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Effects of collaboration on the qualities of autobiographical recall in strangers, friends, and siblings: both remembering partner and communication processes matter

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ABSTRACT

Recalling autobiographical memories with others can influence the quality of recall, but little is known about how features of the group influence memory outcomes. In two studies, we examined how the products and processes of autobiographical recall depend on individual vs. collaborative remembering and the relationship between group members. In both studies, dyads of strangers, friends, and siblings recalled autobiographical events individually (elicitation), then either collaboratively or individually (recall). Study 1 involved typing memory narratives; Study 2 involved recalling aloud. We examined shifts in vividness, emotionality, and pronoun use within memory narratives produced by different relationship types. In Study 2, we also coded collaborative dyads' "collaborative processes" or communication processes. In Study 1, all relationships showed decreased positive emotion and I-pronouns and increased negative emotion within collaboratively-produced memory narratives. In Study 2, all relationships showed increased vividness, reduced emotionality and positive and negative emotion, and increased I- and we-pronouns within collaboratively-produced memory narratives. However, strangers used collaborative processes differently from friends and siblings. Some collaborative processes were associated with memory qualities. Across studies, collaboration influenced memory quality more than did relationship type, but relationship type influenced dyads' recall dynamics. These findings indicate the complexity of social influences on memory.

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Autobiographical memories are often recalled in collaboration with others (Harris, Barnier, Sutton, & Keil, 2014). These conversations range from reminiscing about shared events with close others, to telling the people in our lives about events that we experienced but they did not, to getting to know new acquaintances by describing important events from our personal past (Alea & Bluck, 2007; Beike, Brandon, & Cole, 2016; Beike, Cole, & Merrick, 2017; Pasupathi & Rich, 2005). Each of these forms of conversational remembering varies in terms of the relationship and the degree of shared knowledge between conversational partners, and different conversations serve different social functions, including maintaining existing relationships, developing new relationships, making conversation, teaching or informing others, and empathising with others (Alea & Bluck, 2003; Harris, Rasmussen, & Berntsen, 2014; Webster, Bohlmeijer, & Westerhof, 2010). The people with whom we recall memories and our reasons for recalling memories with them may influence which memories or aspects of memories are recalled as well as how they are recalled. In this paper, we focus on autobiographical remembering in the context of fostering and maintaining close relationships, particularly for friends and siblings. In the current research, we compared joint autobiographical remembering among close groups to joint autobiographical remembering among unacquainted groups of strangers.

For close relationships, transactive memory theory (Wegner, 1987; Wegner, Erber, & Raymond, 1991; Wegner, Giuliano, & Hertel, 1985) predicts benefits of shared remembering: an overall increase in the amount of information recalled. According to this theory, intimate acquaintance can lead to the distribution of memory across two or more people, such that they share the encoding, storage, and retrieval of information (Wegner et al., 1985; Wegner et al., 1991; see also Barnier, Sutton, Harris, & Wilson, 2008; Hollingshead, 2001). A transactive memory system is argued to involve integrated knowledge that is known by all members of the system, differentiated knowledge that is known by only some members of the system, and higher-order knowledge about who knows what within the group (Wegner et al., 1985). Consistent

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with transactive memory theory, research suggests that intimate partners may be able to use this higher-order knowledge to cross-cue each other and access the differentiated knowledge that only their partner knows (Harris, Keil, Sutton, Barnier, & McIlwain, 2011; Sutton, Harris, Keil, & Barnier, 2010), even though strangers cannot (Meudell, Hitch, & Boyle, 1995).

Transactive memory has mostly been studied using simple stimuli or memory task (Hollingshead, 1998a, 1998b; Wegner et al., 1991), and most often in the context of work team performance (Argote & Ren, 2012; Barnier, Klein, & Harris, 2017). However, the autobiographical memory context – in which more remembering is not necessarily better – it is less clear what benefits we might expect from transactive memory systems. Theories of emergence suggest the amount of information recalled is not the way in which groups might benefit memory, but that memory qualities can be enhanced by social remembering, such that we might see richer remembering or new understandings emerging in conversations, rather than simply more information recalled (Barnier et al., 2017; Harris, Barnier, et al., 2014; Theiner, 2013).

The qualities of autobiographical memories can be shaped by conversations. Regardless of relationship or shared experience, narrators tell stories more vividly if their listener is attentive than if their listener is distracted (Pasupathi & Billitteri, 2015; Pasupathi & Rich, 2005; Pasupathi, Stallworth, & Murdoch, 1998). Moreover, each time a narrative is told, it is pitched to the listener/s, a practice known as audience tuning (Echterhoff, Higgins, & Groll, 2005). Certain aspects of an event may be silenced by a listener or self-censored by the narrator themselves. For instance, groups of three unacquainted university participants downplayed the emotional impact of a culturally significant event compared to when they recalled it alone (Harris, Barnier, Sutton, & Keil, 2010). This effect appeared to arise because groups' goals changed from remembering the event itself to minimising its significance in order to generate a shared understanding. Whether or not certain aspects of an event are emphasised or deemphasized depends on the conversational partners, group norms, and the particular goals of remembering in conversation. Therefore, emotional aspects of an event may be either emphasised or censored depending on the conversational partners' relationship, their conversational behaviour, their reasons for remembering, and the norms expressed within the group (Choi, Kensinger, & Rajaram, 2017; Harris et al., 2010; Maswood, Rasmussen, & Rajaram, 2019).

Transactive memory theory emphasises that it is specific communication behaviours that generate the benefits of remembering with intimate others (see also Harris et al., 2011, 2018). We can measure communication by looking at collaborative processes, which are communicative behaviours that help or hinder collaborative recall. Examples of collaborative processes found to benefit recall include elaborations, corrections, acknowledgments, and restatements (Harris et al., 2011; Meade, Nokes, & Morrow, 2009; Reese & Fivush, 1993; Vredeveldt, Hildebrandt, & van Koppen, 2016), but these processes have not been studied in the context of autobiographical memory. The use and impact of collaborative processes on group quality of recall may depend on factors such as expertise and relationship. For instance, expert pilots used different kinds of collaborative processes to novice pilots when collaboratively recalling flight narratives, and only experts benefited from collaboration (Meade et al., 2009). Married couples vary in their use of collaborative processes, and the pattern in which they use them can influence their collaborative performance (Harris et al., 2011).

The other critical aspect of transactive memory systems, in addition to communication processes, is the nature of the relationship itself: transactive memory systems develop over time in established and close relationships as people learn what each other know and coordinate their cognition. This "cognitive interdependence" links with research suggesting that people in close relationships can develop a shared identity, in which the boundaries between the self and other become blurred (Aron & Aron, 1996; Brewer, 2007). Because of autobiographical memory's close ties to identity (Conway, 2005), the presence of a shared identity between people remembering shared autobiographical memories is likely to have an impact on how those memories are recalled. Shared identity can be revealed in the use of personal pronouns, particularly first-person singular and plural pronouns ("I" and "we"). People who use we-pronouns over I-pronouns tend to identify with each other more and have stronger relationship ties than people who use I-pronouns over we-pronouns (Pennebaker, 2011). In the studies reported in this paper, we examined how recalling autobiographical events with another person shifted pronoun use, and whether this shift depended on the type of relationship they shared.

The relationships we focus on in this paper are non-romantic, namely friend and sibling relationships. Most research on collaborative remembering in acquainted adults has focused on romantic couples (Barnier et al., 2014; Gould, Kurzman, & Dixon, 1994; Gould, Osborn, Krein, & Mortenson, 2016; Harris et al., 2011; Harris, Barnier, et al., 2014), with fewer studies on friends (e.g. Andersson & Rönnberg, 1995; Harris, Barnier, & Sutton, 2013). Howerver, other kinds of relationships involve joint remembering, which may be similar and different from couples in interesting ways. Siblings have developed alongside each other in childhood and adolescence (Bank & Kahn, 1997; Cicirelli, 1995; Goetting, 1986). Growing up in the same family means their early experiences of recalling with others were with the same parents and with each other (Fivush, 2008). This shared developmental history may give them the ability to scaffold each other's recall of shared events in a way that young adult romantic couples may not yet possess (Barnier et al., 2014). Siblings may be less motivated to negotiate a consensus about their shared past than

people in other intimate relationships. Growing up, siblings learn to define themselves both in terms of how they are different from (differentiation), as well as how they are similar to (identification), their siblings (Whiteman, McHale, & Crouter, 2007; Wong, Branje, VanderValk, Hawk, & Meeus, 2010). Differentiation is particularly important for sibling relationships. Friends also share a non-romantic intimacy, but do not have the same lengthy shared experience or shared home life in childhood that siblings have. However, their relationship is voluntary, potentially motivating them to use recalling shared autobiographical memories to maintain their relationship (Ueno & Adams, 2006). These different kinds of relationships, with different histories and different goals, have the potential to impact collaborative recall of autobiographical memories in different ways.

Study 1

In this study, we examined the effects of collaboration on the quality (vividness, emotionality, pronoun use, and emotional valence) of autobiographical memories recalled by strangers, friends, and siblings, using a procedure in which they typed their memory narratives into a computer. We predicted that collaboration would influence the vividness, emotionality, and emotional valence of friends' and siblings' memories of shared events they had experienced together, but less so for strangers' memories of unshared events. We also predicted that collaboration would increase the use of first-person plural pronouns (we-pronouns) and decrease the use of first-person singular pronouns (I-pronouns) in friends and siblings recalling shared events, but not in strangers recalling unshared events, providing evidence that collaborative remembering involved joint identity.

Materials and methods

Participants

We recruited 156 participants (128 females) from Macquarie University. They made up 39 dyads and 78 individuals.

Strangers. We recruited 52 stranger participants (43 female). Half completed the study as dyads (26 participants comprising 13 dyads: 8 female-female, 4 male-female, 1 male-male) and the other half completed the study as individuals (26 participants). Stranger participants ranged in age from 17 to 42 years ($M = 22.26$, $SD = 7.44$). Strangers were all first-year Psychology students at Macquarie University participating for course credit.

Friends. We recruited 52 friend participants (43 female), who always attended as a friend-pair. Half completed the study as dyads (26 participants comprising 13 dyads: 7 female-female, 5 male-female, 1 male-male) and the other half completed the study as individuals (26 participants). Friends ranged in age from 18 to 32 years ($M = 21.60$, $SD = 3.55$). Only friends who had been close for at least one year were eligible to participate. Their friendship length ranged from 1 year 0 months to 19 years 10 months ($M = 4.54$, $SD = 4.20$). We recruited friends using posters around the university campus and via the Psychology student participant pool. They received $15 each per hour or course credit for participation.

Siblings. We recruited 52 sibling participants (42 female), who always attended as a sibling-pair. Half completed the study as dyads (26 participants comprising 13 dyads: 9 female-female, 3 male-female, 1 male-male), and the other half completed the study as individuals (26 participants). Siblings ranged in age from 17 to 31 years ($M = 21.43$, $SD = 3.11$). The age gap between siblings ranged from 0 years 0 months (i.e. twins) to 5 years 10 months ($M = 2.31$, $SD = 1.80$). We recruited siblings using posters around the university campus and via the Psychology student participant pool. They received $15 each per hour or course credit for participation.

Research design

Figure 1 shows the research design. All participants typed their memory narratives individually in an initial "elicitation" phase, and we used this initial recall as a baseline for comparison. In the subsequent "recall" phase, half of the participants typed narratives of the same memories collaboratively and half typed them individually again. The selection of events to be recalled in each phase depended on the relationship between participants, since strangers by definition did not have shared events (see Figure 1). For strangers, those in the individual condition simply typed their recall of the same two separate events in both phases, resulting in 4 events recalled across the two participants. Those in the collaborative condition also typed their recall of two events each at elicitation (i.e. 4 events), and then collaborated to recall one event from each individual (i.e. 2 events). For both friends and siblings, pairs nominated two shared events at the beginning of the study. Those in the individual condition typed their recall of these same two shared events individually in both phases. Those in the collaborative condition separately typed their recall of the same two shared events in elicitation, and then typed their recall of these same two events jointly in collaborative recall. Therefore, for each relationship type, the study was $3 \times 2 \times 2$ mixed design, with relationship (strangers versus friends versus siblings) and condition (individual versus collaborative) as between-subjects' independent variables and recall phase (elicitation versus recall) as a within-subjects' independent variable. All analyses were conducted at the dyad level.

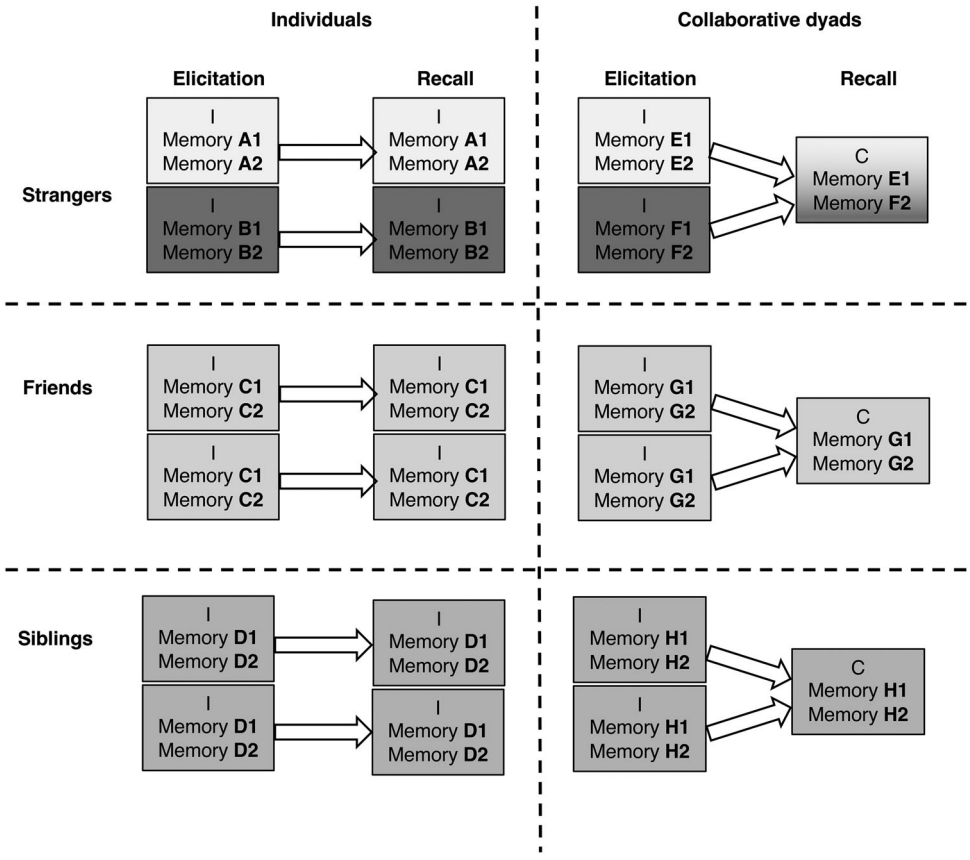

Figure 1. Study 1 research design. I = individual recall, C = collaborative recall.

Materials

We used Superlab software to record participants' typed event narratives of the events across both the elicitation and recall phases.

Questionnaires. All participants completed demographic questionnaires regarding their age, gender, country of birth, and languages spoken at home. Questionnaires for friends and siblings included additional items assessing relationship length and living arrangements. Friends and siblings also completed a modified form of the Personal Assessment of Intimacy in Relationships questionnaire (PAIR Inventory; Schaefer & Olson, 1981) that we adapted for each relationship by removing the sexual intimacy subscale and replacing "partner" with "friend" or "sibling". These changes left a 30-item questionnaire with four intimacy subscales (emotional, social, intellectual, and recreational) and a conventionality subscale.

Procedure

Participants completed the tasks described below as part of a 90-minute session. The session involved two phases, elicitation and recall, separated by an eight-minute distraction. In each phase, dyads completed additional memory tasks, but only the results of the autobiographical memory task are reported here (Selwood, 2015). Participants completed all tasks by typing their responses into the computer. Following the memory elicitation and recall, participants completed the pen-and-paper questionnaires individually.

Elicitation. During elicitation, all participants recalled autobiographical memories individually, typing their responses onto separate computers at either side of a partition. They typed detailed descriptions of two autobiographical memories: a recent birthday celebration and a significant event of their own choice. Friends and siblings elicited shared events: they had 1 min to discuss and agree upon event selection immediately before moving to their separate computers. Strangers always elicited unshared events. First, all participants were given 10 min to type their "birthday" memory. All participants rated the clarity, valence, and importance of their memory, and dated the event. Then, strangers in the collaborative condition had 2 min to read each other's typed event descriptions, to give them some basis for later collaboration. The other participants did not do this. All participants then repeated this elicitation procedure for their memory of a "significant" event, first spending 10 min describing the event in detail and then rating its qualities. Finally, in this session, participants completed a number of other memory tasks not reported here and finished the first phase of the experiment with an eight-minute distractor task (Sudoku).

Recall. For the recall session, participants in the collaborative condition moved to sit together at one computer, and the two participants recalled together. For strangers in the collaborative condition, we told them to recall the "significant event" elicited earlier by the participant sitting on the left and the "birthday" event elicited earlier by the participant sitting on the right. The strangers in the collaborative condition completed other joint tasks not reported in this paper prior to collaborative autobiographical recall. We told all other participants to collaborate to recall the two events that they had elicited in the first phase. Participants in the collaborative condition were instructed to work together as much as possible to recall the events, and to recall them in as much detail as possible. Participants in the individual condition remained at their individual computer and were instructed to recall alone the two events that they had elicited earlier in as much detail as possible. We gave all participants in both conditions 10 min to type their joint narratives of each event, and they rated each event for its qualities after the 10 min had elapsed. After recall was complete (including additional memory tasks not reported here), participants completed the questionnaires and were debriefed.

Coding and scoring

Vividness and emotionality. We coded all individual and collaborative memory narratives for vividness and emotionality. The coding system was based on that developed by Habermas and colleagues (Habermas & Diel, 2013; Habermas, Diel, Mahmoudi, & Streck, 2009), which we translated from German to English. These independently-rated scales allowed us to index the vividness and emotionality of the memory narratives, in addition to using participants' self-reports of memory phenomenology, which may vary between two members of a collaborative dyad. As per the coding system, each memory narrative received scores for vividness and emotionality that ranged from 0 to 3 (see Appendix 1 for examples of typed event descriptions with vividness and emotionality scores). Two independent coders scored 25% of the individual and collaborative event descriptions. Cohen's Kappa was 0.79 for emotionality and 0.74 for vividness. One coder scored the remaining event descriptions.

Positive and negative emotion. We used LIWC2015 software (Pennebaker, Booth, Boyd, & Francis, 2015) to measure the use of positive emotion words and negative emotion words in the typed event descriptions. Positive emotion words included "love", "nice", and "sweet", and negative emotion words included "hurt", "ugly", and "nasty" (Tausczik & Pennebaker, 2010).

Pronoun use. We used LIWC2015 software (Pennebaker et al., 2015) to measure the presence of first-person single and plural pronoun in the typed event descriptions. First-person singular pronouns included "I", "me", and "mine". First-person plural pronouns included "we", "us", and "our". In the analysis, we refer to the two categories of pronouns as I-pronouns and we-pronouns.

Intimacy. Friends' and siblings' PAIR subscale scores (emotional, social, intellectual, and recreational) correlated significantly with their partner's, $r = .692$, $p < .001$; $r = .705$, $p < .001$; $r = .627$, $p < .001$; and $r = .316$, $p = .023$, respectively, showing agreement within dyads. Therefore, for all friends and siblings, we created dyad-level scores for overall PAIR scores by averaging the two partners' scores (Table 1).

Results

We averaged scores on all dependent variables across the two event types of "recent birthday" and "recent significant event". We gave each individual or dyad memory quality scores at initial baseline elicitation and at recall. Thus we performed separate 2 (condition: collaborative vs. individual) × 3 (relationship: strangers vs. friends vs. siblings) × (2) (phase: elicitation vs. recall) mixed ANOVAs for: (1) coded vividness; (2) coded emotionality; (3) positive emotion words on the LIWC; (4) negative emotion words on the LIWC; (5) I-pronouns on the LIWC; (6) we-pronouns on the LIWC (see Figure 2). Where there was a significant main effect of relationship, to test for differences between strangers, friends and siblings, we performed planned orthogonal contrasts comparing (1) strangers with friends and siblings, and (2) friends with siblings. We also performed follow-up t-tests for significant interactions (with α adjusted for Bonferroni correction of multiple comparisons).

Table 1. Friends' and Siblings' mean intimacy scores in each experiment.

Pair Inventory score	Friends	Siblings	Total	F	η_p^2
Study 1					
Emotional	4.26 (0.44)	3.71 (0.76)	3.99 (0.67)	14.93**	.16
Social	3.77 (0.52)	3.29 (0.72)	3.53 (0.66)	11.51*	.13
Intellectual	4.13 (0.46)	3.64 (0.69)	3.89 (0.63)	14.08**	.16
Recreational	3.88 (0.43)	3.54 (0.69)	3.71 (0.60)	6.82*	.08
Study 2					
Emotional	4.18 (0.62)	3.68 (0.73)	3.92 (0.72)	8.17*	.11
Social	3.82 (0.53)	3.40 (0.77)	3.60 (0.70)	7.16*	.10
Intellectual	4.13 (0.51)	3.64 (0.76)	3.88 (0.69)	9.02*	.12
Recreational	3.89 (0.44)	3.72 (0.48)	3.80 (0.46)	2.82	.04

Note: Standard deviations appear in parentheses. *$p < .05$, **$p < .001$.

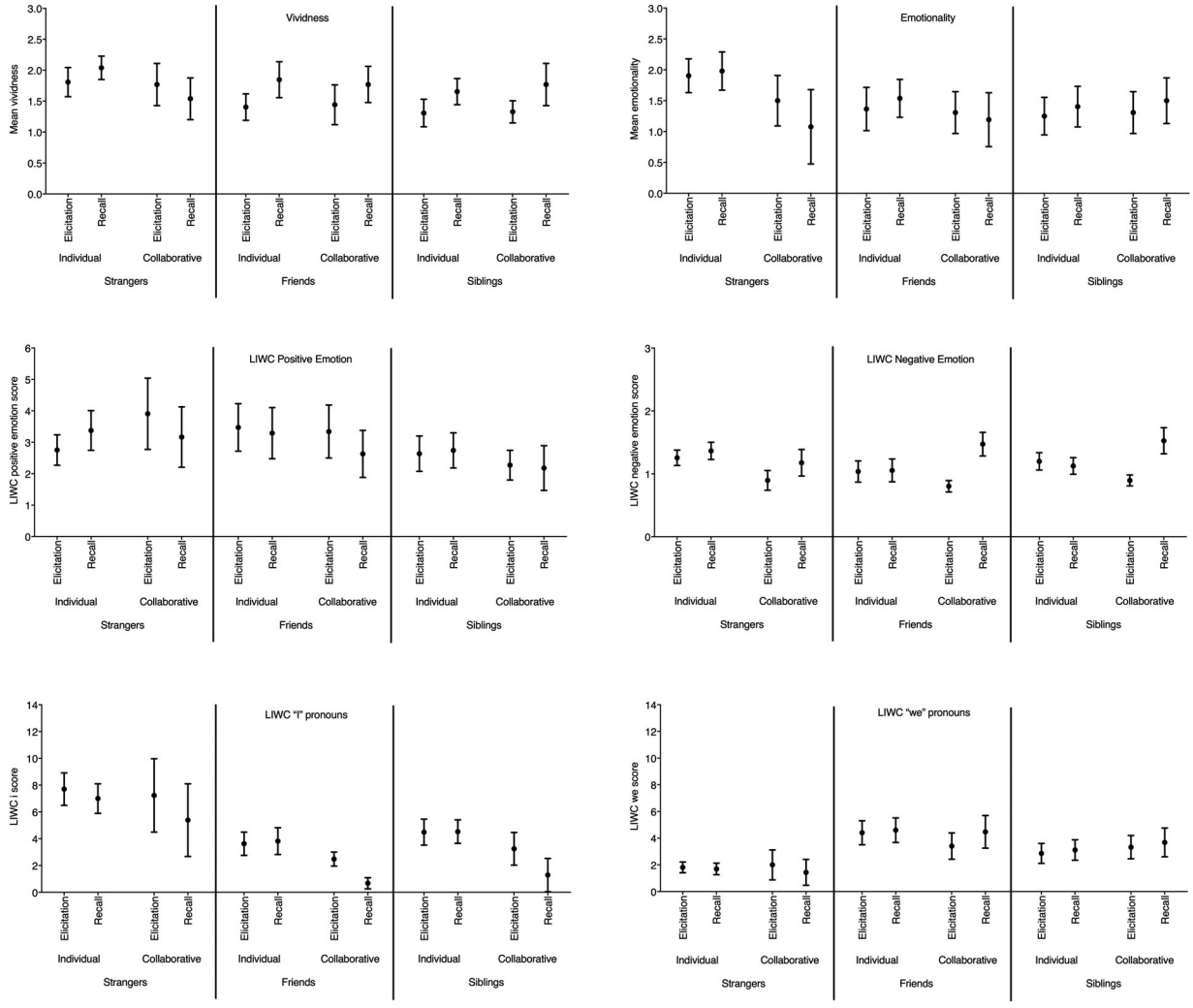

Figure 2. Mean scores for vividness (top left), emotionality (top right), positive emotion (middle left), negative emotion (middle right), I-pronouns (bottom left), and we-pronouns (bottom right) in Study 1 at elicitation and recall by relationship and collaborative condition. Error bars represent 95% confidence intervals. For vividness and emotionality, possible scores ranged from 0 to 3.

First we analysed the coded qualities of the narratives. For coded vividness, there was a significant main effect of phase, $F(1,111) = 25.22$, $p < .001$, $\eta p^2 = .19$, such that event descriptions increased in vividness across recall occasions. This was qualified by a significant interaction between phase and relationship type, $F(2,111) = 5.86$, $p = .004$, $\eta p^2 = .10$. Follow-up t-tests indicated that event descriptions increased in vividness from elicitation to recall for friends and siblings, $t(38) = -4.35$, $p < .001$ and $t(38) = -4.58$, $p < .001$, respectively, but not strangers, $t(38) = -1.05$, $p = .303$. The remaining main effects and interactions were not significant, all Fs < 2.70, all ps > .071. Regardless of whether participants collaborated or not, vividness increased on the second recall occasion for friends and siblings, but not for strangers (see Figure 2).

For coded emotionality, there were no significant main effects or interactions for any variables, all Fs < 3.75, all ps > .055.

Next we turn to the LIWC categories. For positive emotion words, there was a significant main effect of relationship, $F(2,111) = 3.78$, $p = .026$, $\eta p^2 = .06$, but the main effects of phase and collaboration were not significant, $F(1,111) = 2.77$, $p = .099$ and $F(1,111) = 0.45$, $p = .503$, respectively. Follow-up contrasts showed that friends' event descriptions ($M = 3.35$) had more positive emotion words than siblings' ($M = 2.46$), $p = 0.026$, but the number of positive emotion words in strangers' event descriptions ($M = 3.32$) were not significantly different from friends' and siblings' ($M = 2.85$), contrast estimate = 0.48, $p = 0.121$. There was a significant interaction between phase and collaboration, $F(1,111) = 12.32$, $p = .001$, $\eta p^2 = .10$. Follow up t-tests indicated that event descriptions decreased in positive emotion words in recall when they were recalled collaboratively, $t(38) = 2.75$, $p = .009$, but not individually, $t(77) = -1.65$, $p = .103$. The remaining interactions were not significant, all Fs < 3.01, all ps > .052. Overall, collaboration decreased positive emotion words across relationship types, and friends and strangers used more positive emotion words than siblings.

For negative emotion words, there was a significant main effect of phase, such that event descriptions

increased in negative emotion words across recall occasions, $F(1,111) = 28.80$, $p < .001$, $\eta p^2 = .21$, but the main effects of relationship and collaboration were not significant, $F(2,111) = 0.01$, $p = .987$, and $F(1,111) = 0.36$, $p = .548$, respectively. Event descriptions increased in negative emotion words across recall occasions. However, this was moderated by a significant interaction between phase and condition, $F(1,111) = 24.01$, $p < .001$, $\eta p^2 = .18$. Follow up t-tests ($\alpha = .025$ for Bonferroni correction of multiple comparisons) indicated that event descriptions increased in negative emotion words across recall occasions when they were recalled collaboratively, $t(38) = -5.61$, $p < .001$, but not when they were recalled individually, $t(77) = -0.43$, $p = .672$. No other interactions were significant, all Fs < 2.74, all ps > .069. Overall, collaboration increased the presence of negative emotion words across relationship types.

For I-pronouns, there was a significant main effect of phase, $F(1,111) = 63.68$, $p < .001$, $\eta p^2 = .37$, such that event descriptions decreased in I-pronouns across recall occasions. There was a significant main effect of collaboration, $F(1,111) = 6.97$, $p = .010$, $\eta p^2 = .06$, such that those in the collaborative condition used fewer I-pronouns than those in the individual condition. There was a significant main effect of relationship, $F(2,111) = 28.41$, $p < .001$, $\eta p^2 = .34$. Follow-up contrasts showed that strangers ($M = 6.81$) used more I-pronouns in their event descriptions than friends and siblings ($M = 3.30$), $p < .001$, but the number of I-pronouns in friends' ($M = 2.90$) and siblings' ($M = 3.69$) event descriptions were not significantly different, $p = .151$. Phase and collaboration interacted significantly, $F(1,111) = 61.77$, $p < .001$, $\eta p^2 = .36$. Follow up t-tests indicated that event descriptions decreased in I-pronouns in recall when they were recalled collaboratively, $t(38) = 7.26$, $p < .001$, but not individually, $t(77) = -0.14$, $p = .862$. No other interactions were significant, all Fs < 0.86, all ps > .431. Overall, although strangers used the most I-pronouns of the relationship types, collaboration decreased the use of I-pronouns across the board.

For we-pronouns, there was a significant main effect of relationship, $F(2,111) = 22.66$, $p < .001$, $\eta p^2 = .29$. Follow-up contrasts showed that strangers ($M = 1.80$) used fewer we-pronouns in their event descriptions than friends and siblings ($M = 3.93$), $p < .001$, and friends ($M = 4.43$) used more we-pronouns than siblings ($M = 3.44$), $p = .014$. No other main effects or interactions were significant, all Fs < 2.84, all ps > .062. Overall, friends used the most we-pronouns, and strangers used the least.

Therefore, vividness increased across recall occasions for friends and siblings recalling shared events, but not for strangers recalling unshared events, regardless of whether they collaborated or not. Memory narratives contained less positive emotion and I-pronouns and more negative emotion in recall when they were collaboratively recalled. Strangers used more I-pronouns, and fewer we-pronouns than friends and siblings. Friends used more positive emotion words and we-pronouns than siblings.

Discussion

Despite some differences in the qualities of memory narratives across strangers, friends, and siblings, collaboration had broadly similar effects on memory qualities across relationships. Recalling autobiographical memories collaboratively shifted the emotional content of event descriptions to be less positive and more negative, regardless of whether collaborative recall was in a group of strangers who had not shared the event or a group of friends or siblings who had shared the event. This unexpected result is consistent with those of Choi et al. (2017), who found that collaboration increased memory for shared negative emotion content using pictorial laboratory stimuli. However, for autobiographical memories, our results showed an increase in unshared negative emotion content as well, given that emotional content shifted in a similar way for strangers as well as friends and siblings.

Overall, collaboration appeared to have a lesser impact on autobiographical memory narratives than expected. Apart from the shift in emotional content described above, the only memory quality that was influenced by collaboration was I-pronouns. Collaborative dyads' lower use of I-pronouns compared to individuals may have been due to the fact that the event descriptions were typed rather than reflecting shifts in identity. Typing meant the event descriptions were co-authored, and so participants were likely aware that it would be unclear whom "I" referred to in the event descriptions.

Differences between relationships were apparent over and above the impact of collaboration. Strangers' memory narratives did not increase in vividness across recall occasions in the same way as friends' and siblings' did. Strangers had fewer constraints than friends and siblings on the types of events they could elicit. Unlike friends and siblings, strangers' events did not necessarily have to be shared with anyone in particular, meaning that some birthday memories were about their own uncelebrated birthday and some significant event memories were of individually experienced events that may not have been as compelling as friends' and siblings' shared birthdays and significant events.

Strangers also used pronouns differently to friends and siblings, using more I- and fewer we-pronouns than did friends and siblings across the board. Due to the differences in the tasks that strangers performed compared to friends and siblings, these changes may have reflected aspects of the task rather than a reduced tendency to engage in joint identity during collaboration. Instead, strangers tended to recall more self-focused events than friends and siblings, who were asked to elicit events they had experienced together.

During the experiment, it appeared typing on a shared computer was not conducive to rich and interactive collaborative remembering. The experimenter noted that most collaborative dyads appeared to discuss the event, then stop discussing it to type or summarise what they had said. In

other words, memory narratives were jointly and interactively recalled, but typing the narratives disrupted collaboration, and the typed event descriptions, used for analysis, did not completely capture their richer memory narratives produced verbally. Therefore, in Study 2, we focused on verbal recall.

Study 2

In Study 2 we aimed to replicate the findings from Study 1, using transcripts of verbally-recalled autobiographical memory narratives rather participants' typed event descriptions. We also aimed to extend these findings by examining how particular communication processes were used by different kinds of dyads and how this influenced the outcomes of collaborative recall. We used the same memory quality variables as in Study 1. Along with method of capturing memory narratives, we changed the procedure. Participants elicited and recalled six events instead of two. Instead of eliciting and then recalling the same event twice in the one session, we asked participants to elicit memories in one session and recall them in a second session one week later. We also asked strangers to recall memories shared with a particular friend or sibling they nominated at the start of session 1. These changes gave us more control over the kinds of memories participants recalled, ensuring the memories were as similar as possible across the three relationship types.

In this study, we focused on dyads' collaborative processes and their impact on memory quality shifts during collaborative recall. Collaborative processes can be associated with relationship and the knowledge shared by collaborative partners in different ways. We chose to analyse collaborative dyads' cuing, mirrored repetitions, co-constructed sentences, and corrections and disagreements, based on prior research (Harris et al., 2011; Harris, Barnier, Sutton, & Savage, 2018; Meade et al., 2009). Successful and unsuccessful cuing can reveal collaborative partner's attempts to aid each other's recall such as in transactive memory (Harris et al., 2013; Meudell et al., 1995). Thus, the use and impact of each of the collaborative processes on the memory quality of stranger's, friends', and siblings' collaborative recall may reflect the nature of their relationships.

Materials and methods

Participants

We recruited 140 new participants from Macquarie University. These participants made up 35 dyads and 70 individuals.

Strangers. We recruited 46 stranger participants (42 female). Half completed the study as dyads (22 participants comprising 11 dyads: 9 female-female, 2 male-female) and the other half completed the study as individuals (24 participants). Strangers ranged in age from 18 to 50 years ($M = 22.42$, $SD = 6.90$). Strangers were all first-year Psychology students at Macquarie University participating for course credit.

Friends. We recruited 48 friend participants (34 female), who attended in friend-pairs. Half completed the study as dyads (24 participants comprising 12 dyads: 7 female-female, 3 male-female, 2 male-male) and the other half completed the study as individuals (24 participants). Friends ranged in age from 18 to 32 years ($M = 19.30$, $SD = 2.25$). Only friends who had been close for at least one year were invited to participate in this study. Their friendship length ranged from 2 years 5 months to 18 years 0 months ($M = 7.47$, $SD = 3.57$). We recruited friends using posters around the university and via the first year Psychology participant pool. They received course credit or $15 per hour payment for participation.

Siblings. We recruited 48 sibling participants (32 female), who always attended in sibling-pairs. Half completed the study as dyads (24 participants comprising 12 dyads: 6 female-female, 4 male-female, 3 male-male) and the other half completed the study as individuals (24 participants). Siblings ranged in age from 18 to 45 years ($M = 21.68$, $SD = 6.27$). The age gap between siblings ranged from 0 years 0 months (i.e. twins) to 10 years 7 months ($M = 2.55$, $SD = 2.67$). We recruited siblings using posters around the university and via the first year Psychology participant pool. They received course credit or $15 per hour payment for participation.

Research design

Figure 3 shows the research design. All participants elicited eight events individually in Session 1, providing only a brief description. One week later, in Session 2, participants provided as many details as they could recall about each event. Half of the participants described six of the events collaboratively and half described them individually. The selection of events to be recalled in Session 2 depended on the relationship between participants, since strangers by definition do not have shared events (see Figure 3). For strangers, those in the individual condition recalled six of the events they had previously elicited in Session 1. In the collaborative condition, each member of the dyad took turns to describe three of the events they had previously elicited in Session 1, resulting in six events being described per dyad in total. For friends and siblings in both the collaborative and individual conditions, the two members of the dyad recalled the same six events, three events that each participant had previously elicited in Session 1. As in Study 1, we analysed groups separately depending in their relationship, since events were unshared for strangers and shared for friends and siblings. Therefore, for each relationship type, the study was a between-subjects design with condition (individual and collaborative) as the independent variable. For memory qualities, we only analysed the detailed event descriptions provided in Session 2.

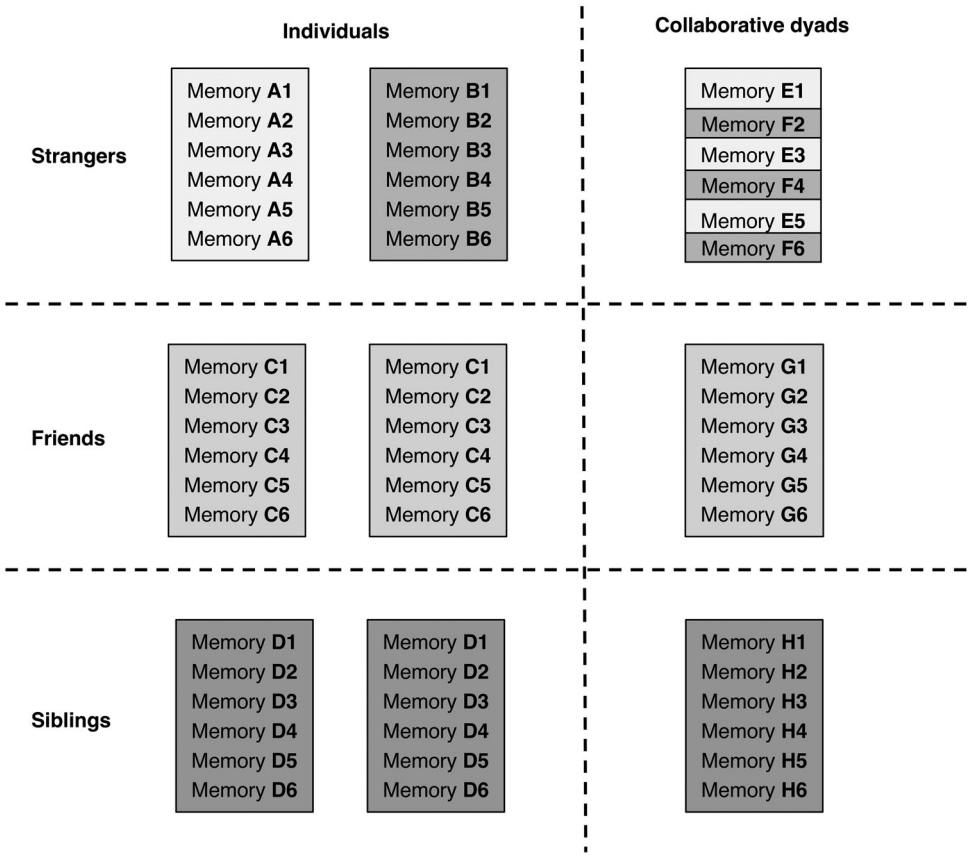

Figure 3. Study 2 research design.

Materials

Audio recording. We audio recorded the experiment using MacBook Pro internal microphones and Audacity software.

Questionnaires. As in Study 1, all participants completed demographic questionnaires regarding their age, gender, country of birth, and languages spoken at home. Questionnaires for friends and siblings included additional items assessing relationship length and living arrangements. Friends and siblings also completed the PAIR Inventory (Schaefer & Olson, 1981) to measure relationship intimacy. Scoring was the same as in Study 1.

Procedure

We ran the study in two sessions, approximately one week apart (plus or minus one day).

Session 1. In Session 1, participants were interviewed individually. During the interview, all participants completed the demographic questionnaire and friends and siblings completed the modified PAIR Inventory as in Study 1. All participants elicited eight specific events they had shared with one friend or sibling, providing a brief description only for each one. Strangers nominated a friend or sibling at the beginning of the session, and friends and siblings elicited events shared with the friend or sibling with whom they were participating. We adapted the event elicitation procedure used by Addis, Pan, Vu, Laiser, and Schacter (2009) and Barnier et al. (2014). In Session 1, in addition to event descriptions, we asked participants to provide five details for each event: (1) the year, (2) another person involved (other than their friend or sibling), (3) the location, (4) a physical object, and (5) a brief descriptive title. These five details were used as memory cues in Session 2. Participants rated each event using three five-point Likert scales rating the degree of detail or vividness, emotion and personal significance of the event. If participants had difficulty generating events, they could view a cue list of approximately 70 generic events to help remind them (e.g. "a memorable birthday", "doing a fun run", "a special moment from a holiday").

Session 2. One week after Session 1, participants first completed some list based recall tasks not reported here (for details of list recall tasks, see Selwood, 2015). This meant that the strangers in the collaborative condition had met each other and completed some joint tasks prior to collaborative autobiographical recall. For all participants in the individual condition, only one experimenter was present. For all participants tested as dyads in the collaborative condition, two experimenters were present.

The autobiographical memory recall procedure was adapted from Addis et al. (2009). We asked participants

to recall six of the events they had elicited in Session 1. The procedure depended on the relationship and condition. Strangers in the individual condition recalled six of their own events. They viewed a PowerPoint slide for each event with the five details they had provided in Session 1 (year, person involved, location, object, and title) as memory cues. For each event, they had 3 min to verbally describe the event in detail. After the three minutes, participants rated their memory for the event using the same scales as in Session 1. Strangers in the collaborative condition sat together and viewed a PowerPoint slide for each event with the details they had provided in Session 1 (title, person involved, location, and object) as memory cues; three events from each partner in an alternating fashion. At the top of the slide, the names of the "memory owner" and the friend or sibling they had nominated appeared. We asked collaborating strangers to work together to recall each event, even though only one of them had experienced it. For each event, dyads had 3 min to recall each event in detail, and the memory owner rated each event on the same scales as in Session 1.

For friends and siblings, both participants were given the same events to recall as their friend or sibling in both conditions, even if they were participating as individuals: three events from each partner in an alternating fashion. Participants viewed a PowerPoint slide for each event with the details they had provided in Session 1 (title, person involved, location, and object) as memory cues, either individually or jointly depending on condition. Both individuals and collaborative dyads had 3 min to recall each event in detail, before rating their memory for the event using the same scales as in Session 1.

Coding and scoring

We coded two aspects of recall: (1) autobiographical memory qualities as in Study 1; and (2) collaborative communication processes (collaborative dyads only).

Vividness and emotionality. We coded all events for vividness and emotionality using the same coding scheme as in Study 1 (Habermas & Diel, 2013). Two independent coders scored 25% of the transcripts. Cohen's Kappa was 0.86 for emotionality and 0.94 for vividness. One coder scored the remaining events.

Positive and negative emotion words. As in Study 1, we used LIWC2015 software (Pennebaker et al., 2015) to calculate participants' use of positive emotion words and negative emotion words in each event.

Pronoun use. As in Study 1, we used LIWC2015 software (Pennebaker et al., 2015) to calculate participants' use of I- and we-pronouns in each memory.

Collaborative processes. We counted the number of instances in each event for five collaborative processes: (1) successful cues, (2) unsuccessful cues, (3) mirrored repetitions, (4) co-constructed sentences, and (5) corrections and disagreements. Definitions, examples and the mean rates of each collaborative process per event are provided in Table 2. Two coders independently scored 25% of the transcripts, with Cohen's Kappa ranging from 0.71–0.83 across the five collaborative processes. One of the coders scored the remainder of the transcripts.

Intimacy. As in Study 1, friends' and siblings' PAIR subscale scores (emotional, social, intellectual, and recreational) correlated significantly with their partner's, $r = .591$, $p < .001$; $r = .723$, $p < .001$; $r = .616$, $p < .001$; and $r = .593$, $< .001$, respectively, showing agreement. Therefore, for all friends and siblings, we created dyad-level scores for overall PAIR scores by averaging the two partners' scores (Table 1).

Results

We collapsed scores across the six events, calculating mean recall scores on each memory quality variable for each collaborative dyad or each individual, depending on the condition. Thus, we performed separate 2 (collaboration: individuals vs. dyads) × 3 (relationship: strangers vs. friends vs. siblings) multivariate ANOVA for: (1) coded vividness; (2) coded emotionality; (3) positive emotion words on the

Table 2. Study 2: definitions and examples of collaborative processes with means per event by relationship.

			Strangers	Friends	Siblings	Total
Variable	Definition	Examples	M (SD)	M (SD)	M (SD)	M (SD)
Successful Cue	Successful attempt to elicit information from partner	*A: What did we eat? B: Bibimbap.*	3.30 (2.91)	3.61 (2.07)	3.31 (3.47)	3.41 (3.15)
Unsuccessful Cue	Unsuccessful attempt to elicit information from partner, including when cue is ignored	*A: What did we eat? B: I don't know.*	0.52 (1.04)	0.90 (1.20)	1.00 (1.26)	0.81 (1.19)
Mirrored Repetition	Immediate repetition of word or phrase said by partner to affirm their input	*A: Anita. B: Anita was there.*	1.33 (1.63)	4.11 (2.90)	4.60 (3.18)	3.40 (3.02)
Correction or Disagreement	Correcting or disagreeing with partner's input	*A: Anita was there. B: No, she came later.*	0.26 (0.54)	2.08 (3.35)	2.96 (3.68)	1.81 (3.12)
Co-constructed Sentence	Finishing or contributing to partner's sentence, including words and phrases said simultaneously with partner	*A: She has no idea how to do make-up so, B: It took ages to get ready. A: We travelled by A & B: Ferry.*	0.35 (0.75)	3.12 (2.61)	2.97 (3.88)	2.20 (3.06)

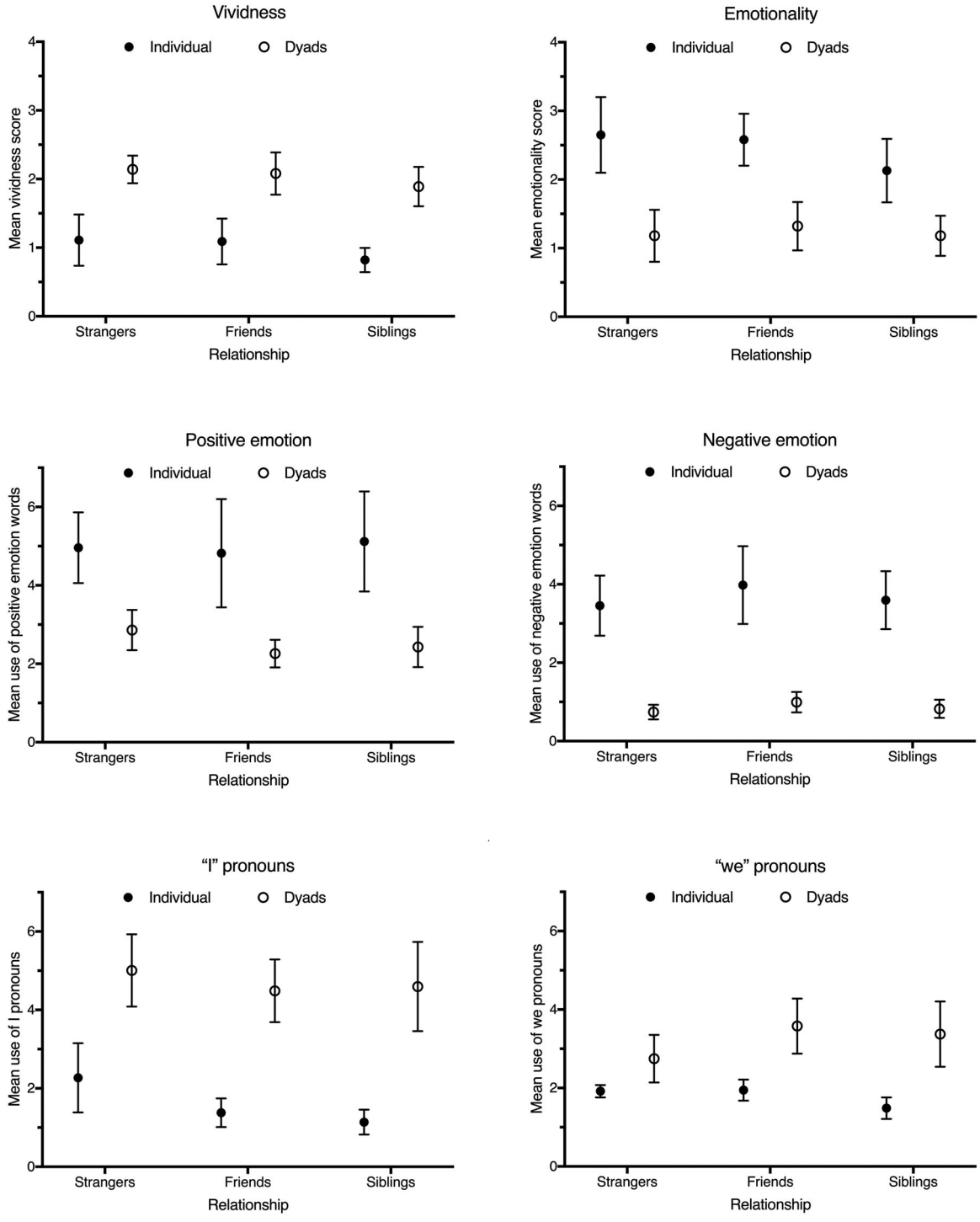

Figure 4. Mean scores vividness (top left), emotionality (top right), positive emotion (middle left), negative emotion (middle right), I-pronouns (bottom left), and we-pronouns (bottom right) in Study 2 at recall by relationship and collaborative condition. Error bars represent 95% confidence intervals. For vividness and emotionality, possible scores ranged from 0 to 3.

LIWC; (4) negative emotion words on the LIWC; (5) I-pronouns on the LIWC; (6) we-pronouns on the LIWC (see Figure 4). To test for differences between strangers, friends and siblings, where there was a significant main effect of relationship, we performed planned orthogonal contrasts comparing (1) strangers with friends and siblings, and (2) friends with siblings. We also performed follow-up t-tests for significant interactions (with α adjusted for Bonferroni correction of multiple comparisons).

Memory quality variables

For coded vividness, dyads' event descriptions scored higher than individuals', $F(1,64) = 109.30$, $p < 0.001$, $\eta_p^2 = .63$. There was no significant main effect of relationship or interaction,

both Fs < 3.04, both ps > .054. For coded emotionality, dyads' event descriptions scored lower than individuals', $F(1,64) = 65.31$, $p < 0.001$, $\eta_p^2 = .52$. There was no significant main effect of relationship or interaction, both Fs < 1.52, both ps > .228. Similarly to Study 1, collaboration appeared to enhance vividness of narratives, but in Study 2 this occurred for strangers as well as for friends and siblings.

Next we turn to the LIWC categories. For positive emotion words, dyads' event descriptions scored lower than individuals', $F(1,64) = 54.16$, $p < 0.001$, $\eta_p^2 = .46$. There was no significant main effect of relationship or interaction between them, both Fs < 0.41, both ps > .671. For negative emotion words, dyads' event descriptions scored lower than individuals', $F(1,64) = 109.30$, $p < 0.001$, $\eta_p^2 = .63$. There was no significant main effect of relationship or interaction, both Fs < 1.03, both ps > .363. Overall, collaboration appeared to decrease the emotion words present in memory narratives, across relationships.

For I-pronouns, dyads' event descriptions scored higher than individuals', $F(1,64) = 119.05$, $p < 0.001$, $\eta_p^2 = .65$. There was no significant main effect of relationship or interaction, both Fs < 2.01, both ps > .143. For we-pronouns, dyads' event descriptions scored higher than individuals', $F(1,64) = 52.58.05$, $p < 0.001$, $\eta_p^2 = .45$. There was no significant main effect of relationship or interaction, both Fs < 2.55, both ps > .086.

Thus, dyads' event descriptions were more vivid, less emotional, less positive, less negative, and contained both more I and we-pronouns than individuals' event descriptions. Overall these effects of collaboration did not interact with relationship type, and patterns were similar for strangers, friends, and siblings.

Collaborative processes

We performed a one-way ANOVA comparing relationship for each collaborative process. Where there was a significant main effect of relationship, we performed planned orthogonal contrasts comparing (1) strangers with friends and siblings, and (2) friends with siblings. Appendix 2 shows examples of dyads' use of collaborative processes. There was significant effect of relationship for mirrored repetitions, corrections and disagreements, and co-constructed sentences, $F(1,32) = 8.31$, $p = 0.001$, $\eta_p^2 = .34$, $F(1,32) = 5.46$, $p = 0.009$, $\eta_p^2 = .25$, and $F(1,32) = 10.49$, $p < 0.001$, $\eta_p^2 = .40$, respectively. Follow-up contrasts showed that strangers ($M = 1.33$) used fewer mirrored repetitions than friends and siblings ($M = 4.35$), $p < .001$, but friends' ($M = 4.11$) and siblings' ($M = 4.60$) use of mirrored repetitions were not significantly different, $p = .567$. Strangers ($M = 0.26$) used fewer corrections and disagreements than friends and siblings ($M = 2.52$), $p = .004$, but friends' ($M = 4.11$) and siblings' ($M = 4.60$) use of mirrored repetitions were not significantly different, $p = .290$. Strangers ($M = 0.35$) used fewer co-constructed sentences than friends and siblings ($M = 3.05$), $p < .001$, but friends' ($M = 3.13$) and siblings' ($M = 2.97$) use of mirrored repetitions were not significantly different, $p = .819$. Therefore, prior acquaintance mattered: strangers used collaborative processes differently from friends and siblings, using fewer mirrored repetitions, corrections and disagreements, and co-constructed sentences.

Table 3 shows the correlations between collaborative processes and memory quality variables. Dyads who had more corrections and disagreements described the events with more negative emotion words, $r = .50$, $p = .002$. Dyads who used more co-constructed sentences also used more we-pronouns, $r = .46$, $p = .006$. No other correlations between collaborative processes and memory quality variables were significant, all $r < .32$, all $p > .060$.

Discussion

As in Study 1, collaboration influenced the quality of strangers', friends' and siblings' recall of events, in broadly similar ways across relationships. Unlike in Study 1, however, collaboration influenced the quality of the three relationships in similar ways. In strangers, friends, and siblings, collaboration increased the vividness and pronoun use and decreased the emotionality, positivity, and negativity of event descriptions. The main differences between relationships emerged in their use of collaborative processes. Friends and siblings used more mirrored repetitions, corrections and disagreements and co-constructed sentences than strangers.

Stranger's collaborative process use contrasted with friends' and siblings'. Most of strangers' collaboration was in the form of questions asked by non-memory owner, which acted as either successful or unsuccessful cues (for examples, see Appendix 2). As Table 2 shows, strangers used cues more than other collaborative processes. These cues were mostly successful because they tended to be straightforward requests for clarification or contextual information. Thus, stranger dyads who used many collaborative processes recalled the event in an interview-like style. In contrast, dyads who used fewer collaborative processes described the events in a storyteller/listener style. In these dyads, the non-memory owner tended to wait until the

Table 3. Study 2: Pearson correlations between collaborative processes and memory quality variables across relationships.

	Vividness	Emotionality	Positive Emotion	Negative Emotion	I-Pronouns	we-Pronouns
Successful Cues	.11	−.16	.07	.09	.08	.05
Unsuccessful Cues	−.09	−.06	.08	.27	.09	−.01
Mirrored Repetitions	−.02	.22	−.09	.32	.15	.03
Corrections and Disagreements	.12	.10	−.17	.50*	.30	.02
Co-constructed sentences	.16	.33	−.14	.22	−.33	.46*

Note: *$p < .05$, **$p < .001$.

narrator finished to ask questions, giving them little time left for cuing. In these dyads, the partner who had not experienced the event played the role of an attentive listener for the majority of the task (Pasupathi & Billitteri, 2015). This narrator/listener style may be more conducive to a vivid and emotional narration between strangers than the interview style (Pasupathi et al., 1998; Pasupathi & Rich, 2005).

In contrast, friends and siblings tended to engage in joint narration (see Table 2), with many mirrored repetitions, corrections and disagreements, and co-constructed sentences. These collaborative processes reflected friends' and siblings' shared knowledge and their use of transactive memory (Barnier et al., 2008; Barnier et al., 2014; Hollingshead, 2001). These two collaborative processes appeared to do similar work in the collaborative recall of shared and unshared autobiographical memories. Both indicated mutual understanding and establish common ground, and mirrored repetitions were often followed by elaborations and additional information (Clark & Bernicot, 2008; Harris et al., 2011; Meade et al., 2009; Svennevig, 2004). Corrections and disagreements reflected friends' and siblings' equal knowledge of the events they were describing and their negotiation over how to describe the events.

Corrections and disagreements were associated with negative event descriptions. This finding could be due to dyads using more negative emotion words during corrections and disagreements, or because dyads tended to disagree more about their shared experiences when those experiences were negative. Either way, corrections and disagreements signified negative emotion in joint recall.

Co-constructed sentences were positively associated with we-pronouns, reflecting a closer, more intimate relationship between collaborators; a joint identity. Without a certain level of intimacy, co-constructed sentences could be interpreted as impolite interruptions. However, between intimate speakers, co-constructed sentences reinforce rapport and solidarity (Bogetic, 2011; Norrick, 2018).

General discussion

Collaboration influenced the memory quality of autobiographical memories across both studies, for all three relationship types. Collaboratively recalled events differed in vividness, emotional content, and pronoun use. The greatest impact of collaboration appeared to be on the emotional content of event descriptions, particularly the inhibition of positive emotion. The ways that collaborative dyads dealt with the emotional content of their events demonstrated how different aspects of an event might be emphasised or de-emphasised depending on the collaborative partner (Echterhoff et al., 2005; Pasupathi & Billitteri, 2015). The findings of Study 1, in which collaboration lowered positive and boosted negative emotional content were similar to the effects of collaboration on shared emotional pictorial stimuli (Choi et al., 2017). However, Study 1 focused on recent birthdays and other significant events, which were perhaps less broad in emotional content. In Study 2, with a larger range of event types, both positive and negative emotion words were reduced by collaboration. The findings of Study 2 were more similar to previous findings of the effects of collaboration on the emotional content of shared culturally-significant events, in which collaboration inhibited negative emotion (Harris et al., 2010). The emotional aspects of an event tend to be experienced internally, and therefore may be less relevant to a shared account of an event than they are to an individually described account of the event, leading to the silencing of these aspects in a collaborative setting. This emotional inhibition may also have occurred because participants were unwilling to disclose the emotional aspects of an event in front of a collaborative partner (Pasupathi & Billitteri, 2015). In another study, collaboration lowered the emotional content for previously negatively perceived shared events but not for positively or neutrally perceived events of the same kind (Maswood et al., 2019), suggesting that negative emotion may be more susceptible to silencing due to collaboration (see also Harris et al., 2010). Therefore, the effect of collaboration on the emotional content of memory appears to be complex, depending on the type of memory recalled and its emotional valence.

Relationship had a lesser impact on the influence of collaboration on memory quality than expected across both studies. The lack of relationship effects occurred even though strangers recalled unshared memories, whereas friends and siblings recalled shared memories, and strangers' collaborative process use differed to friends' and siblings' in Study 2. Our measures of memory quality may not have been sensitive enough to reveal differences due to relationship and collaborative process use. Vividness and emotionality were coded as scores from zero to three and were originally developed for individually, not collaboratively, recalled memories (Habermas et al., 2009; Habermas & Diel, 2013). Therefore, they may not have picked up more subtle changes in memory quality experienced across relationship. However, the LIWC measures were more sensitive and should have picked up relationship effects if they were there (Pennebaker et al., 2015; Tausczik & Pennebaker, 2010). Another explanation for the lack of relationship effects is that there may be too much variability within relationships for the interaction between collaboration and relationship to be statistically significant. Stranger dyads may have differed in terms of the rapport they experienced and their willingness to share their personal experiences with their partner. Friend and sibling dyads may have differed in their emotional closeness and experience in recalling their shared past together. The standard deviations for PAIR inventory intimacy scores were quite large, especially for siblings (Table 1). Therefore, future studies using larger samples may be required to compare the effects of collaboration on memory quality across relationship types.

Nevertheless, the impact of relationship and its links to transactive memory were revealed when we examined collaborative processes in Study 2. Strangers used fewer mirrored repetitions, corrections and disagreements, and co-

constructed sentences than friends and siblings. This pattern of collaborative process uncovers how integrated knowledge within a transactive memory system is negotiated (Gupta & Hollingshead, 2010; Wegner et al., 1985). Friends' and siblings' use of their integrated knowledge could be seen in their mirrored repetitions, co-constructed sentences, and even corrections and disagreements, such that the processes of collaboration looked quite different for acquainted compared to unacquainted pairs. Differentiated knowledge, which is only held by one person, is accessed using cues, which friends and siblings used at a similarly low rate to strangers. Thus, when recalling shared events with close others, accessing differentiated knowledge to generate a more comprehensive account of the event may less important than accessing integrated knowledge to maintain intimacy or shared identity (Alea & Bluck, 2007).

Our findings regarding collaborative processes in Study 2 also suggest that higher-order knowledge about what a collaborative partner knows may be less critical for successful cuing as the transactive memory literature suggests. It is often claimed that groups with a shared history can remember more together than separately using cross-cuing (Barnier et al., 2014; Meudell et al., 1995). In other words, friends' and siblings' knowledge of what each other knows should lead them to cue each other more successfully than strangers can (Wegner, 1987; Wegner et al., 1985; Wegner et al., 1991). However, strangers were able to successfully cue each other, potentially using their own similar experiences, scripts, or cultural expectations (Barnier et al., 2008). Strangers also appeared to be sensitive to their partners' lack of knowledge and to adopt effective cuing strategies that took their relative knowledge into account, suggesting that transactive memory-like processes can occur even between strangers: being sensitive to what your partner *does not* know may be as important as knowing what they do know. Strangers' cues may not be based on shared knowledge in the same way as those provided by close others, but they can still contribute positively to recall. Whether cues differ in their effectiveness based on their content is an important question for future research.

The significant correlations between collaborative processes and memory qualities and the differences in collaborative process use across relationships, suggest a link between relationship and memory qualities mediated by collaborative processes. However we did not find significant differences between dyads with different relationships. Corrections and disagreements were associated with negative emotion and co-constructed sentences were associated with more we-pronouns. Even though both collaborative processes were used more by friends and siblings than strangers, friends and siblings did not have higher negative emotion word use or we-pronouns than strangers. This pattern may have occurred due to similar reasons to the lack of overall relationship effects in memory quality described above, in which variation in that nature of relationships – even within the different relationship types – may have masked overall effects. Given the potential variation in collaborative process use and memory quality within relationship types, correlations may be more able to pick up the effects of collaboration on memory quality better than the categorical ANOVA comparisons between relationship types. Some relatively strong correlations between collaborative processes and memory qualities were not statistically significant, such as between co-constructed sentences and emotionality ($r = .33$, $p = .051$) and co-constructed sentences and I-pronouns ($r = -.33$, $p = 053$). Therefore, future research with larger sample sizes may have more power to illuminate these effects.

Studies 1 and 2 different methodologically, mainly due to the different method of recall: participants typed their memory narratives in Study 1 and verbally narrated in Study 2. Typing appeared to disrupt the collaborative recall of autobiographical memories in Study 1. Typing or writing is often used in both list-based collaborative recall tasks and individual autobiographical memory tasks (Harris et al., 2013; Harris, Barnier, & Sutton, 2012; Meade & Gigone, 2011; Pereira-Pasarin & Rajaram, 2011; Talarico, Labar, & Rubin, 2004), for ease of scoring recall. However, typed recall is a less natural form of collaboration than verbal recall, and much of what is recalled and verbally stated is not recorded in the written narrative. Verbal recall that is audio recorded and transcribed appears to be the superior method for collaborative autobiographical memory tasks, or at least to differ from written accounts in important ways. Using verbal recall means that the process of collaboration is embedded in the recall output and its effects on recall are clear. Dyads in Study 1 are likely to have collaborated in similar ways to Study 2 before they interrupted the process of collaboration so that they could record the product of their recall. Focusing on the typed memory narratives therefore misses important information about the effects of collaboration of recall, such as how it is negotiated between collaborators. Thus, the results of Study 2 not only reflect more closely how people collaborate outside the laboratory than those of Study 1, but they also provide more insight into how the product of collaboration is constructed.

Study 2 differed from Study 1 in other ways as well. First, in Study 1, elicitation and recall both occurred in the same session and participants recalled the event in full during elicitation. In Study 2, however, elicitation occurred a week prior and only consisted of recalling particular details to be used as cues during the recall session. Second, in Study 1, only two events were elicited and recalled; in Study 2, eight events were elicited per participant, and six events were recalled (three from each participant in a dyad). Third, in Study 1, all participants described a recent birthday and a significant event of their choice, which had to be shared between friends and siblings but had no restrictions on who else experienced the event for strangers. However, in Study 2, there were no restrictions on the types of events participants could elicit, but all three relationships had to elicit events that they had shared with a particular friend or sibling. These

methodological differences may partly account for the differences in the effect of collaboration on the emotional content of memories across studies. However, given all of these methodological changes occurred together and alongside changes in the modality of recall, it would be purely speculative to discuss exactly how each of these changes may have influenced our results. Future studies would be better able to pinpoint how each of these methodological details separately influence collaborative recall.

The two studies reported in this paper support the notion that collaboration can influence the qualities of autobiographical memory recall, and memories recalled with another person differ in meaningful ways from memories recalled alone. The process of collaboration may change depending on the collaborative partners' relationship and the shared or unshared distribution of knowledge about the event. Thus, future studies on the collaborative recall of autobiographical memories need to consider the relationship between collaborative partners as well as the method of recall and the process of collaboration itself.

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Data Availability

Data will be made available by the corresponding author on request.

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Appendices

Appendix 1: Examples of Vividness and Emotionality Scores for Typed Memories (Study 1)

Square brackets indicate information has been removed for conciseness or anonymity.
Event 1 (collaborative strangers, recall):
Vividness 0, Emotionality 0.

Tennis competition at [suburb]. Mum drove me there, she didn't want me to be by myself. Played in the under 14 and 16 singles and under 14 doubles with my friend. I was twelve at the time and I had made it into the quarterfinals for the under 14's, the semi-final for the under 16's and my partner and I won the doubles event. It was late in the afternoon and finished at night, and we won the first set 6–3 and the second set was 7–6 (7–2).

Event 2 (individual stranger, recall):
Vividness 3, Emotionality 2.

I had to work the day me and my boyfriend was celebrating my birthday, but he picked me up from work and took me to [bar] in [suburb]. We had a beer, but he felt sick so we had to go home. It was something awkward about him, but I couldn't really figure out what it was. I came in through the door and the apartment smelled of smoke. My boyfriend doesn't smoke, so I shouted out "have you been smoking in here?" What we didn't know was that my friends were hiding in the living room and of course some of them had been smoking. I was on my way to the bathroom when I saw the balloons and the lights turned on and I had finally someone to blame for the smoke. I was so surprised and happy that all my friends were there for me. J[xxx] taped the whole thing, while I was hugging everyone and got cake and a crown with my name on. I went to put on something nicer, before we drank some more beers. A guy named A[xxx] had a glass of red wine on the table. M[xxx] sat on the table, and the wine glass fell (somehow) on the floor. That was out first red stain on the carpet floor of our new apartment. All of a sudden our neighbour was in our living room. The music stopped and everyone froze. Especially me. I sank down in the sofa, and was so embarrassed. She eventually kicked us out, and everything was fine. I had some trouble getting everyone out though … We got down to [pub], and met some other Norwegian people, before we went to have some pie on our way home.

Appendix 2: Examples of Collaborative Processes in Strangers', Friends', and Siblings' Recall (Study 2)

SC = Successful cue; UC = Unsuccessful cue; MR = Mirrored repetition; CC = Co-constructed sentence; CD = Correction or disagreement. Square brackets indicate information has been removed for conciseness or anonymity. All examples are excerpts from the full transcripts.
Strangers:

A:	[monologue cut]. … So my dad thought it would be a good, a funny idea if he jumped onto the ledge and screamed at the same time to scare my mum. And it did. And it was very funny. And so we all laughed and my mum was a bit annoyed but we all thought it was really hilarious. Yep.	
B:	What was the weather like?	SC
A:	Uh the weather. Yeah actually yeah, it was cloudy. Um there wasn't much sunlight, I mean it's England, so you know, it's not particularly sunny so it was cloudy. It wasn't raining though. Um there was a bit of dew on the ground. Uh not too much. But yeah it was a bit muggy I guess 'cause we had to wear um wellington boots um as we were trudging across the moor.	MR
B:	Um was it cold? Like was it?	SC
A:	Yes.	
B:	Did you have to wear really?	SC
A:	Um it wasn't, I would say it would be about 10 degrees, maybe less, which wasn't too cold for me. But yeah I guess that's all relative. Um. I'm not sure what else …	CD
B:	Um when did this happen?	SC
A:	2004.	
B:	2004?	MR

Friends:

A:	This was last year? No year before.	
B:	Year before.	MR
A:	Formal.	
B:	It was our year 12 formal.	MR
A:	We went to C[xxx]'s house for pre-drinks.	
B:	Yeah.	
A:	And our, all our partners were all friends.	
B:	Yep. My partner was my boyfriend at the time. And now your partner's your boyfriend now.	
A:	We were having champagne with raspberries in it, I remember that.	
B:	Yeah.	
A:	In crystal glasses. Um everyone was in so many different coloured dresses. My mum came down from [city] to get me ready for that and came to our pre's, it was at [venue] at [suburb].	
B:	Mm.	
A:	Um I was in a big, massive champagne dress and you were wearing this silver,	
B:	Silky, purple-y, yeah dress. And C[xxx] was in like a coloured what do you call that?	CC, SC
A:	Purple.	
B:	Purple?	MR, CD
A:	Magenta I think it's called.	
B:	Yeah magenta. Magenta coloured dress.	MR
A:	Um they looked really good in photos together.	
B:	Yeah.	
A:	Um.	

B:	We had our corsages.	
A:	Yeah. C[xxx]'s aunty was taking photos of us on her proper camera.	
B:	Oh yeah that's right. Um we were all really excited. There was a lot of build up towards formal.	
A:	Yeah. We did [a run] around.	
B:	All the time.	CC
A:	[Venue], which gave us motivation to lose weight.	
B:	Um what else about that?	SC
A:	It was the best night; it was so good.	
B:	It was, it was actually the best night.	MR
A:	And then we got like a little hotel room thing.	
B:	And everyone went back there. Some people drank, some people didn't. We just, had a laugh.	
A:	Yeah stayed there the night and just spoke about the whole formal and everything.	

Siblings:

A:	This is my auntie's wedding, L[xxx]. And she is one of my favourite ones. Actually, she's the only one I get along with. Out of 5 aunties I have. Out of the 4 aunties I've got sorry. And she got married in 2007? 7? 2008. A year after my year 12 graduation. And it was held in [suburb] reception. And I was her bridesmaid, and I was so, so, so excited.	
B:	It was the first time you were bridesmaid.	
A:	It was the first time and it was her wedding so I was even more excited 'cause I just love her so much. And her dress colours were red and there were 3 of us.	MR
B:	The bridesmaid dresses.	CD
A:	Yeah, oh sorry the bridesmaid dresses were red and there were 3 of us and we had to be with her from the morning until late at night, um before she headed off to the hotel. And her and my other sister actually came to the wedding late.	MR
B:	Not late late, just before dinner.	CD
A:	Just before dinner was served. Like an hour before dinner was served, according to family, that's late. Her and my other sister. Why were you late? I can't remember why you were late?	MR, UC
B:	I don't remember why, I think something to do with the car, that's yeah.	
A:	'Cause you guys, they came with my aunty, my other aunty, they were all late to the wedding, so um, yeah. And you were pissed off the whole night (laugh).	
B:	And we also had to bring something for you as well and the bag.	
A:	Oh yeah, yeah, they had, 'cause we do a traditional dance.	
B:	Yeah cultural dance at the wedding.	
A:	Like after the wedding, after the dinner, just before, like they say "bye" and stuff.	
B:	No just before she, yeah with her white dress.	CD
A:	No when the bride changes to her white dress, we do a traditional dance and she had to bring my dress.	MR
B:	Yeah 'cause she left it with,	
A:	'Cause I left it at home when we went to get photos.	MR
B:	Yeah, she left it with me to bring.	MR
A:	And I think she didn't, B[xxx] didn't know where it was, that's why you guys were late.	
B:	Yeah.	
A:	'Cause it has like a specific shoes, dress and jewellery. And I had it all left, I don't know I put it in a bag somewhere.	
B:	She didn't take it with her, she told me to bring it for her, when she should've taken it with her earlier, so and then,	
A:	She had trouble finding it.	CC
B:	Yeah and also 'cause I'm very slow at getting ready, I like to just,	
A:	Just take her special time.	CC
B:	Not time just tend to start getting late, dressed really late.	CD
A:	It'll take me 20 min. It'll take her 2 h.	
B:	So yeah, so I had to bring her stuff as well and she kept calling me, "where are you? Bring my clothes!"	