couple. Recall 2, completed in the second session 1 week later, was collaborative, with the two members of the couple recalling together. Thus, nominal group versus collaborative recall was manipulated within-subjects with couples as the unit of analysis, so that the effects of collaboration were scored against each couple's nominal (pooled individual) baseline. All sessions were audio-recorded with the permission of the participants for later verbatim transcription.

2.2.1. Recall 1

After participants had completed informed consent, they moved to separate rooms, with a gender-matched interviewer. Individually, participants completed a series of memory tasks and neuropsychological tests detailed in Barnier, Harris, et al. (unpublished data), including recalling word lists and recalling autobiographical events, in a 1–2 h session. For the purposes of this study, these included two memory tasks. The first was the "European Countries" task, a relatively non-personal memory task in which participants were asked to recall and list the names of all the countries in Europe. The experimenter told them to "Try to make your list as long as possible." Participants were given 2 min to recall as many countries as they could, and the experimenter instructed them to keep trying to recall additional countries until 2 min had elapsed. The second was the "Mutual Friends" task, a relatively more personally relevant memory task, in which participants were asked to recall and list the names (first name and surname) of all the mutual friends they shared with their spouse, excluding family members and people who were deceased. The experimenter told them to "Try to make your list as long as possible." Participants were given 2 min to recall as many names as they could, and the experimenter instructed them to keep trying to recall additional names until 2 min had elapsed. Session times were based on prior research in which we have conducted these kinds of recall tasks with older adults (e.g., Harris et al., 2011, 2017) and were designed to be sufficient for recall to proceed until blocked while constraining the overall length of the experimental session.

2.2.2. Recall 2

One week after the first session, the experimenters returned to participants' homes for a second experimental session. For Recall 2, the memory tasks were conducted in the same way except that they were collaborative. For the European Countries task, couples were instructed to "work together" to recall and list the names of all the countries in Europe, and similarly for the Mutual Friends task, couples were instructed to "work together" to recall and list the names of their mutual friends and acquaintances. For both tasks, couples were given 4 min to complete them, such that the pooled individuals together had the same total time in Recall 1 (2 min for each individual) as the two individuals collaborating in Recall 2 (4 min for the couple; for more discussion of the time course of collaborative recall, see Hyman, Cardwell, & Roy, 2013).¹ The experimenter instructed them to keep attempting to recall additional countries or names until 4 min had elapsed.

2.3. Scoring and coding

2.3.1. Calculating benefit scores

To index the outcomes of collaboration in terms of the number of items recalled, we calculated a "benefit" score for each couple on each task. First, we pooled the items listed by individuals during Recall 1, to create a nominal group score for each couple on each task. Nominal group scores were calculated by adding the items recalled by the two individuals together while only counting redundant items once, indicating the potential of the two individuals recalling together (see Barnier, Harris, et al., 2018; Basden, Basden, & Henry, 2000; Weldon & Bellinger, 1997). Then, we subtracted the nominal Recall 1 score from the collaborative Recall 2 score, such that a positive value indicated collaborative benefits and a negative value indicated collaborative costs. As reported elsewhere (Barnier, Harris, et al., unpublished data), couples on average demonstrated collaborative benefits on both the non-personal and personal tasks, such that they remembered more together on Recall 2 than they did separately on Recall 1. Thus, the benefit score quantifies this increase and captures the differences between couples in the extent to which they demonstrated collaborative benefits.

2.3.2. Communication variables

Using the transcription of the recorded collaborative recall sessions, a trained coder scored the number of instances of 13 communicative behaviors in the two collaborative recall tasks. These behaviors and examples of each are detailed in Table 1. Variables included those scored and reported by Harris et al. (2011), based on the findings of Meade et al. (2009) and additional previous studies: strategy use and disagreements, cues, successful cues, failed cues, corrections, acknowledgments, repetition, extraneous information, and nominated expert. Harris et al. (2011) found that these communication variables explained 84% of the variance in collaborative recall performance in their sample of 12 older couples completing a personal semantic memory task. Extending prior research, we also added codes for positive and negative comments about memory performance, and attempts to shut down the recall session, because we noticed that these were

Table 1
Coded communication variables, with definitions and examples

Variable	Definition	Examples
Group strategies	Number of times a strategy was introduced.	M: Think of where the Tour de France goes F: Let's go alphabetically
Strategy disagreements	Number of times an introduced strategy was disagreed with or ignored.	M: Do you want to start with the church group? M: Let's go alphabetically F: No, I can't do it that way F: We go from the North? M: Italy, Greece
Cuing	Number of times there was an explicit question or reminder designed to prompt remembering in the other partner	F: Karen and...husband's name? F: Who's the guy with red hair? F: And there's another one that starts with A...
Successful cue	Number of coded cues that produced hits	M: Not Luxembourg, um, the little... F: Lichtenstein M: Monteneveo, what's it called? F: Montenegro
Failed cue	Number of coded cues that did not produce a hit	M: Along the Mediterranean, have we missed any along there? F: I don't know
Correction	Correction of one partner by the other	M: Turkey F: No, that's not in Europe M: Ian Hunter F: No, he's family so he doesn't count
Acknowledgment	Verbal acknowledgment of what the partner has said	M: Yes F: Right M: Mhmm F: True M: Good
Repetition	Exact repetition by one partner of what was said immediately prior by the other	F: Diane Miller M: Di, of course F: What about your golf club? M: Oh, my golf club, yes...
Extraneous information	Additional elaborations about a recalled item, not strictly required by the task	F: Oh George, he has all his teeth missing... M: Oh, Ukraine. They've been all over the news lately haven't they.
Recall shutdown	Number of attempts to terminate the task	M: That's it, time up F: I think we're done M: Oh, I don't know any more F: I'm out
Nominated expert	Number of references to one partner having particular knowledge or expertise on the task	M: Oh, you'll be good at this... F: He knows all the countries because he's traveled there
Positive metamemory	Positive appraisals of the process or content of remembering	M: We did pretty good F: That was a lot better than last week M: We got most of them

(continued)

Table 1. (continued)

Variable	Definition	Examples
Negative metamemory	Negative appraisals of the process or content of remembering	M: I can never remember those names F: I don't know, I was never good at geography M: I did much better last week

Note. Names have been changed. Shading indicates where multiple turns occurred adjacently in the transcript.

common features of the collaborative recall. A second independent coder scored one transcript for each of the couples (either the European Countries task or the Mutual Friends task, chosen alternately). Thus 20 of the 39 transcripts were double coded for the European Countries task (51%) and 19 of the 39 transcripts were double coded for the Mutual Friends task (49%). Inter-rater reliability as measured by intra-class correlation across all coding categories was $r = .95$ for European Countries and $r = .97$ for Mutual Friends.

2.3.3. Conversational style

To index conversational style, in each transcript we calculated the number of words in total and the number of words and conversational turns taken by each partner. Using these measures, we calculated: (a) average words spoken per turn within the conversation, overall and for each partner, such that a lower number indicated more rapid back-and-forth communication; (b) discrepancy in contributions, as the absolute difference in words spoken between members of the couple, with a lower number indicating more equal contributions; (c) discrepancy in words-per-turn, as the absolute difference between words-per-turn between members of the couple, with a lower number indicating more similar words-per-turn. Conversational dynamics such as rapid back-and-forth turn-taking may indicate more equal collaboration and more genuine joint “co-construction” during collaborative recall, so we selected these indices as one way of capturing differences in the ways different couples collaborated (see also Barron, 2000; Fay, Garrod, & Carletta, 2000; Sacks, Schegloff, & Jefferson, 1974).

3. Results

3.1. Collaborative benefits

The major aim of the current research was to identify the communication processes that emerged during conversational remembering and to index which processes were associated with memory benefits of collaboration. Our overall findings of collaborative benefits are reported elsewhere in detail (Barnier, Harris, et al., 2018), but the scores relevant to the current analysis are briefly summarized here (see Table 2). We used paired samples t-tests to compare nominal Recall 1 to collaborative Recall 2 within-subjects, with couples as the unit of analysis. For both the European Countries task, $t(38) = 4.94$, $p < .001$, $d = .807$, and the

Mutual Friends task, $t(38) = 10.02$, $p < .001$, $d = 1.872$, there were significant collaborative benefits: collaborative Recall 2 scores were higher than nominal Recall 1 scores (see Table 2; Cohen's d calculated using adjustment for within-subjects comparisons).

There also were substantial individual differences between couples and across tasks in the extent of these collaborative benefits. On the European Countries task, 8 of the 39 couples experienced collaborative costs, recalling fewer items during Recall 2 than on Recall 1. Three couples recalled the same number on both occasions. The remaining 28 couples recalled more during Recall 2 than during Recall 1, demonstrating collaborative benefits. On the Mutual Friends task, one couple recalled the same number of items on both Recall 2 and Recall 1. The remaining 38 recalled more during Recall 2 (and many substantially more), demonstrating collaborative benefits (see Table 2).

3.2. *Communication variables*

What were couples doing during collaboration that enabled them to support and facilitate each other's recall? As described above, we coded specific communication variables within couples' collaboration during Recall 2 for the recall tasks. To group similar communication variables together, and to replicate and extend the findings of Harris et al. (2011), we conducted a principal components analysis to identify common factors, with a varimax rotation to create orthogonal factors and to minimize cross-loadings, and an eigen-value criterion of 1. We considered that an item loaded on a particular factor if its factor loading was greater than 0.5. This analysis yielded five factors (see Table 3 for the factor loadings). Factor 1 was consistent with the "group-enhancing" factor identified by Harris et al. (2011). It included cuing, response to cue, and non-response/cue failure, as well as mirrored repetitions. Factor 2 was consistent with the "filler" factor identified by Harris et al. (2011). It included acknowledgments and extraneous extra information, as well as group strategies. Factor 3 was consistent with the "group-diminishing" factor identified by Harris et al. (2011). It included strategy disagreements, corrections, and having a nominated expert in the group. The final two factors included the additional variables not scored by Harris et al. (2011). Factor 4 included negative meta-statements about memory, as well as a cross-loading of failed cues. Factor 5 included positive meta-statements about memory, and, with a negative loading, attempts to end the recall task. Overall these five factors accounted for 65.73% of the variance among the items.

We used the regression method to give each couple a score on each of the five communication factors, and we also calculated a "benefit score" for each couple on each task,

Table 2
Items recalled by couples across recall sessions and memory tasks

	European Countries	Mutual Friends
Recall 1 (nominal)	26.56 (6.68)	30.85 (12.34)
Recall 2 (collaborative)	29.79 (7.52)	47.64 (17.99)
Range of benefit score	-5.00 to 11.00	0.00 to 38.00

as the difference between Recall 2 and Recall 1, described in Method. Then we used a stepwise regression with the outcome of the collaborative benefit score to determine which of the five communication factors were predictive of collaborative benefit. As well as scores on Factors 1–5, we included both wives' and husbands' ages, length of relationship in years, a categorical variable coding the task (European Countries vs. Mutual Friends), and Recall 1 scores as predictors. Thus, we controlled for baseline productivity. For predicting benefit scores, we found that task, $\beta = 10.02$, $p > .001$, group-enhancing Factor 1, $\beta = 2.72$, $p = .005$, and positive meta-cognition Factor 5, $\beta = 2.28$, $p = .012$, were significant predictors, resulting in a significant 3-factor regression model, $F(3, 74) = 26.15$, $p < .001$. The remaining predictors were not significant, all β s < 0.16 , all p s $> .07$. The overall model fit was $R^2 = 0.52$.

Over and above the effects of the task itself, communication variables explained collaborative benefits: specifically, beneficial communication variables were those associated with Factor 1 (cuing, and both cue success and cue failure, and mirrored repetitions) and Factor 5 (positive comments about memory performance, and a lack of attempts to end the recall session). Contrary to our previous findings, we did not find that the “filler” factor or the “group-diminishing” factor was associated with poorer collaborative performance.

3.3. Conversational style

We examined the effects of conversational style, indexed by couples' productivity in terms of total words spoken, words spoken in each turn (with a low number indicating rapid back-and-forth collaboration), and any discrepancy in contributions. We tested for relationships between conversational style, our five communication factors, and

Table 3
Factor loadings of each coded communication variable on the emergent five factors

	Factor 1 Group Enhance	Factor 2 Filler	Factor 3 Group Diminish	Factor 4 Negative Meta-Cog	Factor 5 Positive Meta-Cog
Cues	0.96	0.04	0.05	0.18	-0.03
Cue successful	0.89	0.07	0.03	-0.19	0.17
Repetitions	0.62	0.47	-0.10	0.03	0.12
Cue failed	0.55	-0.03	0.03	0.60	-0.28
Strategies mentioned	0.05	0.77	0.14	0.14	-0.06
Acknowledgments	0.22	0.61	-0.13	0.19	0.29
Extraneous info	0.02	0.56	0.09	-0.28	-0.20
Nominated expert	-0.03	-0.32	0.76	0.02	0.08
Corrections	0.12	0.14	0.74	-0.07	0.02
Strategy disagreements	-0.10	0.34	0.56	-0.11	-0.03
Negative meta comment	-0.07	0.09	-0.11	0.81	0.11
Cue failed	0.55	-0.03	0.03	0.60	-0.28
Positive meta comment	-0.05	-0.01	0.17	-0.10	0.79
Recall out	-0.32	0.05	0.17	-0.35	-0.63

Note. Shading indicates which variables loaded onto each factor.

collaborative benefit. In terms of overall productivity, total words spoken by the couple during collaboration was positively associated with both group-enhancing Factor 1 and filler Factor 2, $r = .38$, $p = .001$, and $r = .66$, $p < .001$, respectively. When looking at the words spoken by each of the partners separately, both husbands' and wives' words spoken correlated with group-enhancing Factor 1 and filler Factor 2, all r s $> .22$, all p s $< .05$. Interestingly, husbands' words spoken were also positively correlated with group-diminishing Factor 3, $r = .32$, $p = .004$, although wives' words spoken were not, $r = -.13$, $p = .24$.

Next, we examined words-per-turn for both partners, as well as the discrepancy between them, and whether they were associated with the clusters of communication variables. Husbands' words-per-turn were negatively associated with filler Factor 2, $r = -.24$, $p = .031$, and positively associated with group-diminishing Factor 3, $r = .31$, $p = .005$. Moreover, the tendency for one partner to dominate the recall (as indexed by the absolute difference between partners in their words-per-turn) was negatively associated with group-enhancing Factor 1, $r = -.24$, $p = .03$, and filler Factor 2, $r = -.26$, $p = .022$.

Finally, we examined whether any of the conversational style metrics were associated with collaborative benefit. The only significant relationship was with the extent to which the male partner spoke in monologues (indexed by words per turn), which was negatively associated with collaborative benefit, $r = -.27$, $p = .018$.

Overall, these patterns suggest that both group-enhancing Factor 1 and filler Factor 2 contributed to successful collaborative communication, in terms of general productivity and equality of contributions. Group-diminishing Factor 3, although not significantly associated with items recalled, was characteristic of a less interactive and equal collaboration. Overall, conversational styles were associated with the use of different communication variables, but only the husbands' words-per-turn were directly associated with collaborative benefit.

4. Discussion

In this study, we aimed to determine whether communication variables and/or conversational style were associated with collaborative benefits when long-married couples remembered together. We identified five clusters of communication variables within the collaborative recall (see also Harris et al., 2011), some of which were directly predictive of collaborative benefits and others that were associated with broader conversational styles. Factor 1 was a "group-enhancing" factor that included cuing, as well as both successful and unsuccessful responses to cues, and mirrored repetitions (Harris et al., 2011), and was associated with collaborative benefit. This factor appeared to indicate group-level coordination and contribution, in which both individuals were actively engaging with and responding to each other. It was also associated with back-and-forth conversational style.

Factor 2 was similar to the "filler factor" identified by Harris et al. (2011), including simple acknowledgments, extraneous elaborations, as well as strategies mentioned. Harris

et al. (2011) found that this factor was associated with poorer collaborative recall performance, although we found no relationship with collaborative recall in this study. This filler factor was still associated with more words spoken during the collaboration, and with a tendency to engage in more rapid turn-taking. Overall, this factor appears to include utterances that are unnecessary to the task at hand, indicating weaker versions of engagement or going off-topic. It is somewhat surprising that mentions of a group strategy loaded here, rather than with the more beneficial Factor 1. In prior research (Barnier, Harris, et al., 2018; Harris et al., 2011), we had found the presence of a group strategy was unreliable as a predictor of collaborative performance and so had excluded it from the final analysis in preference for strategy disagreements. Based on the conceptualization of this factor as a “filler factor,” this suggests that explicitly mentioning strategies may be less beneficial for collaboration than stronger versions of engagement and coordination like cuing, consistent with prior research that implicit strategies may be more helpful than explicit joint recall strategies for couples (Harris et al., 2011; Hollingshead, 1998a).

Factor 3 was consistent with the “group-diminishing” factor identified by Harris et al. (2011) and included corrections, strategy disagreements, and nominating an expert. Unlike the findings of Harris et al. (2011), this factor was not significantly associated with collaborative benefits (or the lack of them) in this study. It was, however, associated with a particular conversational style characterized by dominance by the male partner and less back-and-forth interaction. Finally, Factors 4 and 5 captured negative and positive meta-cognitive aspects of the collaboration, respectively. The “negative meta-cognition” factor also included failed cues, suggesting that while these failed cues loaded on the beneficial “group-enhancing” factor, they could also be associated with a sense of poor performance. The “positive meta-cognition” factor also included a lack of attempts to terminate recall early, suggesting that this factor captured positive motivation and a sense of accomplishment on the task.

Overall our findings suggest that the nature of communication during collaborative recall is a crucial predictor of benefits experienced by long-term collaborators in intimate groups, and they point to particular microprocesses that are beneficial for collaborative recall. This is consistent with the predictions of transactive memory theory (Wegner, 1987; Wegner et al., 1985) regarding the importance of successful communication or “transactions” in bringing about the memory benefits associated with transactive memory systems. These findings suggest that the costs and benefits of collaborative recall cannot be understood by measuring group output alone. Instead, analysis of the conversation that happens during collaborative remembering can explain when and how such costs and benefits come about. Future research would be needed to further investigate other aspects of transactive memory, such as the distribution of knowledge among group members, and their role in determining the outcomes of collaborative recall.

A focus on the processes of collaboration also emphasizes the heterogeneity in outcomes in terms of the costs and benefits of collaboration, even when testing highly intimate groups who have spent decades sharing their lives and reminiscing about their experiences. Even among these groups who are most likely to collaborate effectively, there are individual differences in the extent to which they adopt beneficial

communication strategies and conversational styles, and individual differences in the extent to which they experience collaborative benefits. This heterogeneity adds complexity and nuance to predictions about where we might expect to find collaborative benefits and effective transactive memory systems. To some extent, such benefits have proved relatively elusive (Barnier et al., 2014; Harris et al., 2011; 2017), at least when recall output is measured in terms of amount recalled. It appears that shared experiences and intimacy are necessary but not sufficient for collaborative benefits to emerge, which may help to explain why previous research on the effects of collaboration in intimate groups versus strangers has yielded mixed results, and generalized benefits for intimate groups have been difficult to identify (Andersson & Rönnerberg, 1995, 1996; Gould et al., 2002; Harris et al., 2013; Wegner et al., 1991). Although we operationalized intimacy in terms of groups with an existing relationship (in contrast with the strangers typically tested in collaborative recall) even long-standing groups like couples may vary in the extent to which they are intimate, and other features of the individuals and their relationship may contribute to heterogeneity in collaborative success (see also Barnier et al., 2014).

Our findings therefore suggest a layer of complexity in the predictions of transactive memory theory: Even for intimate groups, collaborative benefits are task-specific and depend on effective communication. In terms of task specificity, it is notable in the current research that benefits were greatest for the personally relevant Mutual Friends task. In Harris et al. (2011), benefits were not found on average when couples collaborated on another personally relevant task: listing the names of members of their social club. Instead, large individual differences meant some couples experienced costs and others experienced benefits. In contrast, in this study we identified large and almost universal benefits on the Mutual Friends task. One possible reason is that the club members task in the Harris et al. (2011) study often involved very uneven expertise: In many cases, the men were members of the club and the women only attended occasionally as guests. In our analysis of communication processes, having a nominated expert was associated with poorer collaborative recall. The Mutual Friends task in this study did not have this asymmetry built into it, and nominating an expert was rare. However, the possible role of shared expertise in driving the large collaborative benefits we found requires further investigation, as does the importance of balancing overlapping versus specialized expertise in couples' transactive memory systems (see also Barnier, Klein, et al., 2018). The crucial importance of specific communication techniques also has implications for any application of the benefits of collaboration to groups who need memory support (Barnier, Harris, & Congleton, 2013; Blumen et al., 2013). Not all individuals and groups may benefit equally from collaboration, but our findings raise the possibility that effective communication could be trained in cases where it has not developed naturally (see also Meade et al., 2009).

We considered whether the collaborative benefits that we found may have reflected simple practice effects. Collaborative recall was always the second recall test, and couples may have discussed the tasks with each other in the week between sessions. However, simple practice effects would not explain the role of communication variables in predicting who benefited most from collaboration. Moreover, to assess stability of

collaborative benefits, we returned to 32 of the 39 couples approximately 2 years later and tested their collaborative recall on the European Countries and Mutual Friends tasks (Recall 3) with no initial individual recall. For both tasks, significant collaborative benefits remained. On average, couples recalled more when collaborating 2 years later than they did on nominal Recall 1. There were also significant correlations between Recall 2 and Recall 3 performance, suggesting stability of collaborative success over time, such that those couples who collaborated best on Recall 2 also collaborated best on Recall 3 (see Barnier, Harris & Norris, unpublished data). Taken together, these findings suggest that the skilled communication that couples bring to collaboration may result in some couples being reliably better collaborators than others.

There are a number of limitations of this study which suggest avenues for further research. Our analysis of the communication features was not exhaustive. There are multiple additional variables we could have coded for and other features of the communication that are likely to impact on the effectiveness of the collaboration. For instance, for each correction in the collaboration we scored how it was responded to, whether the other partner accepted it or disagreed with it. However, breaking the variables down further in this way resulted in too few instances to analyze. In addition, we focused our analysis on two particular list-based tasks and have noted that the effects of collaboration are quite task specific. In previous research, we have found that such list-based tasks involve complex collaborative processes and autobiographical reminiscing (Harris et al., 2011, 2017; see also Table 1). These tasks were designed to be less personal (European Countries) and more personal (Mutual Friends). Both tasks were more semantic than episodic, focusing on listing items rather than recalling events. However, this distinction between non-personal and personal, and between semantic and episodic is not clean. For instance, even in the non-personal European Countries task, many couples used trips they had taken in Europe as a strategy for recalling the countries, and in both tasks, autobiographical reminiscing occurred particularly during collaborative recall (see also Harris et al., 2017; Renault, Davidson, Palombo, Moscovitch, & Levine, 2012). We deliberately used these tasks so that we could quantify the costs and benefits of collaborative recall relative to pooled nominal group performance, consistent with the benchmark for collaborative performance established within the collaborative recall literature (Basden et al., 2000; Weldon & Bellinger, 1997). For more event-based, autobiographical tasks, such quantifying of recall (and pooling to form nominal group scores) becomes more complex. Thus, further research is required to determine whether similar communication processes drive successful collaboration on other kinds of memory tasks. Finally, our study involved older couples, but further research directly comparing both older and younger couples and strangers remembering together will further illuminate the factors that underlie successful collaboration.

We aimed to determine the features of collaboration that lead to benefits for memory in older, long-married couples. We replicated previous results (Harris et al., 2011) in a different sample and on a different memory task, finding that the “group-enhancing factor” that we had previously identified—cues, responses to cues, and mirrored repetitions—was associated with collaborative success. In this study, this group-enhancing factor was also associated with a more equal collaborative style, and with words spoken overall.

We also identified a new positive factor associated with collaborative success—making positive statements about memory performance and persisting with the task. Our previously identified “group-diminishing factor”—correcting each other, having uneven expertise, and strategy disagreements—was not associated with the outcomes of collaborative recall in this study, but was associated with a less interactive, more “monologue” style of collaboration. These findings suggest that even among very longstanding intimate groups, not all collaborate equally successfully, and the presence of effective transactive memory systems cannot be assumed from length of relationship alone. This diversity in outcomes is at least partially explained by the nature of couples’ communication processes and styles. Overall, our results suggest the need to focus on the processes as well as the products of collaborative recall in understanding the effects of collaboration on memory.

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Note

1. We chose to match the total time allowed for nominal recall (4 min total, 2 min each) and collaborative recall (4 min total) for both tasks, to avoid disadvantaging the collaborative group, especially in light of typical findings of collaborative inhibition. To check whether this decision was responsible for the collaborative benefits we found, we scored, from the audio recordings, how many items collaborating couples recalled within the first 2 min. We found that for both tasks, collaborating couples already numerically exceeded the recall of the two pooled individuals, even with this strictest comparison. Thus, we do not consider this choice about timing to have driven our collaborative benefits, but future research could examine the best ways to time open-ended recall tasks to match nominal and collaborative groups. We also scored how many individuals and couples appeared blocked before the time was up and found that the condition where recall was most likely to be “cut off” by the timer was the couples collaboratively recalling their Mutual Friends (more than 50% cut off). Therefore, if anything, we disadvantaged these couples on the task where they showed the most benefit.

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