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Remembering and Retelling Stories in Individual and Collaborative Contexts

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SUMMARY

Collaborative cognition, in which two or more people work together on a cognitive task, may be typical of everyday life, and may even represent an important aspect of everyday cognitive adaptation for older adults. We examined collaborative memory for stories by comparing younger (n = 64) older (n = 66) individuals and dyads with collaborative performance produced by married spouses and stranger dyads. Overall, across four collaborative recall products (two positive and two negative performance indicators), some evidence for our hypothesis of general or selective collaborative effectiveness was observed. Moreover, such evidence was obtained at both an immediate and delayed recall episode. Discussion includes applications, limitations and suggestions for future research.

Everyday individual cognition occurs in a variety of influential contexts or situations (e.g. Greeno, 1998; Hess, 2005). For adults of all ages, an important context of daily cognitive performance may be one of the most obvious and proximal ones: Other individuals who share some aspects of a particular cognitive experience (e.g. Clancey, 1997; Edwards & Middleton, 1986; Lave & Wenger, 1991). Through conversation one's interpersonal context may affect quantitative and qualitative characteristics of actual cognitive performance (Garrod & Pickering, 2004; Paulus, 1989; Resnick, Levine, & Teasley, 1991), perhaps especially so for vulnerable populations (e.g. older adults, Baltes & Staudinger, 1996). Increasingly, research has been directed at examining the issue of whether—and, if so, to what extent—older adults' cognitive adaptation can be said to benefit from the interactive human context that envelops many of the cognitive challenges they confront in their everyday lives. In the present paper, we report the results of an experiment that models selected facets of this general issue. In particular, we examine the roles of adult age (younger and older adults), collaborative condition (recalling as individuals or as dyads), and relationship status (married spouses and stranger dyads) on a set of both traditional (actual amount of recall) and novel (e.g. elaborations) indicators reflecting performance on remembering and retelling stories.

We define collaborative cognition neutrally as the cognitive activity that occurs in the context of more than one individual, especially when that activity is directed at solving an objectively common task and performed together (Dixon, 1999). At least three aspects of our study situate it in the area of applied cognitive aging. First, we examine the everyday activity of remembering and retelling personal stories in mixed-gender interactively collaborating dyads (including married partners). Second, in addition to a traditional laboratory measure of accurate recall, we expand the representation of collaborative performance to include novel objective products of individual and interactive story memory episodes. Such products may better reflect (and not

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penalize) older adults, who may view the everyday retelling of a story in more conversational or narrative terms than as a literal rote recall task (e.g. Adams, Labouvie-Vief, Hobart, & Dorosz, 1990; Gould, Trevithick, & Dixon, 1991; Marsh & Tversky, 2004). Third, we perform several novel comparisons within the experiment. Theoretical factors of cognitive aging are explored in a model of everyday performance; these include (a) comparing actual individual performance to actual dyadic performance across both age (young, older adults), collaborative condition (recalling individually or collaboratively), and relationship status (collaborating with a spouse or stranger), and (b) evaluating actual performance across a delay condition reflecting the common shared event of later retelling a jointly experienced narrative.

Our approach derives from selected strands of the literature of individual cognitive aging, collaborative cognition and collaborative cognitive development. First, research in cognitive aging is bristling with studies on age differences and changes in episodic memory performance. At the individual level, both cross-sectional and longitudinal studies have confirmed a gradual decline during the later years of adulthood (e.g. Dixon, Wahlin, Maitland, Hultsch, Hertzog, & Bäckman, 2004; Zacks, Hasher, & Li, 2000). This decline applies also to semantically rich material (such as stories). Only the rare theoretical mechanism would predict sustained or improved levels of memory performance with aging. Among these, aspects of the encoding or retrieval contexts have been explored (Hess, 2005) including the presence, participation or even recruitment of human memory aids (Dixon, 1999). The latter links the theoretical background with a practical dimension. Prominent among the everyday episodic remembering activities are families and friendship groups reconstructing stories from a shared past, and spouses and caregivers helping a memory-impaired older adult recall important information, duties or dates (e.g. Cavanaugh et al., 1989). Is everyday memory adaptiveness enhanced by such contextual factors? Some research has suggested that older adults believe that working with a partner, especially a spouse or equivalent, may be beneficial to overall memory performance (e.g. Dixon, Gagnon, & Crow, 1998). However, the empirical evidence thus far regarding the veridicality of this belief is inconclusive (e.g. Berg et al., 2007; Gould, Osborn, Krein, & Mortenson, 2002; Margrett & Marsiske, 2002; Strough & Margrett, 2002). One possible reason is that individuals' beliefs about collaboration may include more aspects or factors of the everyday collaboration experience and performance than are typically modelled or measured in collaborative cognition experiments. In this study, we explore not the beliefs about collaboration, but selected the aspects of collaborative performance that may inform everyday beliefs about collaborative effectiveness, which have not yet influenced research about collaborative cognition.

Group size and composition are among the factors that influence collaborative memory performance. In general, young and older groups tend to recall more actual information than corresponding individuals. However, collaboration has been shown to be more (e.g. Clark, Hori, Putnam, & Martin, 2000; Hinsz, 1990) or less (e.g. Andersson & Rönnberg, 1995, 1996) productive than selected comparison units or groups. For example, when comparing actual dyadic performance of younger (Andersson & Rönnberg, 1995, 1996) and older adults (Johansson, Andersson, & Rönnberg, 2000, 2005) to that of a `nominal' aggregation (i.e. a hypothetical performance created from the pooling of two actual individual's memory products), dyads recalled less information. Actual groups may experience collaborative process-related loss because of `collaborative inhibition'. This reflects such interactional factors as reduced motivation or increased disruptions to individual-level encoding, retrieval or strategy implementation (Weldon & Bellinger, 1997). Other conditions of the collaborative activity may produce process gains or collaborative enhancement (e.g. number and familiarity of partners). For example, by focusing on actual performances only (rather than pooled, hypothetical or aggregated performance), groups outperform individuals on recognition memory tasks (Hinsz, 1990), on the completeness and correctness of testimony (Clark, Stephenson, & Kniveton, 1990; Stephenson, Abrams, Wagner, & Wade, 1986; Stephenson,

Brandstatter, & Wagner, 1983), and on the total amount of information recalled (Basden, Basden, Bryner, & Thomas, 1997; Meudell et al., 1992, 1995; Weldon & Bellinger, 1997). In a previous study with older adults, Dixon and Gould (1998; Study 1) observed that both younger and older adults' actual story memory performance benefited from the presence of collaborators. Study 2 showed that older married spouses' levels of story recall were similar to those of younger married spouses. This result indirectly supported the notion that, with interactive experience, collaborators might coordinate their joint cognitive efforts, enhancing their performance and avoiding some inhibiting effects (Berg et al., 2007; Engeström, 1992; Garrod & Pickering, 2004; Gould, Kurzman, & Dixon, 1994; Johansson et al., 2000; Wegner, Giuliano, & Hertel, 1985). However, other research with young adult friends (Andersson & Rönnberg, 1995) and older couples (Gould et al., 2002) has produced inconsistent results. Because no supplemental recall-related information (e.g. elaborations) has been studied, the practical implications are unknown.

A possible reason for inconsistent results in the literature is across-experiment variations in (a) to-be-recalled materials, and (b) range of identified and scored recall-related products and processes (see also Takahashi & Saito, 2004; Wright & Klumpp, 2004). Some to-be-remembered materials (e.g. word lists) are less likely to produce extensive recall-related conversations than others (e.g. narrative stories), and correspondingly less opportunity for collaborative conversations. In addition, some performance indicators (e.g. verbatim or gist recall of items) may not truly represent the range of recall-related products actually occurring in more extensive collaborative conversations. Examples of heretofore largely unexamined positive or functional aspects of re-telling an original story are inferences, elaborations and themes (Adams et al., 1990; Gould et al., 1991; Marsh & Tversky, 2004). Naturally, not all utterances occurring during collaborative recall would be considered productive, but similarly little research has examined such negative or counter-productive statements as complaints or errors. Theoretically, both could be disruptive to the collaborative recall process, perhaps inhibiting productive recall or even promoting cascading distractions or errors. Arguably, examination of a broader and balanced range of conversational indicators and products could be informative. In everyday life, it is arguably adaptive to re-tell brief narratives with emphasis on balancing rote recitation of objective facts and associated details with information that offers personal perspective, entertaining context, but that is consistent and related (Dudukovic, Marsh, & Tversky, 2004). As transcribed, such narratives would be characterized by the predominant presence of accurate gist recall supplemented by consistent and possibly story-enhancing elaborations and inferences with relatively few errors and distracting or disruptive comments (metastatements).

An additional factor is the temporal aspect of everyday collaboration experience. One early study modelled the delay that occurs between everyday encoding and recall (Andersson & Rönnberg, 1995). Comparing the relative number of reminisced items (RI) (i.e. number of items recalled in the delayed recall that were not immediately recalled) and forgotten items (FI) (i.e. items recalled immediately but not at delay), young adult individuals performed better than the dyads in terms of both (more) reminisced and (fewer) FI (see also Meudell, Hitch, & Boyle, 1995; Meudell, Hitch, & Kirby, 1992). At least one study has shown that collaboration may benefit performance at a delay (Takahashi & Saito, 2004), but no studies have examined this temporal characteristic of collaborative memory with older adults.

In the present study, we explore the roles of age (younger, older), relationship status (spouses, strangers) and collaborative condition (individual, dyad) on both positive (gist, elaborations) and negative (errors, metastatements) indicators of story recall performance, as measured immediately and after a brief delay. Our materials and procedures are derived from previous individual and collaborative recall experiments (e.g. Dixon & Gould, 1998; Dixon et al., 2004). Four main hypotheses are examined. Our first hypothesis was comprised of five baseline

expectations of selected group similarities and differences. A pattern of expected results would confirm and support important aspects of our sample selection, manipulations and characteristics. (a) We expected that older individuals would recall less story information than younger individuals. This common finding in the cognitive aging literature (e.g. Zacks et al., 2000) would establish that the present individual adults are `typical' and imply that any older dyadic performance advantages would be due to collaborative effects, not to unusual older individuals' abilities. (b) Similarly, to attribute dyadic performance to collaborative experience rather than unusual individual abilities, we expected that individuals from the groups of spouses and the strangers would recall a similar amount of story information. (c) We expected individual performance to be similar regardless of order of experimental procedures. (d) Moreover, we expected that dyads would recall more story information than individuals. As shown in previous research comparing collaborative and individual cognitive performance (e.g. Dixon & Gould, 1998; Takahashi & Saito, 2004), collaboration should result in a higher amount of story recall than working alone. (e) Finally, across all conditions we expected that younger adults would recall more information than older adults.

For our second hypothesis, we expected that younger spouses, younger stranger dyads and older spouses would perform similarly, and better than older stranger dyads for the positive (more gist recall and elaborations) and negative (fewer metastatements and errors) story-related products. We theorized (see Engeström, 1992) that if the collaborative familiarity effect is strong, older spouses may overcome their individual age-related decline via working with a partner with whom they have extensive experience collaborating (i.e. a spouse). Accordingly, spouses, having extensive experience working together, could make more useful story-related productions, and inhibit negative products, as a part of the positive manifold of overall accurate recall.

Our third and fourth hypotheses concerned the unique temporal aspect of collaborative recall. The third hypothesis was that there would be an overall loss of story information (all products) from the immediate to delayed recall condition, or `decay with delay', but that the delay profiles would vary by age, relationship status, individual-dyadic order and collaborative experience. Because of the lack of previous research, we tentatively expected that the same patterns of performance for the positive and negative products would occur at the delay (as at the immediate) recall interval. For the fourth hypothesis, we examined the relative amounts of reminisced and FI. Overall, we expected that due to their collaborative opportunity or experience, dyads (versus individuals) and spouses (vs. strangers) might produce results qualifying the `decay with delay' idea. Although previous research showed that young adult individuals experienced less reminiscence loss than did dyads, we explored the possibility that the opposite pattern would be observed for older adult dyads.

METHOD

Participants

Sixty-four younger (age range = 22-37 years) and 66 older (age range = 58-84 years) adults participated in this experiment. The subjects were recruited from a volunteer subject pool and the community. Half the participants in each age group were recruited as married couples. The remaining half was recruited as individuals, with equal numbers of women and men for subsequent pairing as stranger dyads. From the latter pool of individuals, we constructed each stranger dyad so as to approximate the age and gender pairing of a given married couple. Therefore, each stranger dyad was similar in age to one of the couples. For the younger adults, the 32 pairs of participants included 16 younger married couples (*M* age male = 30.81 years, SD = 3.83; *M* age female = 29.56, SD = 4.03) and 16 mixed-gender stranger dyads (*M* age male = 30.00, SD = 4.02; *M* age female = 29.56, SD = 4.24). For the older age group, the 66 individuals were distributed into 17 married couples (*M* age male = 70.59 years, SD = 6.14;

M age female = 70.06, SD = 7.20) and 16 mixed-gender stranger dyads (*M* age male = 70.56 years, SD = 6.10; *M* age female = 70.19, SD = 6.82). The older adults were on average approximately 70 years old, an age in which normal cognitive decline is typically underway (Dixon et al., 2004).

Married spouses were assumed to have more collaborative experience than stranger dyads. Older married couples were assumed to have more collaborative experience than younger married couples. We confirmed these assumptions by conducting four additional checks. First, we established that younger and older stranger dyads had not previously met (i.e. no collaborative experience). Second, we established that the groups of younger and older spouses had been married for distinctly different and non-overlapping periods. Specifically, whereas the younger spouses had been married for a period between 1 and 9 years (*M* = 4.53 years, SD = 3.07), the older spouses had been married for a period between 28 and 55 years (*M* 45.79 years, SD = 6.99). Third, as documented below in the measures section, we checked the collaborative experience factor by examining results from a preliminary two-part inventory pertaining to spousal knowledge (factual information about each spouse) and spousal expertise (division of duties and skills in everyday couple activities). A MANOVA was conducted on the percentage agreement between spouses on the spousal knowledge and spousal expertise scales of the inventory. The multivariate effect was significant, Wilks' $F(2, 63) = 4.74$, $p < .012$, partial $\eta^2 = .131$. The two follow-up ANOVAs showed that older spouses (*M* = 57.35%, SD=11.46) agreed to a lesser extent than younger spouses (*M* = 66.02%, SD=11.33) on the spousal knowledge domain, $F(1, 64)=9.52$, $p < .003$, partial $\eta^2=.130$. The groups performed equivalently on the spousal expertise domain, $F(1, 64)=.03$, $p > .85$, partial $\eta^2=.001$ (older *M*=81.86%, SD=14.57; younger *M*=81.25%, SD=12.52). The surprising former result is likely due to the nature of the spousal knowledge questionnaire, which included questions pertaining to personal events that were far more remote in older versus younger adults (e.g. what high school your spouse attended?). Thus, in both dimensions, the goal of ensuring that older married spouses are not advantaged as compared to younger married spouses is supported. Accordingly, we may assume that the test of the collaborative experience hypothesis is a relatively conservative one. Fourth, we computed marital satisfaction using the Dyadic Adjustment Scale (Spanier, 1976). The composite scores (Young *M*=111.2, SD=11.85; Old *M* = 117.9, SD=10.24) and all five classification scales revealed clinically similar levels of adjustment. When different, the older spouses responded with slightly higher adjustment scores.

Participants individually completed a 54-item vocabulary survey taken from the Kit of Factor Reference Cognitive Tests (Ekstrom, French, Harman, & Dermen, 1976). A 2 (age group: young, old) ×2 (relationship status: spouses, strangers) analysis of variance (ANOVA) revealed significant main effects for age group, $F(1, 125)=108.26$, $p<.001$, partial $\eta^2=.464$, and for relationship status, $F(1, 125)=10.87$, $p<.001$, partial $\eta^2=.080$, but no significant interaction. As is typical, the older adults (*M* = 44.03, SD=5.44) performed significantly better than the younger adults (*M* = 33.73, SD=6.34) on the vocabulary survey. Overall, the individuals from the group of strangers(*M*=40.52, SD=6.93) performed better than the individuals from the spouses (*M* = 37.51, SD=8.40). Although this difference is unexpected, it does not compromise the hypotheses. In fact, the difference in this direction may provide a more conservative test of the collaborative experience hypothesis. A 2 × 2 ANOVA on years of education revealed only a significant main effect of age group, $F(1, 125)=7.63$, $p<.007$, partial $\eta^2=.058$. Although both groups were generally well educated, the younger adults (*M* = 15.86, SD=2.25) had a greater number of years of education than the older adults (*M*=14.55, SD=2.99). All participants received a small honorarium for their participation.

Design and procedure

The overall design is presented in the schematic of Figure 1. Each adult participated in two testing conditions, individual (alone) and collaborative (with partner). The individualtesting condition resembled a standard cross-sectional cognitive aging experiment. In contrast, the partner-testing condition permitted collaboration between two individuals, either a husband and wife or a stranger man and woman. As can be seen in the figure, the design included two theoretically selected orders, each consisting of three sequential phases. Half of the spouses and half of the strangers were randomly assigned to each order. (Although other orders are possible, these are the two most pertinent to our research questions.) For both orders, an initial intake assessment (e.g. personal information questionnaire) was performed individually. For Order 1, (a) the first phase (immediate recall) was performed (simultaneously) by the two individuals in separate testing rooms, (b) the second phase (delayed recall) was performed by the two individuals together in one testing room, and (c) the third phase (immediate recall) was performed together in one testing room. For Order 2, (d) the first phase (immediate recall) was performed together in one testing room, (e) the second phase (delayed recall) was performed separately in different testing rooms, and (f) the third phase (immediate recall) was performed separately in different testing rooms. Note that the Phase 2-delayed condition involved recalling the story originally presented in Phase 1, and Phase 3 recall involved a new story.

This design provided data to explore each of the four hypotheses. In order to analyze the data with a minimum of experiment-wise error, we conducted selected analyses of variance using only those factors and data appropriate for testing a specific hypothesis. The factors were selected from the following set: Age Group (2: younger, older), Collaborative Condition (2: working together, alone), Relationship Status (2: spouses, strangers), Order (2: order 1: individual-then-dyad performance, order 2: dyad-then-individual performance), and Time of Recall (2: immediate, delay). Given the exploratory and archival purposes of the study, univariate analyses were conducted to provide sensitive indicators of each novel recall-related performance.

Measures

Personal information questionnaire—Each individual provided basic demographic information including age, education and marital status.

Spousal knowledge/spousal expertise inventory—As noted earlier, both younger and older spouses completed this two-part inventory. First, we evaluated *spousal knowledge* with two sets of 15 factual information questions. Each participant provided answers pertaining to themselves for the first set of 15 questions, and then answers pertaining to their spouses for the second set of 15 questions. Each participant's answers about themselves were used to score their partner's answers about them. Second, we evaluated *spousal expertise* via 12 questions regarding division of duties and skills in domains of everyday activities. Scoring of both spousal knowledge and spouse expertise items involved assigning a 1 when spouses agreed and a 0 when spouses disagreed, with a clear correct or incorrect response. For example, if both the wife and husband reported that he was born on 4 November 1938, that item was given a 1. If they responded with different dates, that item was given a 0. (Results are described earlier). Two individuals scored these questionnaires and they required very little interpretation.

When comparing the cognitive performances of younger and older spouses, chronological age is confounded with collaborative experience (i.e. marital length). A full experimental design is not possible, in that older spouses may be both short-term married (e.g. 5 years) and long-term married (e.g. 40 years), but long-term married young adult spouses do not exist. From this perspective, older spouses may have a collaborative (or process-related) advantage over younger spouses attributable to their long-term knowledge of, and experience with, one

another. This potential interactional advantage is in contrast to their individual-level cognitive disadvantage (due to normal aging decline). We used the two dimensions of spousal knowledge and spousal expertise to evaluate the initial presumption of collaborative expertise on the part of both the younger and older spouses. Given that individual cognitive expertise is developed over many years of practice, and that it is often associated with enhanced domain-relevant performance (Ericsson, 1996), we expected that older spouses would demonstrate more spouse-related knowledge than younger spouses. Such an outcome would render our collaborative expertise comparisons as liberal tests of the hypothesis. In contrast, however, we reasoned that similar (or better) performances by the younger (vs. older) spouses would support a more conservative test of the collaborative expertise hypothesis, in that cognitive performance differences (in favour of older spouses) would be interpretable as effects of collaborative expertise. The absence (and impossibility) of a full experimental design may still qualify the collaborative expertise results.

Immediate story recall—Two structurally equivalent stories featuring older adult couples as protagonists were taken from a battery, which was developed by Dixon, Hertzog, Friesen, and Hultsch (1993). The stories were presented at a normal speaking rate by an auditory recording of a professional radio announcer. Whereas the first story, `A Trip Abroad', contains 165 words and 92 propositions, the second story, `Playing Cards', contains 162 words and 90 propositions (Dixon et al., 1993). The two stories were equivalent in the Flesch-Kincaid grade level reading score (ATrip Abroad 7.0; Playing Cards 6.7). The two stories were administered equivalently in each immediate recall phase of the experimental model (see Figure 1). Participants were asked to listen carefully to the story so that they could remember it in their own words. Oral recall performance was recorded and transcribed for scoring. Scoring of free recall of the text was based on the number of propositions correctly recalled using a lenient or gist criterion (Dixon et al., 1993, 2004 for further information on propositional analyses and protocol scoring). For the delayed recall (phase 2), the original story was not re-presented.

As is often the case in story production or recall tests, parts of the protocols cannot be classified as correctly recalled information. Although often discarded in experimental cognitive or cognitive aging research, these elements of the overall production may be classified into thematically important clusters according to their content and function. Accordingly, in order to fully represent the recall and recall-related productions of individuals and dyads, we also scored the transcribed products for the presence of elaborations, metastatements, errors, macrostatements and repetitions. The latter two of these produced insufficient instances for further analysis. In terms of function, we classified the remaining three categories as positive or negative, depending on whether they could be theoretically considered either as useful to the remembering process or as legitimate products of story-retelling (Dixon, 1999). One of these categories is considered positive and the other two are negative. *Elaborations* are defined as comments that are consistent with the story, but not actually contained in it (see Gould et al., 1991). Examples include correct or reasonable inferences, such as indicating that travel to Ireland occurred in an airplane when the latter stipulation was not explicit in the original story. *Metastatements* are complaints or other comments about an individual's memory processes and performance, such as `my memory is not what it used to be' and `I can't remember anything else'. Metastatements are negative recall characteristics because they are inconsistent with the story, theoretically distracting from the recall task at hand, and typically complaints. *Errors* are items produced as recall, but that are incorrect when compared to the original text base.

Our scoring procedure resulted in coding virtually all utterances contained in the recall protocol. Two raters scored all of the story recall products (one rater was blind to the hypotheses and conditions). We evaluated the interrater reliability using approximately 14% of the total story recall tasks (sampling an equal number of individual and dyad protocols). Regarding gist recall (total number of propositions scored) the interrater reliability was r=.97 (p<.001). This

value indicated a very high agreement on the total number of propositions recalled for each story. The most demanding form of interrater reliability reflects agreement on proposition-by-proposition scoring; raters agreed 80% of the time that a particular proposition was recalled from a story. Interrater reliability estimates for each of the recall-related products were also calculated. We observed the following values for elaborations: r=.61,p<.001, metastatements: r.96,p<.001 and errors: r=.64,p<.004. The somewhat lower values for elaborations and errors reflected not disagreements in the identification of these comments, but slight interrater differences in counting the propositions entailed in each comment. Disagreements were minor and were resolved by consensus.

Delayed story recall—After about a 45 minutes delay, participants were asked to recall (without further review) the story presented in the first phase of the experiment. Whereas half the participants encoded and recalled the stories in the first phase as individuals and performed dyad-level delayed recall (order 1), the other half experienced the reverse order (order 2). The conditions and scoring of gist and recall-related performance in delayed recall were identical to those used in immediate story recall. The instructions varied only in that a reference was made to the story recalled previously individually or collaboratively, with a request to remember the original story under the new recall condition (collaborative/individual).

Following Andersson and Rönnberg (1995), the number of RI and the number of FI, when comparing the immediate recall with delayed recall, were calculated. Thus, the actual story propositions recalled in the first phase (immediate) of the experiment were compared with those recalled in the second (delay). Each item that was not recalled in the first phase, but was recalled in the second phase, was given a score of 1 and was summed to indicate RI. Similarly, each `forgotten' item was given a score of 1 and was summed to indicate FI. A difference of RI to FI (RI-FI) was calculated. Larger reminiscence values indicated positive aspects of the delayed recall.

RESULTS

Prior to the analyses, one older individual's story recall data from the spouse condition was removed, as it was more than two standard deviations below the group mean. Table 1 displays all the average immediate recall characteristics according to age group, relationship status and collaborative condition.

Baseline performance checks

The first hypothesis entailed two analyses designed to establish five pre-conditions for considering the subsequent hypotheses. The first analysis tested whether (a) individual younger adults performed better than individual older adults, (b) individuals from the spouses and strangers performed similarly and (c) individual performance at the beginning (Order 1) was different than that at the end (Order 2). We performed a 2×2×2 (age group by relationship status by order) ANOVA on individual-level propositional recall. The significant main effect of age group, F(1, 121)=23.82,p<.000, partial η^2=.164, that older individuals (M=29.71%, SD=11.11) recalled less story information than younger individuals (M=40.01%, SD=12.67). This result replicates that obtained in other story recall experiments with similar tasks (e.g. Dixon et al., 2004). The expected null result for the relationship status tasks indicated that individuals selected for the strangers did not vary from those enrolled as spouses. Individual performance in order 1 (cell A in Figure 1) did not differ from that of order 2 (cell F).

The second analysis examined whether, overall, (d) dyads would recall more information at immediate recall than individuals, and (e) younger participants would recall more information than older adults. A 2×2×2×2 (age group by relationship status by collaborative condition by order) ANOVA was performed on the percentage of propositions recalled. Specifically, we

examined dyadic (cells C and D from Figure 1) and individual (cells A and F) performance level data. A significant main effect of collaborative condition, $F(1, 178)=22.66$, $p<.001$, partial $\eta^2=.113$, revealed that more propositions were recalled when working with a partner ($M=43.54\%$,SD=12.93) than when working alone $M=34.82\%$, SD=12.94). The main effect of age group, $F(1, 178)=27.56$,$p<.001$, partial $\eta^2=.134$ showed that, across other conditions, younger participants ($M=42.68\%$, SD=12.92) recalled a higher percentage of propositions than did older participants ($M=32.91\%$, SD=12.41). The remaining results were not examined.

In sum, our analyses supported all five baseline expectations. This fact establishes important sample and performance characteristics preliminary to subsequent research questions.

Immediate story recall-related performance

The second hypothesis, regarding age and collaborative experience effects, was evaluated using a series of ANOVAs on each of the recall-related products. For archival purposes, Table 1 has relevant performance means and Table 2 shows values of all significant *F*-tests.

Gist-recall (+)—The first ANOVA a involved a 2×2×2 (age group by relationship status by order) on percentage of propositions recalled collaboratively by dyads (cells C and D in Figure 1). A main effect of age group was significant. Younger dyads ($M=48.00\%$, SD=11.91) recalled significantly more story information than older dyads ($M=39.21\%$, SD=12.57). However, the expected two-way interaction between relationship status and age group was not significant, $F(1, 57)=1.82$,$p>.183$, partial $\eta^2=.031$. The order of group means was, however, in the expected direction; whereas younger strangers ($M=48.24\%$, SD=11.38) performed similarly to younger spouses ($M=47.76\%$, SD=12.78), older spouses ($M=42.87\%$, SD=12.96) performed better than older strangers ($M=35.32\%$, SD=11.25). All remaining results for gist recall were nonsignificant.

The remaining recall-related products were evaluated by a 2×2×2 (age group by relationship status by collaborative condition) ANOVA on each. All of the following analyses used data from cells A, C, D, and F in Figure 1.

Elaborations (+)—The main effects of relationship status and collaborative condition were significant. Overall, spouses ($M=21.51$, SD=11.43) made significantly more elaborations than strangers ($M=19.38$, SD=9.04). Moreover, significantly more elaborations were made when participants worked with a partner ($M=26.14$, SD=10.51) than when participants worked alone ($M=17.62$, SD=9.06). These main effects are qualified by the expected significant two-way interaction between relationship status and collaborative condition. There was no significant difference between the number of elaborations made by strangers ($M=17.95$, SD=9.06) or spouses working alone ($M=17.29$, SD=9.11). In contrast, spouses working together ($M=29.94$, SD=11.02) made significantly more elaborative statements than strangers working together ($M=22.22$, SD=8.45), and more than the two individual-level conditions. The remaining results were nonsignificant.

Metastatements (-)—The main effects of relationship status and collaborative condition were significant. Overall, spouses ($M=2.60$, SD=3.08) made significantly fewer metastatements than strangers ($M=3.79$, SD=3.99). Moreover, when working alone ($M=3.94$, SD=3.85) participants made more metastatements than when working with a partner ($M=1.68$, SD=2.46). These effects are qualified by the significant three-way interaction between age group, relationship status and collaborative condition. Figure 2 illustrates the key differences. For the young adults, follow-up analyses showed that stranger individuals made significantly more metastatements than spouse individuals ($M=4.91$, SD=3.84; $M=2.53$, SD=2.03, respectively). However, when younger adults performed as dyads, strangers and spouses

produced few and an equivalent number of metastatements. For the older adults, the stranger and spouse individuals (*M*=4.28, SD=4.93; *M*=4.03, SD=3.78, respectively) produced similarly high numbers of metastatements. In contrast at the dyad level, the older spouses (*M*=.71, SD=1.21) produced the fewest metastatements, significantly fewer than older strangers (*M*=3.00, SD=2.61), and even less than younger strangers (*M*=1.38, SD=1.82) and younger spouses (*M*=1.69, SD=3.32). Collaborating spouses produced the fewest number of metastatements.

Errors (-)—The main effect of relationship status was significant. Overall, strangers (*M*=2.27, SD=1.98) made significantly more errors than spouses (*M*=1.71, SD=1.57). The remaining main effects and all interactions were not statistically significant.

In sum, significant results with elaborations and metastatements were consistent with our second hypothesis. The informally observed nonsignificant mean-level trend for gist recall was also consistent. The results for errors were inconclusive, but not supportive.

Delayed story recall-related performance

According to our third hypothesis, the loss of story information from the immediate to delayed condition would be moderated by the presence or absence of a collaborator at delayed recall. A series of 2 × 2 × 2 × 2 × ANOVA on positive and negative recall-related products performed. The factors include: age group (young vs. old), order (individuals first vs. dyads first), relationship status (spouse vs. stranger), time of recall (immediate vs. delay) with repeated measures on the last factor. The time of recall factor denotes comparisons of immediate versus delayed performance. Hence, from Figure 1, data from cells A and D constituted immediate recall with cells B and E constituting corresponding delayed recall. All significant F-test values are presented in Table 2.

Gist recall (+)—The percentage of story information recalled in the two immediate-delay sets (cells A-B and D-E in Figure 1) was evaluated. There was a main effect of age group. Across the two recall opportunities, younger participants (*M* = 42.55, SD 11.55) recalled significantly more story information than older participants (*M* = 33.72, SD = 9.72). There was also a significant interaction between order and time of recall. As shown in Figure 3, the patterns associated with orders 1 and 2 were quite different. First, a significantly higher percentage of information was recalled at dyad-level delay (M = 40.66, SD = 10.34) than at individual-level immediate recall *M* = 33.40, SD =12.73 (order 1). Second, a significantly higher percentage of story was recalled dyad-level immediate recall (*M* = 43.69, SD = 12.55) than by individuals at delayed recall (*M* 34.56, SD 14.07) (order 2). These contrasting patterns suggest that the typical `decay with delay' phenomenon applies also when individuals perform a delayed recall after they performed immediate collaborative recall. In other words, we found that initial collaboration does not buffer individual-level memory decay. However, as shown in Figure 3, when dyads perform a collaborative delayed recall after an individual-level immediate recall experience, the evidence suggests less decay than a recall boost in the delayed condition. The remaining results were nonsignificant.

Elaborations (+)—We observed significant main effects for relationship status and time of recall, and both were qualified by higher order interactions. The significant two-way interaction between age group and time of recall showed that the younger adults made significantly more elaborations at delay (*M* = 28.53, SD = 12.50) than at immediate (*M* = 21.66, SD = 10.91) recall, whereas older adults made a similar = number of elaborations at delay (M=23.05, SD = 12.29) and immediate (*M* = 22.56, SD = 9.00) recall. The two-way interaction between order and time of recall showed that individuals made fewer elaborations (whether in an immediate or delayed condition) than dyads. Finally, the three-way interaction involving relationship

status, order and time of recall was significant. As displayed in Figure 4, the production of elaborations by individuals did not vary much across relationship status or time of recall (range of means = 17.41-21.19). Notably, elaboration productions were uniformly greater for dyads (range of means = 24.31-36.63) than for individuals. Among dyads, a marked tendency for spouses to produce more elaborations was especially apparent at delayed recall.

Metastatements (-)—A main effect of relationship status was significant. Strangers (*M* = 3.41, SD = 2.58) made significantly more metastatements than spouses (*M* 2.06, SD = 1.62).A crossover interaction between order and time of recall was significant. Significantly more metastatements were made in immediate recall by individuals (*M* 3.37, SD = 3.82) than were made in delayed recall by dyads (*M* = 1.72, SD = 1.97). In contrast,significantly fewer metastatements were made at immediate recall by dyads (*M* = 1.55, SD = 1.87) than at delayed recall by individuals (*M* = 4.24, SD = 3.73). In both immediate and delay conditions, individuals (not dyads) made the most metastatements. The remaining results were nonsignificant.

Errors (-)—The results for the total number of errors showed a main effect of age group. Younger adults (*M* = 1.94, SD = 1.27) made significantly fewer errors than older adults (*M* = 2.36, SD = 1.17). The interaction between relationship status and order and between order SD = 1.52) time of recall were significant. Finally, the three-way interaction between age group, order and time of recall was significant. When immediate recall was individual and delayed recall was dyadic, older adults made significantly more errors in delayed recall (M = 3.13,than in immediate recall (*M* = 1.66, SD = 1.49), whereas younger adults made a similar number of errors in immediate (*M* = 1.66, SD = 1.52) and delayed (*M* 1.50,SD = 1.30) recall. Moreover, the number of errors for both younger and older adults was similar in immediate dyadic recall (*M* 2.25, and SD = 1.70; *M* = 2.53, SD = 1.78, respectively) delayed individual recall (*M* 2.34, SD= = 1.86; *M* 2.12, SD= 1.32, respectively). Overall, the error result showed that older dyads were not uniformly benefiting from their collaboration in the delayed recall condition.

In sum, the analyses of positive production indicators were consistent with the hypothesis. However, the results pertaining to negative production indicators presented a mixed picture. Whereas there seemed to be a clear benefit for collaborators to produce fewer metastatements, older collaborators seemed to make a greater number of errors in delayed recall.

Reminisced items and forgotten items

Our fourth hypothesis was derived from previous research with young adults in which performance in the immediate and delayed conditions is represented as a difference between the number of RI and the number of FI (Andersson & Rönnberg, 1995). A negative difference indicates that there were more FI than RI, whereas a positive (or near zero) difference indicates that there were more RI than FI. In general, the more positive (or less negative) the difference, the better the delayed recall performance. A 2× 2 × 2 × (age × group relationship status × collaborative condition) ANOVA was performed on the RI-FI difference (using the cell pairs A-B and D-E). Only the two-way interaction involving age group and collaborative condition was significant, $F(1, 90) = 9.68$, $p < .002$, partial $\eta^2 = .097$. Depicted in Figure 5, younger individuals (*M*=-5.81, SD=7.33) had a significantly better difference than did younger dyads (*M*-11.38, SD=5.94).this comparison indicates younger individuals reminisced relatively more items (when taking into account the number of their FI) than did younger dyads (a result replicating that of Andersson & Rönnberg, 1995). However, the opposite pattern was observed for older adults. Specifically, older individuals (*M*=10.21, SD=6.78) had a significantly worse RI-FI difference than did older dyads (*M*=-6.31, SD=7.89). As expected and shown in the figure, older dyads are benefiting in their collaborations when compared to older individuals, but younger dyads do not benefit from their collaborations when compared to younger individuals.

In sum, although the collaborative experience part of the expectation was not confirmed, the collaborative effect for older adults was dramatically different than that for younger adults.

DISCUSSION

Although research on collaborative cognition has a long history and benefits from an active past in aging (Baltes & Staudinger, 1996), few studies have examined a broad range of collaborative recall products. In this study, we identify a set of recall-related products, and sort them into positive and negative categories as a function of their theoretically identified contribution to successful everyday story re-telling. Our results contribute unique information about the characteristics of collaborative memory in older adults.

Baseline performance expectations

The purpose of testing five baseline conditions was to establish important sample characteristics, such that subsequent results of substantive hypotheses could be interpreted with more confidence. First, results supported the expectation that older individuals would recall less gist story information than younger individuals. This fact established that our individual participants (as well as the materials and procedures) were typical of those implemented in previous cognitive aging research. Second, as expected, at the individual level of analysis, the participants in the stranger and spouse conditions performed gist recall equivalently. Thus, observed differences at the dyadic level of performance are not qualified by systematic individual-level effects. Third, we wished to establish that individual-level immediate recall performance was not dramatically affected by its position at the beginning of the procedure (Order 1) or at the end (Order 2). Indeed, a null result was consistent with our expectation, thus providing more confidence in our later analyses that compared performances in these two cells of the design. Fourth, we confirmed, based on previous research, that actual dyads would recall more gist story information than individuals. This general result provided the foundation for the fine-grained analyses of collaborative effects on recall and related information. Fifth, across all conditions (including individual vs. collaborative recall) younger adults tended to remember more gist information than older adults. In sum, all baseline pre-conditions were established.

Collaborative story recall-related performance

The second hypothesis focused on age and collaborative experience effects on immediate recall performance. Our prediction for recall-related productions was that, in the context of both individual-level (first pre-condition) and dyad-level (current hypothesis) superiority by younger adults, older married spouses would make more positive and less negative recall-related products than older stranger dyads, and a similar amount as younger collaborating groups. Regarding gist recall, this effect has been inconsistently observed in the literature (Dixon & Gould, 1998), and did not reach significance in the present study. Informally, we note for future reference that the gist recall cell means are in the expected direction, with older spouses recalling more information than older strangers, but not as much as younger strangers and spouses. Given the generally good collaborative memory performance by older collaborators, their differentially good performance on other recall-related measures is notable. Both the elaboration (+) and metastatement (-) results more conclusively support the contention that collaboration with a familiar partner was beneficial to older adults. For instance, dyads produced more of the positive elaborative comments than individuals (see also Gould et al., 1991), and spouses produced more than stranger dyads. Future research should examine the potential mnemonic function of positive but ancillary elaborative statements. Conceivably, contextualizing the story with reasonable and interesting inferences could be based on common experience (Berg et al., 2007) and serve a motivational or strategic purpose during joint recall episodes (Gould et al., 1994).

Moreover, Figure 2 shows that older spouses, quite distinct from older strangers and other collaborative pairs, produced the best (near-zero) performance for the distracting and unproductive metastatements. It will be interesting to replicate and explore the processes accounting for the observation that older married spouses were apparently able to suppress or avoid distracting metastatements better than did individuals and stranger dyads. Theoretically, such off-target commentary may be detrimental to the recall process in two ways: it can (a) lead the collaborative discussion toward unproductive and stultifying complaints, and (b) inhibit the cognitive engagement and performance by both partners. As the content of such off-target comments is not story-related, it is unlikely that they could serve as cues for subsequent productive memory by other collaborators. Instead, both off-target and incorrect statements could lead to further unproductive contributions. This could occur either through reduced motivation to be productive or cascading errors of recall, both of which could have inhibiting effects on collaborative productivity (Weldon & Bellinger, 1997). Therefore the observed advantage for older spouses in apparent avoidance or suppression of metastatements could be viewed as enhancing the process of retelling, as well as the quality of the re-told story. Few (virtually none) off-target comments or complaints clutter the re-told stories of older married spouses, who may be investing their cognitive energies more productively (as in elaborations). Future research can explore whether collaborating older spouses are selectively or deliberately more focused on optimizing their productivity than on bemoaning each other's memory challenges or lapses. Being familiar and mutually productive, they could also be more apt to use commonly known concepts and terminology (Garrod & Pickering, 2004) and less apt to fill silences in recall tasks with distracting comments (Gould et al., 1994).

Decay with delay?

For our third hypothesis, we explored effects of age, collaborative experience and recall condition on recall-related performance across a 45-minute delay. One key issue pertained to the question of the `durability' of episodic memory over short delays. In particular, a novel aspect of our design allowed us to explore immediate and delayed recall as it varied by a selection of individual versus collaborative conditions. Relatively little is known about the effects of delay in a collaborative memory paradigm (Takahashi & Saito, 2004). This is the first effort to examine the phenomenon in aging and with experienced collaborators. Although our procedures were exploratory, we compared the two key `orders', namely (a) immediate-recall-by-individual linked to delayed-recall-by-corresponding-dyad, and (b) immediate-recall-by-dyad linked to delayed-recall-by-constituent-individuals.

Overall, our delay-related prediction regarding correct story recall was that there would be an overall loss of story information from the immediate to delayed recall condition, a pattern familiarly known as `decay with delay'. Although this typical pattern was shown with those participants who started the immediate recall condition as dyads and recalled in the delayed condition as individuals, the reverse was not true (see Figure 3). When participants recalled initially as individuals and then recalled in the delay condition as dyads, they actually recalled more information in delay (Takahashi & Saito, 2004). This pattern, observed for both the married spouse and stranger dyads, suggests both (a) that individual-level decay can be overcome in delay when working collaboratively and (b) that this occurs regardless of collaborative experience.

Regarding our other positive indicator of performance, Figure 4 displays the important three-way interaction for elaborations. As can be seen in the figure, dyads (and especially married spouses) differentially produced story-relevant inferences at delay. Notably, they also produced a substantial amount of recall (over 40% of the original propositions), so the supplemental information provided by elaborations was not necessarily at the cost of gist recall (see also Gould et al., 1991). Despite this set of positive characteristics of delayed story recall,

we observed that the positive recall-related energy from older spouses also came at an unexpected cost. Specifically, we found that older dyads (both spouses and strangers) made the most errors of commission, particularly during the delay recall condition. Moreover, dyads made more errors than did individuals. What is the extent and interpretation of this apparent disadvantage for older adults in working with a partner on memory problems? First, the extent is relatively small in that the mean errors produced in immediate recall (i.e. 1.98) is a value considerably less than the overall gist recall, not to mention the compensatory sum of the productive statements. Nevertheless, the pattern of the observed means is specifically counter to that predicted, and the reason may lie as much in a memory failure as in a monitoring failure, exacerbated by the context of productivity and distributed responsibility for error management. Perhaps dividing the cognitive work associated with remembering and elaborating narratives is accomplished without an attendant metacognitive task of monitoring the series of products for accuracy. In the context of rapid interactive and conversational productive recall, some lack of collaborative monitoring (e.g. Dixon et al., 1998;Hertzog & Hultsch, 2000) or collaborative disinhibition due to distraction (e.g. Connelly, Hasher, & Zacks, 1991;Hasher, Toney, Lustig, & Zacks, 2001) may occur in dyads such that suboptimal monitoring and correction emerges.

Reminiscence at delay—Our fourth hypothesis derives from a research tradition that has previously considered only performance by younger adults. Earlier researchers (Andersson & Rönnberg, 1995; Takahashi & Saito, 2004) compared the number of reminisced to FI in the delay condition. Our notable result was that older dyads were able to reminisce more items (than they forgot) than did older individuals—and this pattern of collaborative benefit is precisely the opposite of that observed for younger dyads and individuals in both our experiment and that of Andersson and Rönnberg. The earlier result led to the seemingly reasonable interpretation that there was a lack of durable productivity in collaborative memory, but this interpretation could now be usefully qualified. As is occasionally found in cognitive aging research, different patterns may be observed for younger and older adults and, in this case, these different patterns lead to dramatically different interpretations of the potential efficacy of memory collaboration.

Limitations—Despite the consistent and interpretable pattern of results, several limitations should be mentioned. First, as we mentioned above, our experiment was somewhat exploratory in that we did not use a full design in two respects. We had only long-term married older spouses and short-term married younger spouses. These two groups were selected because of the specific pertinence to the goals of the study and their frequency in typical marriages. Although it is evident that there are no long-term married younger adults (so a full 4-cell design is not possible), we do acknowledge the availability of, and suggest further research on, short-term married older adults (or other modalities through which older adults may be collaboratively experienced). In addition, as previously noted, we selected the two most pertinent orders for the analyses of the effects of a delay condition. Although other orders (e.g. dyad-to-dyad; individual-to-individual) are important, and should be explored further, we reasoned that beginning the study of collaborative delayed recall by examining the present two orders was justified.

Second, it is possible that recruiting half of our participants as spouses and the other half as individuals may have led to some unmeasured confound or bias in the collaborative experience groups. Other relationship-neutral recruitment techniques may be tried in future research. Third, as noted in the introduction, our experiment broadened the range of performance products, but it did not include a wide range of comparison groups. Future research may examine groups of different sizes and composition, as well as potential nominal groups. Fourth, although our statistical analyses were carefully selected, they were relatively low-powered and further comparisons would add to an already large number of analyses computed. Indeed, the theoretical interest in examining each of a broad range of performance indicators resulted in a

statistical plan that included multiple univariate analyses. However, acknowledging the statistical risks involved, we have been cautious about interpreting single effects, focusing more on the themes emerging from substantially clear patterns and following four explicit hypotheses.

Fifth, our story recall tasks may have underestimated the influence of collaborative experience in memory. Although sharing stories and news articles may be a common occurrence for collaborating adults, retelling a shared event or working together on everyday problems could be even more common (Berg et al., 2007) or practical in everyday life. Further research cataloging the various tasks and actual collaborative processes of everyday life is needed.

In sum, when evaluated across a broad range of cognitive products, some potential advantages for younger and older adults working in collaboration on retelling narratives can be inferred. These possible advantages may be greater if the collaborating dyads have experience working with their partners. Nevertheless, collaboration, in general, and collaborative experience, in particular, was not always markedly superior to individual performance, nor equally useful to younger and older adults. The present study has documented new tasks, measures and results, and pointed to some conditions that contribute to differential effectiveness across age and relationship status. Further research with a broader range of legitimate products, and especially process indicators, will help chart the thematically and clinically important conditions under which collaborative benefits can be maximized and losses can be minimized.

Acknowledgments

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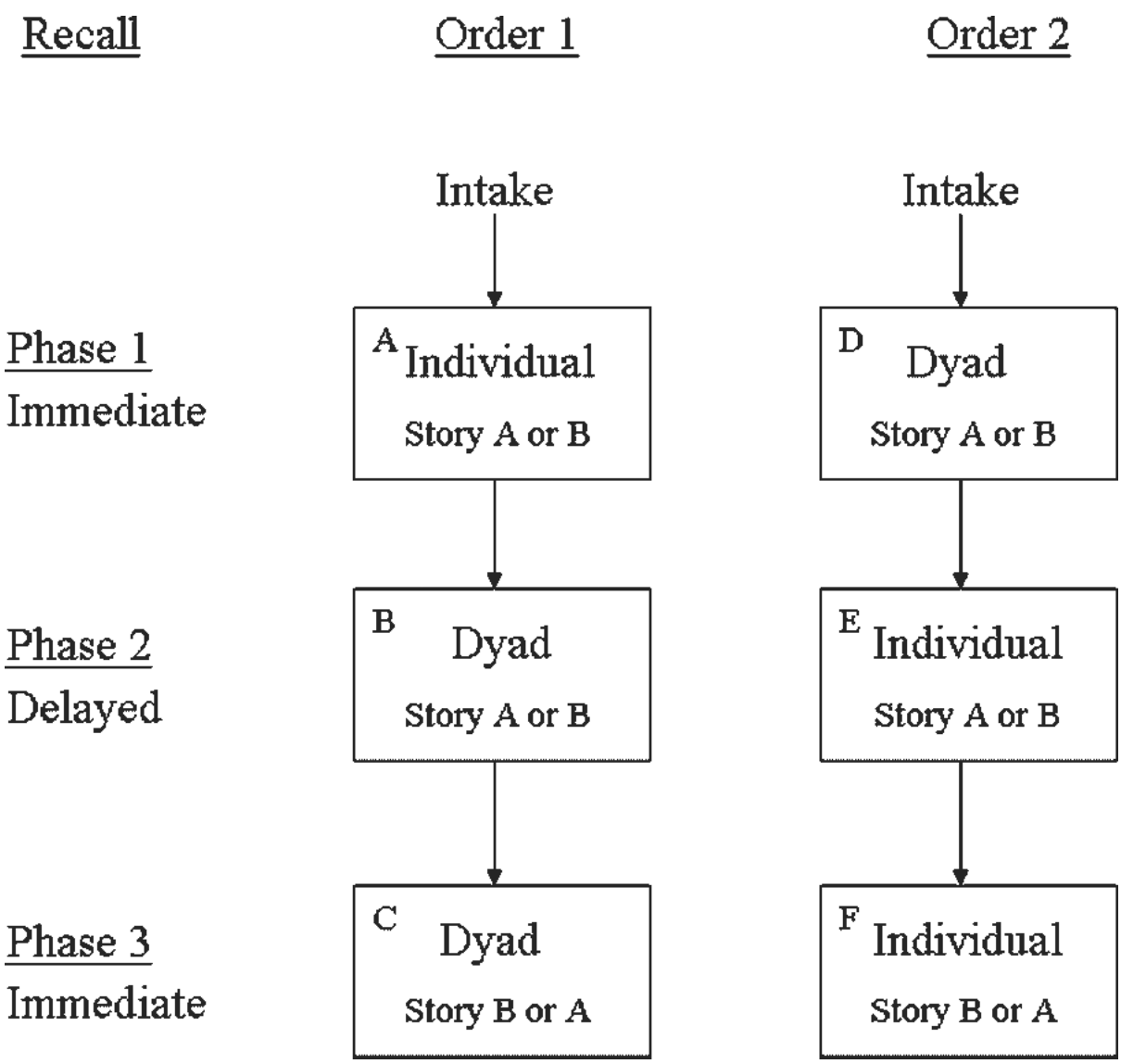

Figure 1.
A schematic of the phases of the experimental design

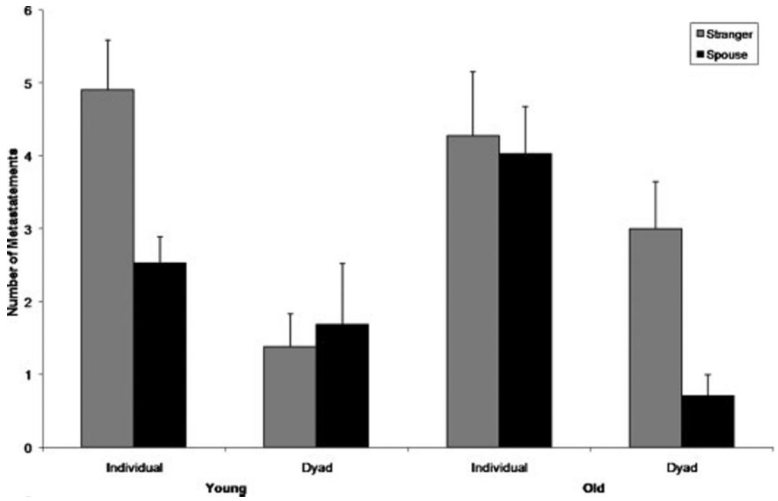

Figure 2.
The number of metastatements made in immediate story recall as a function of age group, collaborative condition and relationship status

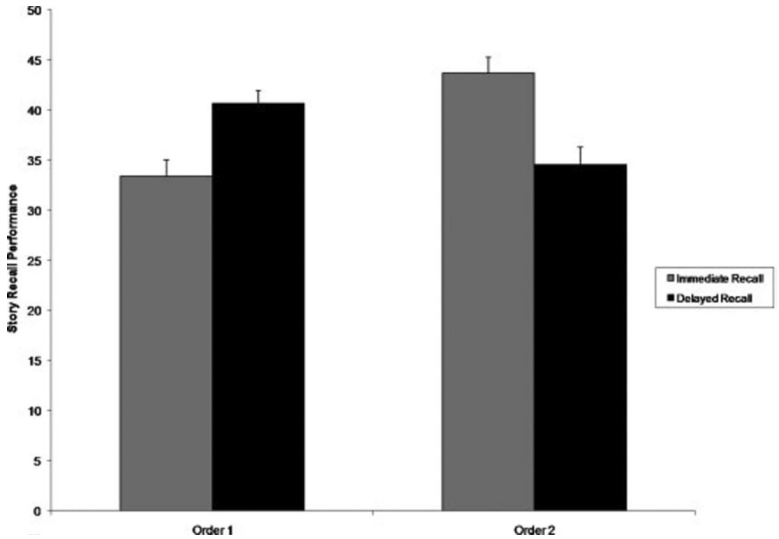

Figure 3.
Immediate to delayed story recall performance as a function of order

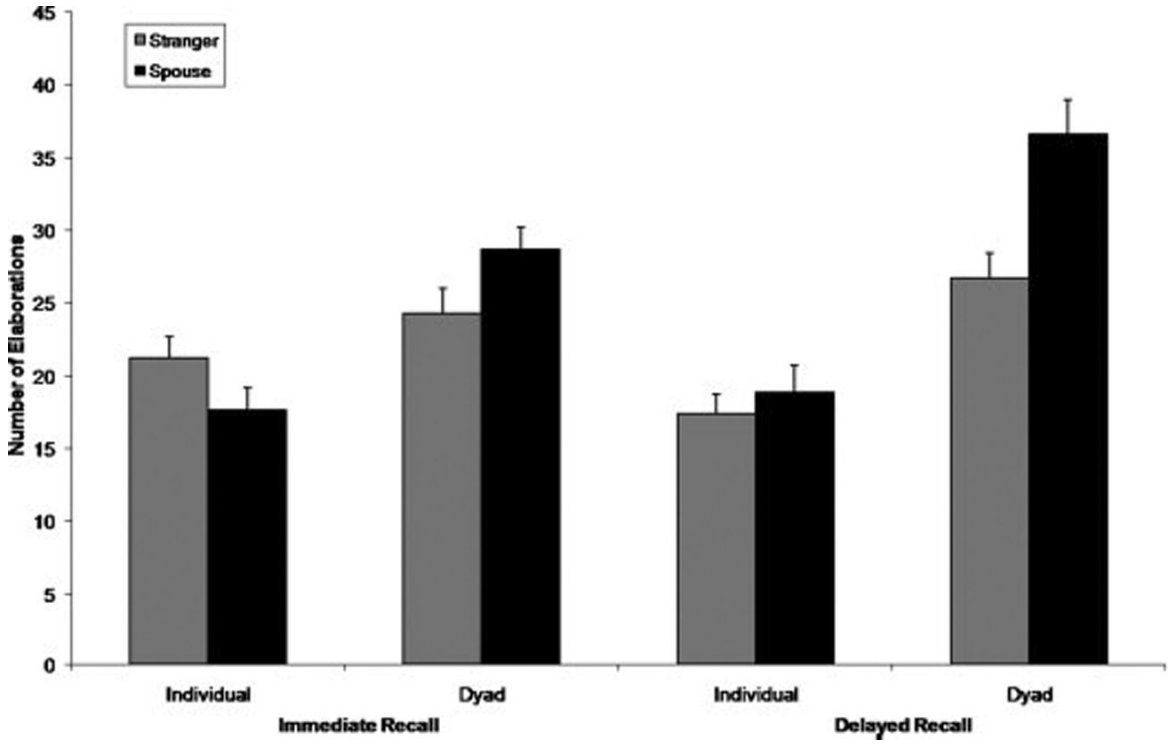

Figure 4.
The number of elaborations in immediate and delayed story recall as function of age group and collaborative condition

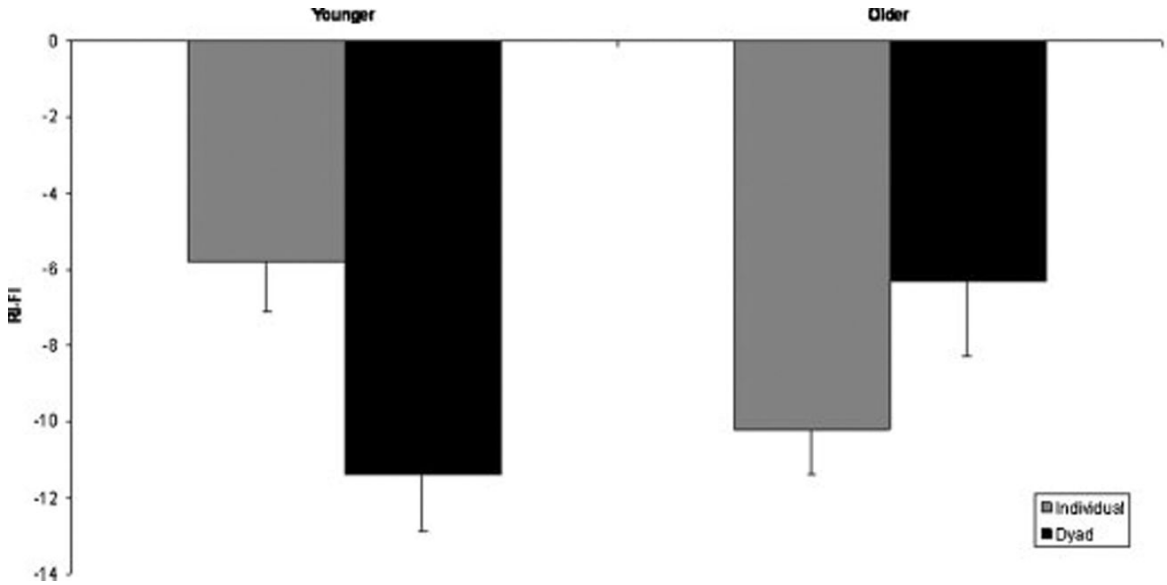

Figure 5.
The difference between reminisced and forgotten items as a function of age group and collaborative condition

Table 1

The means and standard deviations for immediate story recall products

	Spouses				Strangers			
	Younger		Older		Younger		Older	
	Individual	Dyad	Individual	Dyad	Individual	Dyad	Individual	Dyad
Percentage proposition	39.79 (11.75)	47.76 (12.78)	30.66 (10.41)	42.87 (12.96)	40.23 (13.71)	48.24 (11.38)	28.74 (11.87)	35.32 (11.25)
Elaboration	17.72 (10.33)	32.44 (11.92)	16.88 (7.94)	27.59 (9.89)	19.75 (10.22)	21.75 (9.51)	16.16 (7.46)	22.69 (7.52)
Meta-statement	2.53 (2.03)	1.69 (3.32)	4.03 (3.78)	0.71 (1.21)	4.91 (3.84)	1.38 (1.82)	4.28 (4.93)	3.00 (2.61)
Error	1.88 (1.58)	1.44 (1.21)	1.59 (1.69)	1.88 (1.69)	2.16 (2.27)	3.12 (2.33)	1.78 (1.41)	2.63 (1.75)

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Table 2

Significant effects of ANOVA testing performance in the immediate and delayed conditions

	Performance indicator			
Model	**Recall**	**Elaborations**	**Metastatements**	**Errors**
Immediate condition				
Age (2) × RS (2) × Order (2)	Age $F(1,57) = 8.77$ $p < .004$, $p\eta^2 = .133$	N/A	N/A	N/A
Age (2) × RS (2) × CC (2)	N/A	RS $F(1,187) = 6.35$ $p < .013$, $p\eta^2 = .O33$	RS $F(1,187) = 5.00$ $p < .027$, $p\eta^2 = .026$	RS $F(1,187) = 7.25$ $p < .008$, $p\eta^2 = .037$
	N/A	CC $F(1,187) = 35.91$ $p < .001$, $p\eta^2 = .161$	CC $F(1,187) = 18.97$ $p < .001$, $p\eta^2 = .092$	N/A
	N/A	RS × CC $F(1,187) = 8.89$ $p < .003$, $p\eta^2 = .045$	Age × RS × CC[a] $F(1,187) = 5.26$ $p < .023$, $p\eta^2 = .027$	N/A
Delay condition				
Age (2) × RS (2) × Order (2) × Time (2)	Age $F(1,121) = 22.43$ $p < .001$, $p\eta^2 = .156$	RS $F(1,122) = 5.37$ $p < .022$, $p\eta^2 = .042$	RS $F(1,122) = 12.98$ $p < .001$, $p\eta^2 = .096$	Age $F(1,122) = 4.20$ $p < .043$, $p\eta^2 = .033$
	Order × Time[b] $F(1, 121) = 88.07$ $p < .001$, $p\eta^2 = .421$	Time $F(1,122) = 12.65$ $p < .001$, $p\eta^2 = .094$	Order × Time $F(1,122) = 38.48$ $p < .001$, $p\eta^2 = .240$	RS × Order $F(1,122) = 4.10$ $p < .045$, $p\eta^2 = .032$
	N/A	Age × Time $F(1,122) = 7.67$ $p < .007$, $p\eta^2 = .059$	N/A	Order × Time $F(1, 122) = 5.06$ $p < .026$, $p\eta^2 = .040$
	N/A	Order × Time $F(1,122) = 89.91$ $p < .001$, $p\eta^2 = .424$	N/A	Age × Order × Time $F(1,122) = 8.65$ $p < .004$, $p\eta^2 = .066$
	N/A	RS × Order × Time[c] $F(1,122) = 14.04$ $p < .001$, $p\eta^2 = .103$	N/A	N/A

Note: Age = age group (young, old), CC = collaborative condition (individual, dyad), RS = relationship status (spouse, stranger), Order = experimental order (individual first, dyad first), Time = time of recall (immediate, delay).

$p\eta^2$ = partial η^2.

Immediate condition = second set of hypotheses; Delayed condition = third set of hypotheses.

[a] See Figure 2.

[b] See Figure 3.

[c] See Figure 4.