Collaborative Memory: The Role of Closeness, Cognitive Need, and Strategies

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Statement of Candidate

I certify that the work presented in this thesis entitled "Collaborative Memory: The Role of Closeness, Cognitive Need and Strategies" has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree to any other university or institution other than Macquarie University. I also certify that this thesis is an original piece of research and it has been written by me. Any help or assistance that I have received in my research work and the preparation of the thesis itself have been appropriately acknowledged. In addition I certify that all information sources and literature used are indicated in the thesis.

The research presented in this thesis was approved by the Macquarie University Human Ethics Committee (REF 5201300512). Some of the data presented in this thesis (Chapter 2) was collected at Montana State University and an exemption from the Montana State University Institutional Review Board was obtained (MM032913–EX). Confirmation of this exemption was provided to the Macquarie University Human Ethics Committee, who approved inclusion of this data in this thesis.

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Abstract

We remember with others frequently throughout our daily lives. Given how often we remember with others, it is important to understand how such collaboration influences memory performance. Laboratory studies typically find a counter intuitive phenomenon known as collaborative inhibition: collaborative groups recall less than the same number of individuals whose recall has been pooled (nominal groups). Collaborative groups, however, also typically produce fewer intrusions than nominal groups, and individuals who previously collaborated subsequently recall more than individuals who previously recalled alone. Despite having a good understanding of individual cognitive processes that may underlie these findings, we know less about conditions in which collaborative memory costs can be minimised and benefits maximised. In this thesis, I examine if closeness between group members, the cognitive need of group members, and explicit group memory strategies influence the amount recalled and the accuracy of what is recalled both during collaboration and following collaboration. A sense of closeness may make group members more sensitive and responsive to each other, reducing costs and increasing benefits of collaboration (Experiment 1). But this increased coordination may only be possible when they have shared knowledge and experiences (Experiment 2). Young adults also may be most likely to offer help to another person if they perceive that the other person requires memory assistance; for example, due to a temporary demand on the cognitive resources of one group member (Experiments 1 and 2). Finally, rather than leaving strategy development to chance, instructing dyads to explicitly agree on a strategy at retrieval (Experiment 3) or encoding (Experiment 4) may ensure all groups coordinate their recall. Contrary to my hypotheses I found that none of my manipulations changed the typical costs and benefits of collaboration. I discuss the implications of my findings for educational settings, workplaces, and remembering with our family and friends.

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Chapter 1

Introduction

Remembering with others is a common, everyday occurrence (Pasupathi, McLean, & Weeks, 2009). Amongst new acquaintances and within our established relationships (i.e., our family and friends, classmates, and colleagues) we share episodic memories from our lives, both recent (e.g., what we did today) and distant (e.g., something that we did many years earlier). Sharing these autobiographical memories serves a number of adaptive social functions including teaching, relationship initiation and maintenance, and the elicitation of empathy (Alea & Bluck, 2003; Bluck, 2003; Bluck, Alea, Habermas, & Rubin, 2005; Harris, Rasmussen, & Berntsen, 2014; Hirst & Echterhoff, 2012). In addition, we often share non-autobiographical memories with others. For example, with a spouse we might try to remember a shopping list, in a study group we may work together to remember key conceptual knowledge, and in a work team we may work together to remember complex procedures. The sharing of these sorts of memories helps us complete everyday tasks, is one of the goals of group learning pedagogies such as cooperative learning (e.g., Kyndt et al., 2013), and may be lifesaving in high-risk work environments such as those faced by emergency services (e.g., Ford & Schmidt, 2000).

Given the frequency and ubiquity with which we remember with others, it is important to understand how such collaboration influences memory performance. Studies have found that in healthy older adults social engagement is positively associated with cognitive function (Krueger et al., 2009); larger social networks are positively associated with cognitive performance in people with Alzheimer's (Bennett, Schneider, Tang, Arnold, & Wilson, 2006); and that cognitive decline in husbands predicts a decline for wives, with a lag of one year (Gerstorf, Hoppmann, Anstey, & Luszcz, 2009). Thus, at least as we age, socialising with others may be important to our individual cognitive performance, although the direction of this effect is unclear. For example, the size of our social network may shrink when we start experiencing cognitive difficulties. Alternatively, it is possible that social

interactions (especially with people such as a spouse) may help to maintain or offer compensation for cognitive functions if we begin to experience difficulties (Barnier, Sutton, Harris, & Wilson, 2008; Johansson, Andersson, & Rönnberg, 2005). In healthy adults, collaboration has the potential to be both beneficial and detrimental to recall quantity and accuracy (Andrews & Rapp, 2015; Harris, Paterson, & Kemp, 2008; Rajaram, 2011). Remembering together can provide opportunities to cue our memories, reminding us of things we may otherwise have forgotten (e.g., Harris, Keil, Sutton, Barnier, & McIlwain, 2011), correct each other (e.g., Ross, Spencer, Blatz, & Restorick, 2008), and pool information (e.g., Wegner, Erber, & Raymond, 1991). But groups recalling collaboratively also can interrupt one another's recall (e.g., Basden, Basden, Bryner, & Thomas, 1997), expose each other to false memories (e.g., Paterson, Kemp, & Forgas, 2009; Paterson, Kemp, & Ng, 2011; Roediger, Meade, & Bergman, 2001), focus discussions on narrow, shared perspectives at the expense of sharing information that not all group members know (e.g., Hirst & Echterhoff, 2012; Wittenbaum & Park, 2001), and result in forgetting unshared information that was related to shared information (e.g., Coman, Manier, & Hirst, 2009).

Understanding when remembering with others helps rather than hinders recall has considerable implications for education (e.g., Nokes-Malach, Richey, & Gadgil, 2015; Wright, 2016), occupational (e.g., Cohen & Bailey, 1997), and aging domains (e.g., Barnier, Harris, & Congleton, 2013; Blumen, Rajaram, & Henkel, 2013; Dixon, 2013). As noted above, group learning pedagogies (such as cooperative learning) place an emphasis on group work improving individual educational outcomes (Kyndt et al., 2013). In high-risk work environments, such as emergency response, it is imperative that teams remember optimally together (Ford & Schmidt, 2000). And as aging populations face increasing dementia rates and the associated financial costs (Prince et al., 2015), there is interest in collaboration as a non-pharmaceutical memory intervention (Blumen et al., 2013). Yet to date explorations of

the costs and benefits of collaborative memory in these varied contexts typically have been studied in parallel to laboratory-based attempts to identify the individual cognitive processes that influence collaborative memory performance. In this thesis I wanted to begin bridging this gap, by drawing from theories and research about collaborative memory in naturally occurring small groups to identify factors that can be manipulated in a controlled laboratory environment. My empirical program aims to identify and understand the influence and interaction of internal and external conditions that may minimise the costs and maximise the benefits when remembering with others.

Theoretical Framework: Cognitive Scaffolding

To understand the importance of internal (within the person) and external (beyond the person) conditions in collaborative memory performance amongst adults, it is useful to turn briefly to the notion of scaffolding used in child development and educational work. The environment in which we undertake many cognitive tasks, including remembering, can influence both the output produced and the processes associated with the task (Rogoff, 1998). The importance of the social context of cognition was an underlying principle of Vygotsky's child development theory (Vygotsky, 1978). Vygotsky proposed that the provision of support from a more experienced person, sensitive to the child's current level of skill, could help a child achieve a goal beyond their current non-supported ability. Social learning theorists have long conceptualised this as a "scaffolding" process (Wood, Bruner, & Ross, 1976, p. 90), in which developmentally appropriate support (usually from an adult or other 'expert') facilitates a child's (or other less experienced individual's) skill and knowledge. For example, if a child is experiencing difficulty solving addition problems on a worksheet, a teacher could use base ten blocks to physically manipulate and model the mathematical principle of addition. The notion of scaffolding has been applied to a wide range of cognitive learning outcomes including memory (e.g., Cleveland & Reese, 2005; Farrant & Reese, 2000; Fivush, 2011;

Fivush & Fromhoff, 1988; Fivush, Haden, & Reese, 2006; Habermas, Negele, & Mayer, 2010; Haden, 1998; McGuigan & Salmon, 2004; K. Nelson & Fivush, 2004; Reese, Haden, & Fivush, 1993; Van Bergen, Salmon, Dadds, & Allen, 2009; Wareham & Salmon, 2006), language (e.g., Bond & Wasik, 2009), and counting (e.g., Benigno & Ellis, 2004), in both informal (e.g., Reese, 2002; Rogoff & Gardner, 1984) and more formal settings (e.g., Bliss, Askew, & Macrae, 1996).

The presence or absence of scaffolding does not depend only on the presence of strategies used by the "scaffolder" to support the "scaffoldee" but also on how sensitive these strategies are to the developmental and cognitive abilities of the scaffoldee (Greenfield, 1984). The input of the scaffolder is shaped by the contributions of the scaffoldee, and an intended scaffold may not be successful if the scaffolder is not responsive (Rogoff & Gardener, 1984). For example, Bliss et al. (1996, p. 46) observed that classroom teachers and students engaging in joint activity sometimes demonstrated "pseudo-interactions or bypassings" rather than successful scaffolding. A pseudo-interaction might occur if a teacher interprets a student's statement or question through a lens of their own understanding or based on the goals of the task, or if a teacher and student talk at cross-purposes, with the teacher not providing clarification that the student understands (Bliss et al., 1996). In this way, successful scaffolding is an example of coordinated group communication and shared representation; a bi-directional process through which all parties get "on the same page" as each other. The provision of structure alone is not sufficient, but rather the benefits of collaboration emerge from the sensitive interactions between the scaffolder and the scaffoldee shaping the structure.

A focus on scaffolding—exploring how individual cognitive processes may be shaped by, or emerge from, processes outside an individual's own brain—can be seen also in theories of extended cognition. By this view, cognitive processes may exist within and emerge from interactions between our brain and our body, tools, or other people (Clark, 1998; Sutton,

2015). Proponents of extended cognition theories have adopted and broadened the definition of scaffolding beyond encompassing just the support provided to those learning a skill from an experienced other. Sutton (2015) argued that since no mind operates in isolation from the environmental, social, and cultural context, scaffolding provides a conceptual framework for understanding different levels of influence: the broad societal norms in our culture, the physical tools we have at our disposal, and the people that we interact with in our everyday life. Clark (1998) similarly proposed that scaffolding "…denotes a broad class of physical, cognitive, and social augmentations – augmentations that allow us to achieve some goal that would otherwise be beyond us" (p. 194). Clark's (1998) and Sutton's (2015) broader definitions of scaffolding provide a way to conceptualise a variety of internal and external conditions that aid cognition.

Sutton (2015) called for further exploration of the potential spectrum of scaffolding cases from a cognitive science perspective. Given that this thesis focuses on remembering with others, cases in which social memory scaffolding has been found may help us better understand the processes underlying group performance on collaborative memory tasks. I turn now to discuss insights from research in developmental memory and transactive memory.

Insights From Research on Parent-Child Joint Remembering

A parent recalling the past with a young toddler or preschool-aged child provides a canonical case of social memory scaffolding. First, the existing relationship between parent and child increases the chances of sensitive and responsive engagement during shared remembering. Second, a toddler or preschool-aged child has a need for assistance when recalling events from the past. Children display the ability to recall novel stimuli from infancy (Rovee-Collier, 1999), suggesting that the cognitive systems underpinning long term memory are already developed in the preschool years. However, learning how to talk about the past is a social skill that children develop (Fivush, 2011). In addition to the language skills required

to describe past experiences verbally, children also develop metacognitive and narrative skills that help them to place the event in a broader context (e.g., when, where, how, and why the event occurred; Fivush, 2011; K. Nelson & Fivush, 2004; Reese, 2002; Wareham & Salmon, 2006). Drawing on Vygotsky's earlier social constructivist principles of sensitive support from a more experienced person (discussed above), the socio-cultural model of autobiographical memory development proposes that children learn these skills through conversations with adults (typically parents and other caregivers) about past experiences (Fivush, 2011; Fivush et al., 2006; K. Nelson & Fivush, 2004). Importantly, however, a substantial number of studies have found evidence to suggest that parents vary along a spectrum of elaborative reminiscing style (for reviews see Fivush, 2011; Fivush et al., 2006; Wareham & Salmon, 2006). Research across the past two decades has shown how children of elaborative mothers (and, in some studies, fathers) come to describe past events in more detail and with more coherence than do children of less elaborative mothers (Fivush, 2011; Fivush et al., 2006; Wareham & Salmon, 2006). Thus, a mother using an elaborative reminiscing style appears to scaffold their child's memory development through the provision of recall structure and appropriate cues.

Cleveland and Reese (2005) suggested that the maternal elaborative reminiscing styles identified in previous research might have confounded two distinct dimensions of social memory scaffolding: elaboration and autonomy support. Autonomy support during reminiscing refers to the degree to which adults are sensitive and responsive to a child's contribution to the conversation. To explore the independence of elaboration and autonomy support, Cleveland and Reese (2005) coded mother-child conversations about the past for elaborative questions (i.e., "wh-" questions) asked by the mother and rated maternal turns on a five point scale from low autonomy support (i.e., the turn functioned to negate the child's contribution and followed the mother's conversational topic) to high autonomy support (i.e.,

the turn functioned to validate and expand on the child's contribution). Cleveland and Reese (2005) replicated earlier studies showing that children of elaborative mothers recalled more than children of less elaborative mothers. In addition, they found that children of mothers who provided few elaborative questions recalled more if their mother also demonstrated high levels of autonomy support. Similarly, children of mothers who provided elaborative questions recalled more if their mother also provided high levels of autonomy support. Importantly, no correlation was found between maternal elaborative questions and maternal autonomy support. Cleveland and Reese's results suggest that providing structure is not the only factor contributing to memory scaffolding in parent-child dyads. Sensitivity and responsiveness to the child's perspective and contribution can also increase the child's memory performance. This is important as it suggests that a recall partner who attempts to create a shared understanding during a memory task can increase recall, even if the structure being offered by a recall partner is not ideal. The ability to create a shared understanding during a memory task may be particularly relevant to group memory performance in healthy adults. Since a healthy adult may be highly competent at structuring their own recall, the provision of structure by another group member might not be adopted unless it is sensitive and responsive to the individual's own contributions to recall.

These findings from the autobiographical memory development literature suggest that there are at least two social forms of memory scaffolding that support young children in recalling more: the first is structuring the conversation by including high-elaborative prompts, cues, and other descriptive details; the second is sensitivity to, and encouragement of, the child's perception of events. As in the pseudo-interactions between teachers and students described by Bliss et al. (1996), providing structure alone is not as helpful as when that structure is paired with group members having a shared understanding of the task.

Importantly, these developmental studies highlight that memory scaffolding is not present to the same degree in all mother-child dyads.

Insights from Research on Transactive Memory Systems

It is less clear, however, if groups of healthy adults also demonstrate social memory scaffolding, and if social memory scaffolding can minimise the costs and increase the benefits of collaborative memory in these groups. As children develop their reminiscing skills and enter their teenage years the autobiographical memory skills requiring support may change as the level of narrative sophistication increases (Habermas et al., 2010). Current longitudinal studies that are continuing into the teenage years (e.g., Reese, Jack, & White, 2010) will provide opportunities to explore the role of social memory scaffolding during adolescence and beyond.

At the other end of the developmental spectrum, memory may need additional external support as we age and our cognitive resources—already limited—start to decline (Balota, Dolan, & Duchek, 2000; Craik & Byrd, 1982; Kirova, Bays, & Lagalwar, 2015). Physical and social memory scaffolds can provide this external support and can help us to remember more than we might otherwise. Lists, calendars, and diaries are examples of physical aids that augment memory (Barnier, 2010). Social memory scaffolding is less tangible, but may include collaborative communication processes that help individuals within small groups, such as long married couples, families, aged care facilities, and social clubs, to elicit and correct information (Blumen et al., 2013; Harris, Barnier, Sutton, & Keil, 2014; Hirst & Echterhoff, 2012; Hydén, 2011, 2014; Majlesi & Ekström, 2016).

When we conceptualise social memory scaffolding as a form of memory support offered by at least one individual during shared remembering that is sensitive to the needs and abilities of at least one other individual in the group, we see it has much in common with Wegner's (1987) theory of Transactive Memory Systems (TMS). Wegner proposed that

groups develop strategies and processes to distribute, connect, and retrieve memories (Wegner, 1987; Wegner, Giuliano, & Hertel, 1985). The development of these strategies is thought to not only increase efficiency when individuals remember together, but also create emergent benefits such that groups perform in a way that is more than the sum of its parts. As such, whereas instances of social memory scaffolding may be transient or temporary, transactive memory could be viewed as social memory scaffolding that over time has become a stable shared remembering dynamic.

Transactive memory systems have been explored in naturally occurring groups such as work teams (Zhang, Hempel, Han, & Tjosvold, 2007), and romantic couples (Wegner et al., 1991), as well as in strangers (Liang, Moreland, & Argote, 1995; Moreland & Myaskovsky, 2000). One assumption of scaffolding that is explicit in Transactive Memory theory is the importance of metacognitive knowledge about the group. This metacognitive knowledge includes knowing your own skills, knowledge, and expertise, and knowing the skills, knowledge, and expertise of other group members, which allows groups to delegate and integrate where appropriate. For example, in the case of mother-child dyads, both parties may view the mother as the expert, but collaboration will be more successful if the mother does not try to cue for information the child does not know. Metacognitive knowledge can be developed over time by interacting with the group (Wegner et al., 1991), but also can be gained from receiving external information about the knowledge of other group members (i.e., a summary of group member expertise; Moreland & Myaskovsky, 2000). Transactive Memory theory also makes explicit the idea that the other members of the system must be credible (Lewis, 2003). If group members do not trust the reliability of other group members they are less likely to reach out beyond their own individual cognitive processes. Thus, if an individual feels competent at undertaking a given task alone, they may take an individualistic approach, even when asked to collaborate.

Taken together the developmental and transactive memory literature converge on a set of conditions that seem important for scaffolding success and group memory performance: first, some degree of closeness or intimacy, shared knowledge or history between members, which potentially maximises both the sensitivity of scaffolding and willingness to rely on memory partners; second, some degree of cognitive need in one memory partner that leads them to reach for external support, perhaps because the task is beyond their current capacities or because their cognitive resources are limited in some way; and third the use of a raft of communicative, collaborative strategies to "get on the same page". Here, and throughout this thesis I use "get on the same page" to mean sensitive and responsive interactions between group members that help groups align and coordinate their approach to a task. Evidence of being on the same page would include explicit agreement on how to approach a task, acknowledgment of other group members' contributions, or statements that aim to clarify if all group members share the same understanding of the task. In this thesis I aimed to systematically explore the impact of these conditions on collaborative memory success. To achieve this aim, I needed a laboratory method that allowed me to assess the costs and benefits of remembering with others while manipulating various conditions of my remembering groups. The collaborative recall paradigm from cognitive psychology was a natural choice.

Collaborative Recall Paradigm

Over the past 20 years the collaborative recall paradigm has become a dominant methodology for exploring memory performance in groups of adults (Harris et al., 2008; Rajaram & Pereira-Pasarin, 2010). In a typical collaborative recall experiment, participants (typically strangers) study stimuli (typically word lists) individually and then perform a memory test (typically free recall of the word list) either alone or in a collaborative group. The non-redundant items of those who recall alone are pooled to form nominal groups of the

same size as the collaborative groups. Under these conditions, recalling in a group comes with a cost, at least in terms of the amount recalled. Collaborative groups recall more items on average than individuals. However, they recall fewer items than nominal groups, a phenomenon known as collaborative inhibition (Basden et al., 1997; Weldon & Bellinger, 1997).

Social motivational forces (e.g., social loafing) appear to play a minimal role in the collaborative inhibition effect (Weldon, Blair, & Huebsch, 2000). Further, collaborative inhibition is not due to the social structures and norms present when interacting with others during the recall phase. To explore the influence of these social processes on collaborative recall performance, Wright and Klumpp (2004) showed group members either the same word list or different word lists during the study phase, and then asked half the participants to recall in collaborative groups, and half to recall individually to form nominal groups. During the recall phase those in the collaborative condition took turns to recall items. Collaborative inhibition was found in the groups that had studied the same word list but not in the groups who had studied different word lists. Wright and Klumpp's (2004) findings suggest that the act of having to recall in front of others (and the social and motivational factors associated with this public activity) does not cause collaborative inhibition. Instead, individual cognitive processes such as retrieval disruption (Basden et al., 1997; Rajaram & Pereira-Pasarin, 2010) and, more recently, retrieval inhibition (Barber, Harris, & Rajaram, 2015) have been proposed as the underlying causes of the effect. Retrieval disruption, the most commonly explored cause of collaborative inhibition, is thought to occur because individuals encode events in a manner that encourages their own optimal recall. During collaborative recall, exposure to other people's retrieval disrupts individuals' optimal retrieval strategy, resulting in fewer items being recalled by the individuals in the group than if they recalled alone. In contrast, retrieval inhibition is thought to occur when the strengthening of a recalled item during

collaboration supresses the representation of a non-recalled item. While items not recalled during collaboration due to retrieval disruption should be available to be recalled subsequently during individual recall, items supressed during collaboration due to retrieval inhibition will be unavailable during a subsequent individual recall task. In addition, studies exploring the formation of collective memories have found socially-shared retrieval-induced forgetting such that listening to someone else remembering can result in the listener forgetting information that was similar but not remembered by the speaker (Coman, Manier, et al., 2009; Cuc, Koppel, & Hirst, 2007). Barber at al. (2015) suggested that depending on the context of the shared remembering, different individual cognitive processes may play more or less of a role in collaborative inhibition. But regardless of the individual cognitive processes underlying the collaborative inhibition effect, groups may only be able to overcome this cost to collaboration if they can engage in processes that help structure their joint recall and help them get on the same page.

Rajaram and Pereira-Pasarin (2010, p. 651; see also meta-analysis by Marion & Thorley, 2016) described collaborative inhibition as a "robust finding" as it occurs using a range of stimuli other than word lists, such as stories (e.g., Weldon & Bellinger, 1997) and images (e.g., Ross et al., 2008); in groups with established relationships, such as friends (e.g., Harris, Barnier, & Sutton, 2013) and couples (e.g., Ross et al., 2008); and in groups other than young adults, such as school aged children (e.g., Leman & Oldham, 2005) and older adults (e.g., Meade & Roediger, 2009). Collaborative inhibition is not, however, an inevitable artefact of groups remembering together. There are conditions under which collaborative inhibition can be abolished or reduced (for review see Rajaram & Pereira-Pasarin, 2010). For example, if the stimuli consists of a short list of easily categorised words then performance by nominal and collaborative groups is similar (Basden et al., 1997). Short, easily categorised lists may be easier to maintain (i.e., less vulnerable to disruption), reducing the benefit of

uninterrupted recall in nominal groups. Thus, collaborative inhibition is reduced when there is less variance in possible ways for individuals to organise the stimuli, compared to when there are a great number of ways to organise the stimuli (Basden et al., 1997, Exp 1). In addition, if both nominal and collaborative groups are asked to recall using an experimenter-imposed retrieval organisation then collaborative inhibition is eliminated (Basden et al., 1997, Exp 4). These findings suggest that collaborative inhibition can be reduced when groups structure and coordinate their recall together—either because their individual strategies are similar or because the recall organisation is externally limited thus reducing the effectiveness of individual retrieval strategies. This is important because it echoes scaffolding findings: the ability to structure joint recall is an important determiner of more successful collaboration.

While collaboration brings robust costs in terms of how much is recalled during collaboration itself, it also leads to significant benefits for both amount recalled when previous collaborators later recall alone, and for accuracy during collaboration. In terms of amount recalled following collaboration, those who previously collaborated tend to have greater subsequent individual recall compared to individuals who previously recalled alone (Barber & Rajaram, 2011b; Blumen & Rajaram, 2008, 2009; Blumen, Young, & Rajaram, 2014; Congleton & Rajaram, 2011, 2014; Henkel & Rajaram, 2011; for meta-analysis see Marion & Thorley, 2016; Wissman & Rawson, 2015). This post-collaborative benefit is likely due to two aspects of collaboration that are not present in individual recall experiences. First, collaboration re-exposes individuals to items they may have forgotten that another group member recalls (Barber & Rajaram, 2011b; Congleton & Rajaram, 2011). Second, there appears to be a delayed cross-cueing effect, which increases the inclusion of new, emergent information in individual post-collaborative recall (Blumen et al., 2014; Congleton & Rajaram, 2011; Vredeveldt, Hildebrandt, & van Koppen, 2016). Understanding how to further increase this post-collaborative benefit is important because it has implications in settings

such as educational contexts where students may engage in group work but later be tested individually.

In terms of accuracy, although there is a substantial literature showing the potential for remembering with others to introduce errors into an individual's memory (e.g., Hope, Ost, Gabbert, Healey, & Lenton, 2008; Meade & Roediger, 2002; Roediger et al., 2001; Wright, Memon, Skagerberg, & Gabbert, 2009; Wright, Self, & Justice, 2000), the collaborative process also offers opportunity for error correction. Previous studies have found reduced intrusion rates in collaborative groups when compared to nominal groups (Congleton & Rajaram, 2011; Harris, Barnier, & Sutton, 2012; Harris et al., 2013; Hyman, Cardwell, & Roy, 2013; Ross et al., 2008) and in some cases in post-collaborative individual recall (Harris et al., 2012, 2013). This collaborative benefit may only be demonstrated, however, if the collaboration instruction encourages group members to interact, and may not be seen when groups undertake a turn based approach to recall (as in Basden et al., 1997 who found an increased error rate in collaborative turn taking groups). The strongest explanation of this accuracy benefit is that collaboration allows for error checking (Harris et al., 2012, 2013; Ross et al., 2008), rather than because group members are less likely to mention an error in front of other group members (at least in younger adults Harris et al., 2012; Ross et al., 2008). This finding is important, because in some circumstances, such as in a legal context or occupational settings with high levels of risk (e.g., paramedic teams), accuracy of recall may have great ramifications.

Rajaram and Pereira-Pasarin (2010) developed a theoretical framework of the individual cognitive processes that may account for the pattern of costs and benefits typically found in collaborative memory experiments. In their framework, processes such as social contagion, blocking, and retrieval disruption underlie the costs typically seen in collaborative memory (adopting errors from other group members in subsequent individual recall,

forgetting items, and not retrieving items), while other processes such as re-exposure, relearning via retrieval, and error pruning underlie the benefits typically seen in collaborative memory (increased individual recall following collaboration, and fewer errors recalled during collaboration). The framework provides a clear overview of the cognitive processes thought to influence both collaborative and subsequent individual performance. However, the model is relatively static and individually focused in the sense that it currently pays less attention to the collaborative history of the group, potential individual differences in the abilities of group members, and emergent group processes that may arise during collaboration such as cross-cueing. Four studies, one with expert pilots (Meade, Nokes, & Morrow, 2009), one with older long married couples (Harris et al., 2011), one with long-acquainted dyads recalling complex stimuli in a structured interview (Vredeveldt, Hildebrandt, et al., 2016), and one with friends and acquaintances recalling complex stimuli in a structured interview (Vredeveldt, Groen, Ampt, & van Koppen, 2016) support the proposal that underlying individual and group cognitive processes relevant to closeness, need, and strategy influence the benefits of collaborative remembering.

Meade et al. (2009) gave expert pilots, novice pilots, and non-pilots flight-related scenarios and then asked participants to recall the details in collaborative or nominal groups. It is worth nothing that expert pilots work in an environment in which they are trained and have long histories of working with other pilots (although not necessarily the same ones). Their task of flying the plane is a complex one, and they are again trained to work as a team to meet their goals most efficiently. Given this background, it is not surprising that expert pilots recalled more in collaborative groups than in nominal groups, although this finding of collaborative facilitation is vanishingly rare in the literature. In contrast, novice and non-pilots showed the standard collaborative inhibition. The top performing dyads in each condition were identified and their collaborative recall transcribed and coded for distinct

communication strategies (e.g., acknowledgements, repetitions, restatements, and corrections of their recall partner's contribution, and offering explanations for their own contributions). This process analysis found communication differences between the expert pilots and the novice and non-pilot groups. The highest performing expert pilots were more likely to elaborate on the previous statement their partner made, offer more explanations, and provide more corrections than the highest performers in the other two groups. Meade et al. (2009) suggested that expert pilots are not only experts of the content of the material but also have received extensive training to become expert communicators. Combined, these two forms of expertise not only appeared to help structure their joint recall but also ensured they were on the same page.

Harris et al. (2011) asked older couples (married for an average 40.7 years) to recall a range of items (including word lists, members of a shared social group, and autobiographical memories) alone and then two weeks later asked the participants to recall the material together. Somewhat like the pilots, these long married older adults had long histories of remembering together. They reported high levels of intimacy, spending almost all their time together, and often said that remembering together was their natural state. Importantly, Harris et al. noticed differences in individual ability across the various tasks with some older adult complaining that their memories were no long as good as they used to be, or that their spouse was far better. Overall, these couples recalled similar amounts both alone and together; that is, collaborative inhibition was eliminated. Interestingly, when the performance of each dyad was explored, however, some couples demonstrated collaborative inhibition, some no difference, and some collaborative facilitation. Analysis of the collaborative processes for each dyad revealed that 84% of variance in the difference between couples' collaborative performance and their nominal performance could be explained by how they recalled together. Collaborative success was associated with processes that reflected a shared approach to the

task (e.g., successful cuing and repeating what the other person recalled). In contrast, processes that indicated a more individualistic approach (e.g., corrections and absence of cuing attempts) appeared to be detrimental to collaborative recall quantity.

Vredeveldt, Hildebrandt, et al. (2016) conducted a field study that mimicked Dutch police interviewing procedure to explore recall of an emotive 3-minute scene of a theatrical production in acquainted collaborative dyads (mean length of relationship was 31.3 years) and unacquainted nominal dyads. Vredeveldt, Hildebrandt, et al. (2016) first interviewed all participants individually, and then interviewed acquainted dyads together and interviewed the unacquainted participants a second time individually (pooling their recall to form nominal dyads). Although no cost or benefit of collaboration was found in terms of the amount of details recalled, the interviewing procedure (which included a cued recall phase) makes this study difficult to compare to more traditional collaborative recall experiments. Importantly, as in in Harris et al.'s (2011) and Meade et al.'s (2009) studies, Vredeveldt, Hildebrandt, et al. (2016) found that in dyads in which partners repeated, restated, and elaborated on each other's contributions they recalled more during collaboration.

Vredeveldt, Groen, et al. (2016) conducted a similar study to Vredeveldt, Hildebrandt, et al. (2016) using an 8-minute violent scene from a film as stimuli. The collaborative dyads were mostly comprised of participants who knew each other (mean length of relationship was 14.7 months). Participants were interviewed individually, then collaboratively or individually, and then a final time individually. As in Vredeveldt, Hildebrandt, et al. (2016) no collaborative inhibition was found, although once again the style of interview contained a cued recall phase, making comparisons to more traditional collaborative recall experiments difficult. Providing further evidence for the importance of collaborative processes, Vredeveldt, Groen, et al. (2016) found that acknowledgements, repetitions, restatements, elaborations accounted for 54% of the variance of the amount of information recalled. Further, dyads that

elaborated on each other's contributions remembered significantly more information than dyads with fewer elaborations.

All these studies demonstrate that, as theories of scaffolding would suggest, groups differ in the ways in which they approach tasks—perhaps because of their developmental history—which can influence their collaborative performance. Also, just as in the mother-child scaffolding dyads described above, in the Harris et al. (2011) and Vredeveldt, Hildebrandt, et al. (2016) studies it is apparent that groups that we might consider homogenous (e.g., romantic couples, and long-acquainted friends) can have quite different (cognitive) profiles and vary greatly in their collaborative processes, and thus the costs and benefits they experience. Finally, recall partners who coordinated and aligned their retrieval experienced the greatest collaborative benefits.

Reducing Costs and Maximising Benefits of Collaborative Recall

In this thesis, inspired by findings from socio-cultural learning studies, mother-child memory scaffolding studies, and transactive memory studies, I wanted to take some first steps to bridge the gap between cases of collaborative remembering in the world (e.g., remembering with a romantic partner, or remembering in a study group) and what is typically studied in the laboratory. Since cases in the real world involve multiple, interacting (and potentially confounding) conditions, I aimed to experimentally separate and recreate key conditions and tasks in a series of experiments that extend the canonical collaborative recall paradigm. Across the four laboratory experiments described in the chapters that follow, I examine three factors that emerge from my discussion above which may increase opportunities for groups to reduce the costs and maximise the benefits of collaboration: (1) closeness, (2) asymmetrical cognitive need, and (3) the use of explicit group level memory strategies.

Closeness

Collaborative recall experiments typically examine recall in groups of strangers (e.g., Barber et al., 2015; Barber & Rajaram, 2011a; Barber, Rajaram, & Aron, 2010; Blumen & Rajaram, 2009; Congleton & Rajaram, 2014; Finlay, Hitch, & Meudell, 2000; Harris et al., 2012; Pereira-Pasarin & Rajaram, 2011; Weldon & Bellinger, 1997; Weldon et al., 2000). Groups of strangers, however, may not reflect the sorts of groups who might work best together (Barnier et al., 2008). In day-to-day life we frequently remember with people we know and feel close to, such as our family or friends. Considering what is known from studies of social memory scaffolding, closeness may influence the success of collaborative remembering in two ways. First, close groups may have a greater sense of "we-ness" (or merged self/other) and be more sensitive and responsive to their partners' perspective and needs (Galinsky, Ku, & Wang, 2005). But it is unclear if closeness makes people more sensitive and responsive to each other, or if being sensitive and responsive to each other creates a sense of closeness. A sense of "we-ness" could influence the perceived goals of the task, perhaps creating a sense of team-focused goals and achievement, rather than a more individualistic goal focus, and lead to a coordinated approach and shared understanding of the task. Second, close groups may have had more opportunities to practice recalling together and thus be able to structure their recall with greater ease than groups comprised of strangers. As such, groups comprised of close members may be expected to show fewer costs and more benefits of collaborative recall than groups comprised of strangers. But findings on the performance of familiar groups compared to stranger groups have been mixed.

Studies comparing friends and strangers have found that groups of friends typically demonstrate a similar level of collaborative inhibition as groups of strangers when recalling simple stimuli such as word lists (e.g., Andersson & Rönnberg, 1995; Garcia-Marques, Garrido, Hamilton, & Ferreira, 2012). Even when participants encode stimuli together in an

elaborative, personally relevant manner, groups of friends appear to perform similarly to groups of strangers (Harris et al., 2013). Romantic couples recalling together have been found to recall a similar amount together as mixed gender dyads comprised of strangers (Gould, Osborn, Krein, & Mortenson, 2002). For instance, Gould et al. (2002) asked older and younger adults to perform a variety of tasks, including a word list task, with their spouse and with an unfamiliar partner of the opposite gender. Participants performed no better on the word list task when working with their spouse versus working with a stranger.

Although Gould et al.'s (2002) study did not have a nominal group condition, there is little evidence that romantic partners recalling together outperform nominal groups. For example, Ross et al. (2008) asked older and younger couples to recall items from household scenes alone or with their spouse. Both older and younger collaborative couples reported fewer correct responses than nominal groups comprised of the pooled recall of different couples recalling individually. Even when collaborative performance is compared to the group's own individual performance, older couples do not always match or outperform their nominal pooled recall. For instance, Johansson et al. (2005) asked older, long-married couples to recall a short story (episodic memory task) and to answer knowledge questions (semantic memory task) together and also alone. Johansson et al. (2005) found collaborative inhibition on the episodic but not the semantic task when collaborative performance was compared to the pooled nominal recall of the same couples working alone. This is important, as it suggests that the costs and benefits of collaboration may differ for the same groups depending on the memory task.

While traditional collaborative recall studies with romantic partners and friends show little evidence that an established relationship with a recall partner can reliably reduce the cost of collaborative inhibition, this may be because, as I noted in the previous section, groups comprised of familiar members are not homogenous. Wegner et al. (1985) discussed the

theoretically entangled nature of closeness and transactive memory systems. They proposed that transactive memory systems give people the capacity to form intimate relationships. Groups become more intimate by communicating with each other, and the information they share allows for differentiation (e.g., you learn that your partner remembers faces, but you tend to remember the names of people you meet) and integration (e.g., you both remember the holidays you have taken together) underlying an effective transactive memory system. Further, Wegner et al. (1985) claimed that an ineffective transactive memory system in a romantic partnership is a sign of intimacy failure. Due to the theoretically entangled nature of transactive memory systems and closeness, it is difficult to determine the direction of any potential benefit between feeling close to your recall partner and memory performance. More intimate groups may reminisce about shared memories (both together and alone) more frequently than less intimate couples, but this reminiscing is also likely to increase their feelings of closeness to their partner (Alea & Bluck, 2007). As such, it may not be intimacy per se driving the benefits of shared remembering in (some) of the long-married couples in Harris et al. (2011), but rather established relationship dynamics from their history of shared experiences. So in this thesis, I first use a rapid intimacy task to generate a sense of closeness in non-familiar dyads to differentiate the effect of closeness on collaborative recall without the confound of an established relationship (Experiment 1, Chapter 2).

Outside of the collaborative recall paradigm there is some evidence that a rapidly created sense of closeness between individuals with no prior relationship can alter the strategies used by dyads to solve problems. Giuliano and Wegner (as cited in Wegner et al., 1985) asked pairs of participants to complete a “Family Feud” type trivia task by independently predicting the most common response given by 100 undergraduate students to a series of probes (e.g., “Name a good candy bar”). The pairs then completed a short task designed to create a sense of closeness. In this task male/female pairs sat in chairs next to

each other but facing in opposite directions, and the experimenter instructed the pairs to wrap yarn around the two of them, swap places, and then unwrap the yarn. Pairs completed this task without speaking to each other. Participants then once again completed the trivia task, this time either working with the person they had completed the yarn task with (a close dyad) or with a different participant (a distant dyad). Giuliano and Wegner (as cited in Wegner et al., 1985) found that close dyads were more likely than distant dyads to use integrative strategies to resolve differences in individual responses. If, for example, one partner had previously said "Mars" and the other "Milky Way", close groups often elected a third option such as "Snickers". In distant groups, however, participants commonly used a compromise-based approach of alternating the individual response adopted by the group, such that one dyad member's response was selected for a question, and then the other dyad's member response was selected for the following question.

The sense of closeness generated by a rapid intimacy task, however, may not sufficiently mimic the greater level of closeness that characterises naturally occurring groups (such as couples and friends). Further, a sense of closeness without shared knowledge and experiences may not allow for optimal group performance (Wegner, 1987; Wegner et al., 1991; Wegner et al., 1985). Without metacognitive knowledge about what other group members know, or metacognitive knowledge about what processes and strategies are effective for the group, groups may not be able to reduce the costs or increase the benefits of collaboration (Liang et al., 1995; Moreland & Myaskovsky, 2000). It may take time to develop these more complex group processes. So in this thesis, I also tested romantic couples and close friends (Experiment 2, Chapter 3).

Cognitive Need

While differences in a sense of closeness may influence collaborative performance, the cognitive capacity of members in the group may also be important. Outside of

collaborative memory research, in the socio-cultural learning literatures described above, explorations of scaffolding make a distinction between the scaffolder and the scaffoldee; the scaffolder has some level of expertise that the scaffoldee lacks. It is the expertise of the scaffolder that helps to structure the experience for the scaffoldee. But in groups of healthy adults completing a novel task (e.g., recalling a word list), there may not be a clear distinction between the scaffolder and the scaffoldee, or this distinction may fluctuate between different tasks and differing expertise levels. Further, researchers in educational psychology have proposed that any benefits to collaboration will only have an opportunity to be observed when the complexity of the task is greater than an individual's cognitive capacity (Kirschner, Paas, & Kirschner, 2009; Nokes-Malach et al., 2015). In a typical collaborative recall experiment, it is possible that younger adults' high competence in independent recall and their working memory speed and capacity limits the degree to which social memory scaffolding can occur or be of benefit. In the rare example of facilitation found by Meade et al. (2009), it could be that the highly complex nature of the aviation scenarios provided more opportunities for the experts working together to use each other's contributions to cue their retrieval of more information. While Harris et al. (2011) used simple materials (a word list, and names of people in a shared social group), the older age of the participants introduces the potential for greater variation in the cognitive abilities in the sample than in studies with healthy younger adults, since normal aging is associated with a range of cognitive deficits, including in memory performance (Balota et al., 2000; Craik & Byrd, 1982), and executive functions (Allain et al., 2005; Brennan, Welsh, & Fisher, 1997; Kirova et al., 2015).

In attempts to examine the impact of cognitive resources on collaborative recall, Barber and Rajaram (2011a) used an executive functioning depletion manipulation in a study with healthy younger adults but found no evidence to suggest that depleting functioning prior to recall effected the size of the collaborative inhibition effect. In contrast, Pereira-Pasarin and

Rajaram (2011) found that a divided attention task at encoding reduced the magnitude of collaborative inhibition. Pereira-Pasarin and Rajaram (2011) suggested that this somewhat counterintuitive finding was due to those under divided attention having weaker organisational structure at encoding. Less optimal or weak organisational strategies mean that there is less to disrupt later at retrieval when collaborating, thus reducing collaborative inhibition. Since older adults have been shown to report using less optimal encoding strategies than younger adults and middle-aged adults (Hertzog, McGuire, & Lineweaver, 1998), they may also demonstrate less collaborative inhibition than younger adults. However, studies directly comparing older and young adults have found that older adults demonstrate a similar level of collaborative inhibition as young adults, suggesting that any cognitive effects of age alone are not sufficient in moderating the collaborative inhibition effect (in groups of strangers, e.g., Henkel & Rajaram, 2011; Meade & Roediger, 2009; or in couples, e.g., Ross et al., 2008). But as noted above, not all groups of the same type are homogenous. Metamemory beliefs about reduced individual memory performance may make some older adults more willing to seek and accept help on memory tasks than other older adults (Dixon, Gagnon, & Crow, 1998). Willingness to seek and accept help may promote the use of group level strategies that facilitate coordination during recall and reduce collaborative inhibition.

Sensitivity to the ability, and need for assistance, of others in the group may interact with levels of closeness. Close recall partners may, for example, be best able to modify group recall processes to minimise disruption for a cognitively vulnerable group member. Thus, since we are yet to fully understand the independent role cognitive need has on adult collaborative recall, especially when the need is asymmetrical, in this thesis I first asked stranger dyads to collaborate when one partner was under cognitive load from a divided attention task (Experiment 1, Chapter 2). Then I tested whether romantic couples and close

friends would be more sensitive to this need when one partner was likewise under cognitive load from a divided attention task (Experiment 2, Chapter 3).

Explicit Strategy Agreement

Relevant to considerations of both closeness and cognitive need on collaborative recall performance is the ability of group members to structure their recall in a coordinated manner. Collaborative processes in adult groups, just as in mother-child dyads, appear to be associated with memory performance. Whether recalling content with a stranger (Meade et al., 2009) or with a familiar partner (Harris et al., 2011; Vredeveldt, Groen, et al., 2016; Vredeveldt, Hildebrandt, et al., 2016), communication strategies such as elaborating, acknowledging, repeating, and rephrasing a recall partner's contribution are associated with greater recall than when recall partners do not use such strategies.

Further evidence for the importance of collaborative remembering processes in familiar groups can be found in Harris et al.'s (2011) study, described above. Harris et al. (2011) identified types of interactions (e.g., repeating spouse's contribution) that were associated with greater recall, and other types (e.g., corrections) that were associated with lower recall. Perhaps more informative, however, was their observation that structure without coordination or alignment was not helpful in recalling more together. For example, Harris et al. (2011) described a couple trying to remember the names of members of a shared social group. The husband tried to list the names alphabetically and eventually his wife stated that this structure did not work for her as she needed to go around the room, visually imagining each person and then his or her name (Harris et al., 2011, p. 278). This is a clear instance where each member of the group had a different approach to recalling the material and, when asked to work together, an inability to successfully coordinate their individual strategies. Similar to interactions in mother-child dyads with low autonomy support described above, the husband was persistent in his method of recall, and when his wife attempted to contribute

using his alphabetical strategy he negated her contribution. In contrast, Harris et al. (2011) described the complementary approach used by another husband and wife also trying to remember the names of members of a shared social group. In this couple, the husband tended to recall the male members of the group and the wife would then recall the name of each male members wife. The husband's recall strategy appeared to act as a series of successful cues for the wife. This approach may have been less successful if the individuals within the couple were not sensitive and receptive to their partner's contribution to the conversation.

There are few other collaborative recall studies that have directly analysed communication processes in adult groups by coding and/or counting the instances of communication strategies in the transcripts of each group's collaborative recall (which is extremely laborious, especially for large group studies). An alternative way to explore explicit strategy agreement is to ask participants how their group approached the task. Under certain conditions strangers who self-report using group strategies during collaborative recall have been shown to recall more together than strangers who do not self-report using a group level strategy. For instance, in a modified collaborative recall task, Harris et al. (2013) randomly assigned participants to either complete an (incidental) encoding phase by themselves (unshared encoding condition) or in a collaborative group of three (shared encoding condition). In both triads of strangers and triads of friends, collaborative inhibition was eliminated in the shared encoding condition but was present in the unshared encoding condition. In part this might be because the shared encoding phase, although incidental, reduced variation in individual retrieval strategies. In a post-experiment questionnaire, however, Harris et al. (2013) found a greater proportion of those in the shared encoding condition than those in the unshared encoding condition reported that their group used a strategy during recall. Furthermore, Harris et al. (2013) found a positive association between the number of group members indicating that their group used a strategy and group recall

performance. This suggests that self-reported group-level retrieval strategies are beneficial for collaborative recall. The most common strategy reported was cross-cueing each other by using the associated celebrity's name to remember the personality trait. This is a strategy that may be harder to employ in a typical collaborative recall experiment in which the categorisation of stimuli (if present) is often not explicitly stated to the participants, and the participants lack an opportunity to encode the target stimuli in a meaningful way together. The opportunity to encode a shared representation of the stimuli together, however, may be closer to the context-rich, social encoding that occurs in everyday life.

Many of the communication strategies found in Meade et al.'s (2009) and Harris et al.'s (2011) studies (described above) did not require, but also did not rule out, explicit discussion of the group's processes and strategies. Harris et al.'s (2013) study found the more group members able to (post recall) self-report their group had used a strategy, the greater the collaborative performance. In contrast, Hollingshead (1998) found that explicit discussion during encoding was beneficial to strangers working together, but detrimental to couples working together. As such, at least for unfamiliar pairs, discussing and agreeing on strategies to use during a memory task may provide a greater opportunity for scaffolding during recall by helping the group have a shared representation of the task and clearer role definitions. Whether successful scaffolding occurs from the coordinated recall structure, however, will likely still depend on how successfully group members can remain sensitive and responsive to each other. To test this I explored strategy agreement in two ways. First, at the end of each experiment I asked participants who had collaborated if they and their partner used any strategies to help them recall (Experiment 1, Chapter 2; Experiment 2, Chapter 3; Experiment 3, Chapter 4; Experiment 4, Chapter 5). Second, to more directly test the influence of explicit strategy agreement I asked some collaborative dyads to agree on a strategy prior to retrieval (Experiment 3, Chapter 4) or prior to encoding (Experiment 4, Chapter 5).

Thesis Overview

As foreshadowed above, in four laboratory experiments I extended the collaborative recall paradigm to examine the influence of closeness, cognitive need, and explicit strategy agreement on the costs and benefits of collaborative recall.

In Experiment 1 (Chapter 2) I explored the role of *closeness* on the costs and benefits of remembering with others by introducing a rapid intimacy task with stranger dyads. The yarn task used by Giuliano and Wegner (as cited in Wegner et al., 1985) (described above) may have created a sense of closeness because the task was novel and likely humorous to undertake (Fraley & Aron, 2004). The yarn task, however, has not been replicated as a method for inducing a sense of closeness. Another well-researched method for increasing the sense of closeness between pairs of strangers is to encourage mutual self-disclosure of personally relevant information (Aron, Melinat, Aron, Vallone, & Bator, 1997; Collins & Gould, 1994; Hess, Fannin, & Pollom, 2007; Sedikides, Campbell, Reader, & Elliot, 1999; Sprecher, Treger, Wondra, Hilaire, & Wallpe, 2013). So in Experiment 1, I used a modified version of Aron et al.'s (1997) intimacy task, where prior to recalling, participants took turns to ask and answer questions that were designed to either generate a rapid sense of closeness (close condition) or not to generate a rapid sense of closeness (non-close condition). In addition, I examined the role of asymmetrical *cognitive need* by placing one group member under divided attention at recall. During Recall 1, in half the dyads neither participant completed a concurrent task (no divided attention condition), and in the other half of the dyads one participant concurrently completed a task that involved monitoring and turning timers (divided attention condition). Lastly, I asked all participants to recall the word list again to explore the post collaboration and post divided attention effects on individual recall. I tested the impact of closeness and cognitive need both during collaboration and in later individual recall and I measured both amount recalled and accuracy. To examine the role of

strategy, during a post-experimental questionnaire I asked collaborative participants to self-report strategies that they and their partner had used to help them recall the word list. I expected that the magnitude of collaborative inhibition would be lower, the number of intrusions would be lower, and any post-collaborative benefits would be greater for close dyads than for non-close dyads, and in dyads with one member with additional cognitive load than in dyads when neither member had additional load. However, if a sense of closeness and cognitive need are both necessary for groups to collaborate in a manner that reduces the costs and increases the benefit of collaboration, then I expected collaborative inhibition and intrusions would be smallest and post-collaborative benefits greatest for close dyads in the divided attention condition. I also expected that self-report of group level strategies would be positively associated with collaborative performance, and thus expected to see high self-report in close dyads and in dyads with one member under load.

Since a sense of closeness without a shared past or shared knowledge might not be sufficient to structure and coordinate recall, in Experiment 2 (Chapter 3) I recruited dyads of participants in established romantic relationships and close friendships. As in Experiment 1, I also examined the role of asymmetrical cognitive need (by placing one dyad member in half the dyads under divided attention at recall) and strategy by asking the same question in the post-experiment questionnaire. Again I tested the impact of these conditions both during recall and on later individual recall, and I measured both the amount recalled and accuracy. Recruiting people in established relationships also allowed me to consider the potential influence of *what* is being recalled. The shared knowledge and experiences of familiar groups may be most useful to collaboration when the task is not novel to the group, or when it provides opportunities for this shared knowledge to be used. A word list recall task, for example, may not offer many opportunities for familiar pairs to take advantage of their shared knowledge. To explore if different types of memory tasks influence the magnitude of

collaborative inhibition, I also asked participants to recall non-personally relevant semantic information (the countries in Europe), and personally relevant semantic information (the first and last names of their mutual friends and acquaintances). I expected that in familiar young adult dyads, asymmetrical cognitive need in one partner would reduce the magnitude of collaborative inhibition, increase accuracy during collaboration, and increase any post-collaborative benefits. I also expected that more participants in the divided attention condition would report that their group had used a strategy than those in the no divided attention condition, and that self-report of group strategy would be positively associated with group recall performance.

In my final two experiments, I explored more directly the impact of *explicit strategy agreement* by introducing a phase in which half the dyads nominated a strategy to help them recall. Instructing dyads to explicitly agree on a retrieval strategy, rather than leaving its development to chance, may ensure that all groups coordinate their recall. So in Experiment 3, I recruited pairs of strangers and included an instruction to nominate a strategy to use just prior to *retrieval*. Because I was interested in how a strategy instruction may change group performance across a number of recall occasions (as groups may learn to use a strategy and implement it even when not told to), I asked participants to study and then recall three different categorised word lists. Participants assigned to the nominal condition always recalled individually (with the recall later pooled for each word list) and those in the collaborative condition always recalled together. Just prior to the second recall phase, I asked half the nominal dyads to individually nominate a strategy to help them recall the word list, and half the collaborative dyads to agree on a strategy to help them recall the word list. The remaining participants received the same instructions as the first recall phase. At the third and final recall phase all participants received the same instructions as the first recall phase. I measured the impact of this strategy instruction on collaboration both in terms of amount

recalled and accuracy. In addition, I transcribed the first conversational turns for each dyad and coded for attempts to start on the same page by coordinating their recall. I expected that if explicit agreement on a retrieval strategy helps strangers to coordinate their retrieval, then the magnitude of collaborative inhibition should be reduced, and the number of intrusions smaller, for collaborative dyads in the strategy condition at the second and third recall points. I also expected that participants in the strategy condition would be more likely to try and start on the same page as their recall partner after the strategy instruction, and that starting on the same page would be positively associated with collaborative performance.

However, explicit agreement after encoding may be too late for optimal coordination. Thus, in Experiment 4 (Chapter 5) I used the same design as Experiment 3, but moved the explicit strategy agreement to prior to *encoding*. Coordination prior to encoding may reduce diversity in individual encoding experiences (and thus individual retrieval strategies) helping groups to later structure their recall and reduce the cost of collaboration. As in Experiment 3, I measured the impact of this strategy instruction on collaboration both in terms of amount recalled and accuracy. In addition I transcribed the first conversational turns for each dyad and coded for attempts to start on the same page by coordinating their recall. I expected that if explicit agreement on an encoding strategy helps strangers to coordinate their retrieval, then the magnitude of collaborative inhibition should be reduced, and the number of intrusions smaller, for collaborative dyads in the strategy condition at the second and third recall points. I also expected that participants in strategy condition would be more likely to try and start on the same page as their recall partner, and that starting on the same page would be positively associated with collaborative performance.

Together these four experiments promise to extend the collaborative recall paradigm in significant ways, carefully manipulating conditions of closeness, cognitive need, and explicit strategy agreement. By carefully manipulating these conditions I will attempt to find

successful scaffolding, that reduces the costs while increasing the benefits of collaboration in ways that are relevant to the application of collaborative recall in everyday, educational, organisational, and aging settings.

Chapter 2

Experiment 1

Closeness, Cognitive Need, and Strategies: A Laboratory Examination of Strangers' Collaborative Recall

This experiment aimed to take the first step in my empirical program to extend the canonical collaborative recall paradigm. In this experiment, I explore the influence of a sense of closeness and asymmetrical cognitive need at retrieval on the costs and benefits of collaborative recall. A sense of closeness between members in a group may influence the collaborative strategies engaged in by the group, and thus how much and how accurately they recall. Young adults also may be more likely to attempt to scaffold another person if they perceive the other person requires assistance, for example, due to a temporary demand on the cognitive processes of one group member. Successful attempts to coordinate group recall (through scaffolding or other collaborative processes such as cross-cueing) may increase not only group productivity and accuracy during collaboration, but also individual productivity and accuracy on the subsequent recall task. To better understand how a sense of closeness and cognitive need influences the costs and benefits of collaboration while maintaining experimental control, the present study included a manipulation to make young adult strangers feel closer to each other, and a manipulation to place additional cognitive load on one group member. This not only allowed me to examine the influence of each of these factors, but also the interaction that may exist between closeness and cognitive need.

As discussed in Chapter 1, a sense of closeness may make group members more sensitive and responsive to each other, perhaps because they have developed a "we-mode" when working together (Gallotti & Frith, 2013). A sense of group identity amongst close groups (known as group cohesion) might facilitate emergent mechanisms that are thought to help collaborative performance (Evans & Dion, 1991). For example, some close romantic couples may engage in more cross-cueing behaviour and other explicit group memory strategies motivated by a focus on group goals over individual goals. A shared understanding of the task, along with sensitive and responsive interactions, make scaffolding attempts more likely to be successful (e.g., Bliss et al., 1996). To examine the contribution of closeness to

the costs and benefits of collaboration, I attempted to generate a sense of closeness in the lab using a rapid intimacy task. Whereas a rapid intimacy task may not replicate the more complex intimacy found in naturally occurring familiar groups, it allows an opportunity to disentangle closeness from the shared history common to naturally occurring groups. Thus, it offers the opportunity to explore for the first time how closeness between group members alone might influence the magnitude of collaborative inhibition and post-collaborative benefits.

Related to the question of group closeness are questions about the cognitive capacity of group members. As outlined in Chapter 1, explorations of memory scaffolding often involve groups with asymmetric cognitive capacity, with the "scaffolder" having the cognitive capacity to help the "scaffoldee" who has a cognitive need, such as a still developing memory system (e.g., Fivush et al., 2006; Reese et al., 1993; Wareham & Salmon, 2006; Wood et al., 1976), or a memory impairment (e.g., Cavanaugh et al., 1989; Hydén, 2011, 2014; Majlesi & Ekström, 2016). In addition, in healthy adults, groups may only have the opportunity to demonstrate collaborative benefits when a task is beyond an individual's competency level (Kirschner et al., 2009; Nokes-Malach et al., 2015). To date, little work has directly examined the influence of cognitive need in laboratory studies of collaborative memory, and participants typically recruited in collaborative recall experiments are unacquainted younger adults attending university. Because participants recruited from this population may assume other members in their group have a similar level of ability, they may not engage in processes to support or to seek help from other group members. Thus, the present study attempted to create asymmetrical cognitive need in younger adult participants by asking one group member to complete a divided attention task during recall. The divided attention task was introduced at retrieval, because I did not want to weaken encoding strength. Somewhat counterintuitively, weaker encoding can result in a reduction in collaborative inhibition (Pereira-Pasarin &

Rajaram, 2011). Thus, by introducing the divided attention task at recall I aimed to manipulate cognitive need only at retrieval, and not interfere with the ability of participants to encode the stimuli.

A sense of closeness alone or a sense of cognitive need alone may not influence the costs and benefits of recalling with another person. As noted in Chapter 1, in mother-child dyads (dyads in which there is an assumption of asymmetrical need), mothers who are more sensitive and responsive scaffold their child more successfully than mothers who are less supportive of their child's autonomy (Cleveland & Reese, 2005). Thus, if closeness does make group members more sensitive and responsive to other group members, then an individual with cognitive need may be best helped by a close other.

In this experiment, I aimed to examine the influence of closeness and cognitive need of the costs and benefits of collaboration. As noted above, I manipulated closeness by administering a rapid intimacy task and I manipulated cognitive need by placing one group member under divided attention during recall. I then measured participants' collaborative recall performance, individual recall performance post collaboration, self-reported retrieval strategies, and self-report of the helpfulness of collaboration. I expected that, if a sense of closeness encourages group processes that reduce the costs and increase the benefits of collaboration, then the magnitude of collaborative inhibition would be lower, the number of intrusions would be lower, and any post-collaborative benefits would be greater for close dyads than for non-close dyads. Similarly, if asymmetrical cognitive need encourages group processes that reduce the costs and increase the benefits of collaboration, then the magnitude of collaborative inhibition would be lower, the number of intrusions would be lower, and any post-collaborative benefits would be greater in dyads with one member with additional cognitive load than in dyads when neither member had additional load. However, if a sense of closeness and cognitive need are both necessary for groups to collaborate in a manner that

reduces the costs and increases the benefit of collaboration, then I expected collaborative inhibition and intrusions during collaboration would be lowest and post-collaborative benefits greatest for close dyads in the divided attention condition. I expected that self-report of group level strategies would reflect the presence of group processes that reduce the costs and increase the benefits of collaboration. If closeness and cognitive need encouraged the use of group strategies, then I expected to see high self-report in close dyads and in dyads with one member under load. Similarly, I expected that collaboration would be described as most helpful by those in close collaborative dyads and by those who collaborated when one member was under additional load.

Method

Participants and Design

Participants were recruited from two sites using convenience sampling. Participants included 152 students from Montana State University (MSU), Bozeman, United States and 148 students from Macquarie University (MQ), Sydney, Australia, tested in a 2 x 2 x 2 (Closeness (non-close, close) x Attention at Recall 1 (no divided attention, divided attention) x Dyad Type (nominal, collaborative)) between-subjects experiment. The opportunity to recruit from two undergraduate samples simultaneously arose due to a collaboration with the Meade Memory Lab at MSU, and enabled me to test for the robustness of findings across different laboratory samples (see Results for fidelity analyses between the populations). MSU participants received course credit, and MQ participants received course credit or payment of AU$15 per hour.

To maintain fidelity of the rapid intimacy task, which assumes no prior relationship, I excluded 16 dyads (9 from MSU and 7 from MQ) in which participants allocated to a dyad reported that they had met one another previously. In addition, I excluded 5 dyads (2 from MSU and 3 from MQ) for failing to follow task instructions, and 1 dyad from MSU due to a

participant being over 65 years of age, which was outside of my recruitment criteria requiring adults aged 17-50 years of age. This left a final sample of 128 participants from MSU, and 128 participants from MQ, to make a total of 128 dyads (15 male-male, 49 female-male, 61 female-female, and 3 dyads in which a participant did not report gender). Ages ranged from 17 to 45 years ($M = 20.85$, $SD = 4.74$).

Materials

Materials used in the experiment included: (1) a categorised word list, (2) a rapid intimacy task, and (3) a post-experiment questionnaire.

Word list. Participants viewed a list of 45 words presented in black Arial 24 point font sequentially in random order on a white screen using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Every participant saw the list in a different random order from one another. This same list has been previously used by Harris et al. (2012), and included words selected from a subset of 225 from the Affective Norms for English Words list (Bradley & Lang, 1999) and the Edinburgh Word Association Thesaurus (Kiss, Armstrong, Milroy, & Piper, 1973). Neutral concrete nouns (e.g., elbow), affective concrete nouns (e.g., leprosy), and affective abstract nouns (e.g., merry) are each included, with the chosen words forming 9 semantically related categories of 5 words each (see Appendix A). The experimenter did not tell participants about the categories.

Rapid intimacy task. To manipulate participants' sense of closeness to their partners, all of whom were originally strangers, I adapted Aron et al.'s (1997) rapid intimacy task. The rapid intimacy task contains two task conditions: a non-close condition, designed as a control, and a close condition, designed to generate a temporary sense of closeness through mutual self-disclosure. In the non-close condition, participants take turns asking and answering questions about opinions and experiences that are mundane and not emotive (e.g., "Do you prefer digital watches and clocks or the kind with hands? Why?"). In the close condition,

participants take turns asking and answering questions about opinions and experiences that are personally significant or emotive (e.g., “For what in your life do you feel most grateful?”).

Aron et al.’s original task included 36 questions in the non-close condition and 36 questions in the close condition, to be asked during a 45 minute sharing session. To shorten the task, which was necessary given testing time constraints, I adapted it in three ways. First, I shortened the allotted time for the task to 20 minutes. Second, I included only 24 questions from the original non-close condition (see Appendix B), and 22 questions from the original close condition (see Appendix C). Piloting suggested that this number of questions took approximately 20 minutes to answer. Third, in the original task, the questions were split into three sections, with 15 minutes allotted to each section. In the close condition each successive section contained questions requiring greater disclosure. In my adaptation, I did not want to stop the conversational flow by making dyads move onto a new set of questions after 6-7 minutes, so I removed the sections and instead split the questions between two lists, one to be given to each participant in the dyad. In the close condition, I listed the questions in increasing order of required disclosure, however, all participants were told that they could select from their list in any order. This allowed participants to select questions they were most comfortable with first, and also allowed participants to skip questions on their sheet without their partner explicitly knowing they were choosing not to ask a particular question.

Post-experiment questionnaire. At the end of the experiment, participants completed a short paper and pen questionnaire that asked for five kinds of information. First, the participants reported their basic demographic information (age, gender). Second, the participants completed the Inclusion of Other in Self (IOS) scale (Aron, Aron, & Smollan, 1992) as a measure of closeness. The IOS is a seven-item, pictorial scale designed to measure the perceived overlap between self and other. To indicate the best description of the target relationship respondents select from seven images of two circles labelled “self” and “other”

with the circles gradually increasing from no overlap to almost completely overlapping (see Appendix D). In the present study participants selected the image that best described their relationship with the other participant. Third, those in the collaborative condition answered an open-ended question about group strategy use ("Did you and your partner adopt any strategies to help you recall?") as a self-report measure of group coordination (as used in Harris et al., 2012, 2013). Fourth, participants described how helpful it is in their everyday life "to remember with someone else (e.g., a shopping list)" from five options: 1 (very unhelpful), 2 (unhelpful), 3 (neither helpful nor unhelpful), 4 (helpful), or 5 (very helpful) as a measure of beliefs about the effectiveness of collaboration during everyday remembering (adapted from Henkel & Rajaram, 2011). Those in the collaborative condition also described the helpfulness of recalling the word list with the other participant in their dyad using the same five options as a measure of beliefs about the effectiveness of collaboration during the memory task (adapted from Henkel & Rajaram, 2011). Finally, participants who completed the divided attention task described the difficulty of recalling while under divided attention from five options: 1 (very difficult), 2 (difficult), 3 (neither easy nor difficult), 4 (easy), or 5 (very easy) as self-report measure of task difficulty.

Procedure

The experiment consisted of five phases: (1) study, (2) rapid intimacy task, (3) Recall 1, (4) Recall 2, and (5) post-experiment questionnaire. Dyads were allocated to conditions using blocked randomisation. Since the rapid intimacy task required two participants, all dyad partners completed the experiment at the same time, thus there were no post-hoc nominal dyads. At the beginning of the experimental session the experimenter randomly assigned participants to be either "Partner A" or "Partner B". Research assistants from the Meade Memory Lab tested the MSU participants, and I tested the MQ participants. Procedure

training and weekly team meetings were conducted using Skype, with the MSU Lab Manager (VP) overseeing the fidelity of the testing procedure.

Study. Participants sat at individual tables, each with a computer. The experimenter told participants they would see a list of words presented sequentially on the computer monitor and their task was to try to remember these words as best they could. Each word appeared for 5 seconds with an interstimulus interval of 1 second. The verbatim instructions were:

> In a moment I'll be presenting you with a series of words on the computer screen. Each word appears for 5 seconds, and then the next one is presented automatically. Your task is to try to remember these words as best as you can. When you finish, the computer will prompt you to wait for the next task. I will give you further instructions at that time.

Rapid intimacy task. The experimenter asked participants to sit together at a table and told them that their next task was to become more familiar with each other by completing a 20-minute sharing game. The experimenter randomly allocated participants to one of two conditions (non-close or close) in the adapted rapid intimacy task (described above). In both conditions the experimenter asked participants to take turns selecting and reading aloud an item, answering for themselves, and then allowing their partner an opportunity to answer the same item. The verbatim instructions in both conditions were:

> This next task, which we think will be quite enjoyable, is simply to become more familiar with your partner by sharing some personal information about yourself and learning some personal information about them. In order to help you become more familiar, we've arranged for the two of you to engage in a kind of sharing game. Your sharing time will be for 20 minutes. Here are two different lists of questions – one for each of you. [Partner A] will begin by selecting a task or question and reading it out

loud. You will both have an opportunity to do the task or answer the question, beginning with the person who read the item out loud. Once you have both completed the item, [Partner B] will then select and read out loud a task or question from their list for you both to complete. You will continue on like this, taking turns, for the next twenty minutes.

As you go through items take your time with each task or question. Some of the items may ask you to share personal information with your partner. Sharing our thoughts and experiences can help us feel closer to other people. If, however, an item asks you to share something that makes you feel upset then do not disclose that information. Simply tell your partner that you are uncomfortable talking about that and choose a new item from your list. It is not important to finish all the items within the time allotted. Take plenty of time with each item, doing what it asks thoroughly and thoughtfully. You may complete some of the items, or all of the items, depending on the amount of time each partner takes in answering. I will let you know when twenty minutes is up and we will be moving on to the next task. If you finish the task before the twenty minutes, please just sit quietly and wait for me to tell you about the next task.

Recall 1. Immediately following the rapid intimacy task, participants completed a free recall of the word list in one of four conditions: nominal with no divided attention, nominal with divided attention, collaborative with no divided attention, or collaborative with divided attention (see Figure 2.1 for an overview of the possible allocation of roles during Recall 1 for Partner A and Partner B).

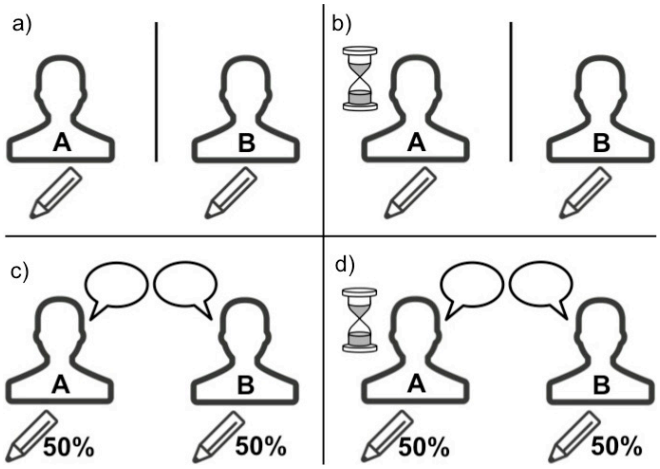

Figure 2.1. Role of Partner A and Partner B during Recall 1 by dyad type and divided attention condition: (a) nominal no divided attention; (b) nominal divided attention; (c) collaborative no divided attention; (d) collaborative divided attention. The pencil icon indicates dyad members who were asked to write down recalled items, in (c) and (d) the scribe role was randomly allocated to Partner A 50% of the time and to Partner B 50% of the time. The timer icon indicates dyad members who were required to complete the divided attention task.

In the nominal conditions participants returned to their individual tables and completed a free recall task, independently writing down as many words as they could remember from the list in four minutes. Participants could not see the other participant's recall sheet. The verbatim instructions were:

> Now you are going to complete a memory test. I need you to recall as many items as possible from the lists previously presented on the computer screen. You can recall the words in any order. You should only include a word if you are sure it was on the list. You will complete the task on your own. You will have 4 minutes to complete this task. If you feel you are finished before your time is up, please let me know.

Following these instructions, the experimenter started the recall task. In the nominal no divided attention condition, there were no additional instructions and no additional materials. In the nominal divided attention condition the experimenter asked Partner A to complete an additional divided attention task, designed to create an asymmetrical cognitive need. The experimenter asked Partner A to concurrently monitor two staggered one-minute sand timers

and turn them over every time the sand was about to run out. A small pilot study found that performance on this divided attention task was not at ceiling, and self-reports suggested that it made recall more challenging but it did not disrupt conversational norms such as eye-contact with a recall partner. The experimenter placed the timers behind a small screen so that only Partner A could see the timers. The verbatim instructions were:

> In addition, you [Partner A] have been randomly assigned to complete an additional task at the same time as you are recalling. Your extra task involves turning over these sand timers just before the sand runs all the way out. When the task starts I'll turn over one timer, then I'll wait for a little bit before I turn over the second timer. While you are recalling, you will need to continuously monitor the sand and turn over the timers every time the sand gets low. Please keep the timers behind this screen. Your performance on both the recall task and the sand timer tasks are equally important. Please try to split your attention and effort equally between turning the sand timers and recalling the word list. I will point out your error if you forget to turn over a sand timer.

In the collaborative conditions participant dyads worked together to recall as many words as possible in four minutes. The experimenter asked participants to remain at the table together, and randomly assigned the scribe role to either Partner A or Partner B, counterbalanced across conditions. The experimenter audio-recorded all collaborative sessions. The verbatim instructions were:

> Now you are going to complete a memory test. I need you to recall as many items as possible from the lists previously presented on the computer screen. You can recall the words in any order. What I want you to do is work together to recall as many of the words from the lists as you can. If it's alright with you I'll be recording what you say. Could you [scribe] write down the words that you both agree were on the list. Place

> the recall sheet where your partner can also see it. For each word that is remembered, you should only write it down if you both agree that it was on the list. You will have 4 minutes to complete this task. If you feel you are finished before your time is up, please let me know.

Following these instructions, the experimenter started the recall task. In the collaborative no divided attention condition there were no additional instructions and no additional materials. In the collaborative divided attention condition the experimenter asked Partner A to complete the same additional cognitive load task during recall as completed by Partner A in the nominal divided attention condition. As in the nominal divided attention condition, screens were placed between participants so that Partner B knew Partner A was completing the additional task but could not see Partner A's progress or performance.

Recall 2. Following Recall 1, the experimenter removed the timers and small screen from those in the divided attention conditions, and asked those in the collaborative conditions to return to their individual tables. All participants then immediately completed an independent free recall task, writing down as many words as possible in 4 minutes. The verbatim instructions were:

> Now I want you to again recall as many items as you can from the original word list. I will give each of you a sheet of paper and you are both to write down as many items as you can remember from the lists. You should only write down a word if you are sure it was on the list. This time, you will [once again] complete the task on your own. You will again have 4 minutes to complete this task.

Post-experiment questionnaire. Following Recall 2, participants independently completed a short questionnaire as described above. At the end of the experimental session participants were fully debriefed, given an opportunity to ask questions about the experiment, and thanked for their time.

Scoring and Coding

Recall performance. At Recall 1, my unit of analysis was dyad performance. To calculate the proportion of correctly recalled words for nominal dyads, I pooled the non-redundant recall on the word list for each dyad member and then divided this total pooled recall by 45 (the total number of words on the list). To calculate the proportion of correctly recalled words for collaborative dyads, I simply counted the number of words each dyad correctly recalled and then divided this total by 45, as in the nominal dyads.

I calculated participant errors in two distinct ways. First, for each dyad I created raw intrusion scores. For nominal dyads, I counted the number of non-redundant, incorrectly recalled words by each dyad member. To create raw intrusion scores for collaborative dyads, I simply counted the number of incorrectly recalled words by each dyad. This allowed me to explore the basic pattern of intrusions. Second, since the number of raw intrusions could simply reflect the productivity of the dyad (e.g., nominal dyads recalling more intrusions because they recall more words total, both incorrect and correct, than collaborative dyads), I also calculated the proportion of intrusions in recall relative to correct recall for each dyad. I did this by dividing the raw intrusion score by the sum of the number of correctly recalled words and the raw intrusion score:

$$Proportion\ of\ intrusions = \frac{Raw\ intrusion\ score}{(Number\ correctly\ recalled\ words\ +\ raw\ intrusion\ score)}$$

This latter calculation enabled me to explore if any differences in mean raw intrusions between conditions were reflective of increased/decreased accuracy, or were simply a by-product of how much dyads were able to recall in total.

At Recall 2, consistent with the collaborative recall literature, my unit of analysis was individual performance as I was interested in the costs or benefits to individuals following collaboration, and not exploring the collective or shared memory overlap of the dyad unit following collaboration. To calculate the proportion of correctly recalled words I counted the

number of words each individual participant recalled and then divided this total by 45 (the total number of words on the list). To create raw intrusion scores, I counted the number of incorrectly recalled words by each participant. In addition to these raw intrusion scores, for each participant I also calculated the proportion of intrusions in recall by dividing the raw intrusion score by the sum of the number of correctly recalled words and the raw intrusion score (as above).

Coding of self-reported group strategy use. To examine how self-reported group recall strategies used in the collaborative conditions might relate to recall performance, I drew on the post-experiment questionnaire, which asked participants to respond to the open-ended question "Did you and your partner adopt any strategies to help you recall?". I piloted a coding scheme that classified the different types of group strategies that participants reported, including categorisation, presentation order, turn taking, and elaboration (e.g., associating words to their own or other's experiences, making stories using the words). I found that this granular coding offered no greater insight into group performance than a simplistic yes/no coding of agreement or disagreement with the statement. In addition, some participants responded "yes" without giving a description of their strategy and using a more specific coding scheme meant that these participants were not included. Thus, I only report on the yes/no coding. Since I was interested only in how participants perceived group processes, I made no judgment on the effectiveness of the reported strategy. A response was coded as "no strategy" if the participant stated "no" or "not really", even if they then described group behaviour that could be considered as a group level strategy (e.g., "No, not really, just using the themes of the words" was scored as "no strategy", despite seemingly reflecting the implicit use of organisation). I coded responses as "reported a group strategy" if the participant reported that their group had used a strategy, regardless of the potential efficacy of

the strategy (e.g., "Yes, we seemed to think the same way" was scored as "reported a group strategy").

Collaborative Processes. As described in Chapter 1, previous researchers have tried to explore the nuances of collaborative recall by transcribing and coding for instances of processes such as acknowledgements, elaborations, repetitions, and corrections. Typically these studies focus on a much smaller number of collaborative groups than the 64 collaborative groups I used (e.g., Harris et al. (2011) tested just 12 collaborative couples, Vredeveldt, Hildebrandt, et al. (2016) tested 18 collaborative dyads, Vredeveldt, Groen, et al. (2016) tested 20 collaborative dyads; and Meade et al. (2009) reported process coding for 16 collaborative dyads). I piloted an approach similar to Meade et al. (2009) and transcribed and coded the top five performing collaborative groups in each condition. Ultimately, however, this was not informative, in part because of the relatively simple memory task I used. For example, in one of my best performing collaborative groups both recall partners said very little aside from listing the words they each remembered. Thus, I do not report any collaborative process coding for this experiment

Results

I present a series of five analyses: (1) costs and benefits during collaboration, (2) costs and benefits post collaboration, (3) effectiveness of the closeness and cognitive need manipulation, (4) self-reported group strategy use in collaborative dyads, and (5) helpfulness of collaboration.

For fidelity, prior to conducting the analyses described below, I compared the MSU and MQ samples on the proportion of list correctly recalled at Recall 1, intrusions at Recall 1, proportion of list correctly recalled at Recall 2, and intrusions at Recall 2. I performed four separate 2 x 2 x 2 x 2 Analyses of Variance (ANOVAs). In all four ANOVAs, Closeness (non-close, close), Attention at Recall 1 (no divided attention, divided attention), Dyad Type

(nominal, collaborative) and Sample (MSU, MQ) were each entered as independent between-subjects variables. In all four analyses, I found a significant main effect for sample, suggesting that MSU participants compared to MQ participants recalled a smaller proportion of correct words at Recall 1 (M = 0.40, SD = 0.12 vs. M = 0.51, SD = 0.13), $F(1, 112) = 25.44$, $p < .001$, $\eta_p^2 = .19$; had more intrusions at Recall 1 (M = 1.66, SD = 1.52 vs. M = 1.08, SD = 1.34), $F(1, 112) = 10.67$, $p = .001$, $\eta_p^2 = .09$; recalled a smaller proportion of correct words at Recall 2 (M = 0.30, SD = 0.11 vs. M = 0.39, SD = 0.13), $F(1, 240) = 36.14$, $p < .001$, $\eta_p^2 = .13$; and had more intrusions at Recall 2 (M = 1.62, SD = 1.98 vs. M = 1.17, SD = 1.36), $F(1, 240) = 8.90$, $p = .003$, $\eta_p^2 = 0.04$. Most importantly, in all four ANOVAs there were no significant interactions between sample population and Closeness, Attention at Recall 1, or Dyad Type suggesting that the observed differences between the two samples were consistent across conditions. Given the lack of interaction between sample population and any of the manipulated factors, I combined the samples together for the analyses presented below.

Costs and Benefits During Collaboration

Amount recalled. At Recall 1, the proportion of the word list correctly recalled by dyads ranged from .13 to .80 (see Table 2.1 for means). To explore the effect of my experimental manipulations on Recall 1 performance, I conducted a 2 x 2 x 2 ANOVA. Closeness (non-close, close), Attention at Recall 1 (no divided attention, divided attention), and Dyad Type (nominal, collaborative) were each entered as independent between-subjects variables and correct recall was entered as the dependent variable. This ANOVA revealed only a significant main effect of Dyad Type, $F(1, 120) = 9.35$, $p = .003$, $\eta_p^2 = .07$. This main effect reflects an overall collaborative inhibition effect: collaborative dyads recalled a smaller proportion of the 45-word list than did nominal groups (see Figure 2.2). No other main effects were significant, all Fs < 2.01, all ps >.159, and there were no significant interactions, all Fs <

1.36, all *p*s >.245, suggesting that the collaborative inhibition effect was consistent across closeness and cognitive need manipulations.

Table 2.1
Mean Proportion of Word List Recalled at Recall 1 by Closeness, Attention at Recall 1, and Dyad Type

	Non-close		Close	
Condition	M (SD)	95% CI	M (SD)	95% CI
No divided attention				
Nominal[a]	0.46 (0.12)	[0.39, 0.52]	0.53 (0.15)	[0.45, 0.60]
Collaborative[a]	0.40 (0.10)	[0.35, 0.46]	0.40 (0.11)	[0.34, 0.46]
Divided attention				
Nominal[a]	0.48 (0.15)	[0.40, 0.56]	0.49 (0.11)	[0.43, 0.55]
Collaborative[a]	0.41 (0.15)	[0.33, 0.48]	0.46 (0.14)	[0.38, 0.53]

Note. CI = confidence interval.
[a]*n* = 16 dyads

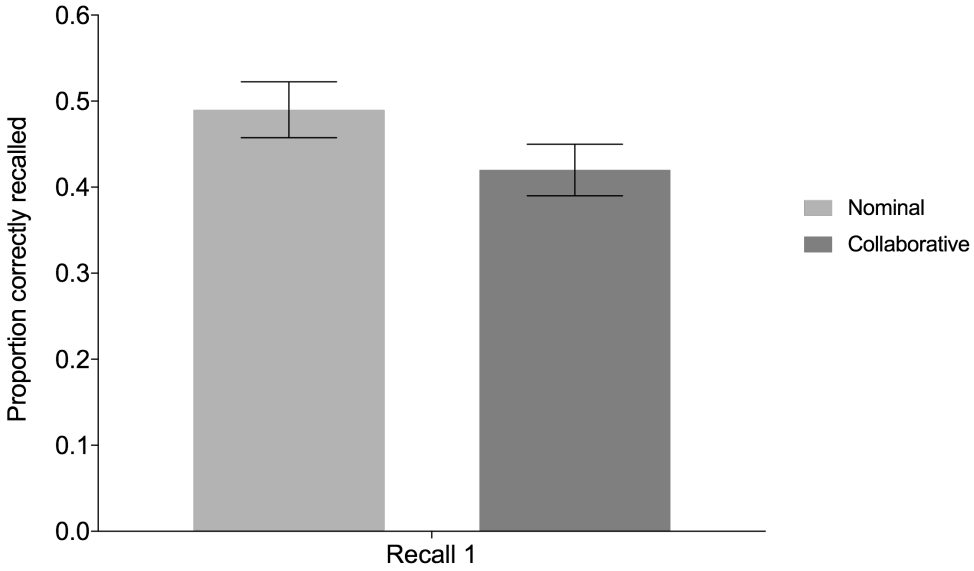

Figure 2.2. Mean proportion of word list correctly recalled by nominal and collaborative dyads at Recall 1. Error bars indicate 95% CI.

Intrusions. At Recall 1, dyad intrusion scores ranged from 0 to 6 (see Table 2.2 for means). To explore the effect of my experimental manipulations on the number of intrusions recalled by dyads, I performed a 2 x 2 x 2 ANOVA. This ANOVA revealed only a significant main effect of Dyad Type, $F(1, 120) = 14.83$, $p < .001$, $\eta_p^2 = .11$. This main effect reflects a collaborative benefit: collaborative dyads ($M = .89$, $SD = 1.04$) recalled fewer intrusions than nominal dyads ($M = 1.84$, $SD = 1.65$). No other main effects were significant, all Fs < .67, all ps > .441, and there were no significant interactions, all Fs < 1.15, all ps > .285. The lower mean number of intrusions produced by collaborative groups could be a result of collaborative groups simply producing fewer words (correct and incorrect) in total than nominal groups. As such, I also performed a 2 x 2 x 2 ANOVA on the proportion of recall that contained intrusions. As above, this ANOVA revealed only a significant main effect of Dyad Type, $F(1, 120) = 5.56$, $p = .020$, $\eta_p^2 = .04$. This main effect reflected that collaborative dyads ($M = 0.05$, $SD = 0.07$) had a lower intrusion rate than nominal dyads ($M = 0.08$, $SD = 0.08$). It should be noted that I observed generally low rates of intrusions, thus a lack of main effect of Attention at Recall 1, and the lack of an interaction effect could be due to a floor effect. Taken together, however these results suggest collaboration increased accuracy, and that this benefit was consistent across closeness and cognitive need manipulations.

Table 2.2
Mean Raw Intrusion Scores at Recall 1 by Closeness, Attention at Recall 1, and Dyad Type

	Non-close		Close	
Condition	M (SD)	95% CI	M (SD)	95% CI
No divided attention				
Nominal[a]	1.69 (1.40)	[0.94, 2.43]	1.94 (1.6 5)	[1.06, 2.82]
Collaborative[a]	1.00 (1.15)	[0.38, 2.62]	1.25 (1.06)	[0.68, 1.82]
Divided attention				
Nominal[a]	1.75 (1.73)	[0.83, 2.67]	2.00 (1.93)	[0.97, 3.03]
Collaborative[a]	0.75 (1.24)	[0.09, 1.41]	0.56 (0.51)	[0.29, 0.84]

Note. CI = confidence interval.
[a]*n* = 16 dyads

Costs and Benefits Post Collaboration

Amount recalled at Recall 2. At Recall 2, the proportion of the word list correctly recalled by individuals ranged from .04 to .67 (see Table 2.3 for means). To explore the effect of my experimental manipulations on subsequent individual recall, I performed a 2 x 2 x 2 ANOVA. This ANOVA revealed only a significant main effect of Dyad Type, $F(1, 248) = 15.49$, $p < .001$, $\eta_p^2 = .06$. This main effect reflects a post-collaborative benefit: individuals who previously collaborated recalled a greater proportion of the word list than individuals who previously recalled alone (see Figure 2.3). No other main effects were significant, all *F*s < 1.53, all *p*s >.217, and there were no significant interactions, all *F*s < 1.43, all *p*s >.233, suggesting that the post-collaborative benefit was consistent across closeness and cognitive need manipulations.

Table 2.3
Mean Proportion of Word List Recalled at Recall 2 by Closeness, Attention at Recall 1, and Dyad Type

	Non-close		Close	
Condition	M (SD)	95% CI	M (SD)	95% CI
No divided attention				
Nominal[a]	0.30 (0.11)	[0.26, 0.34]	0.33 (0.14)	[0.28, 0.38]
Collaborative[a]	0.36 (0.12)	[0.31, 0.40]	0.36 (0.11)	[0.32, 0.40]
Divided attention				
Nominal[a]	0.32 (0.16)	[0.26, 0.37]	0.31 (0.11)	[0.27, 0.35]
Collaborative[a]	0.38 (0.12)	[0.33, 0.42]	0.42 (0.14)	[0.37, 0.46]

Note. CI = confidence interval.
[a]*n* = 32 individuals

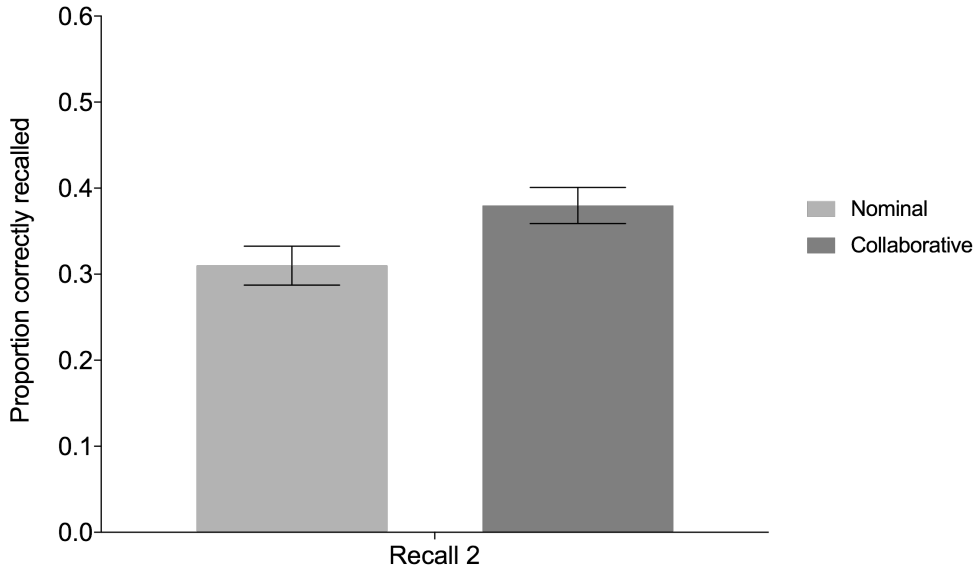

Figure 2.3. Mean proportion of word list correctly recalled by individuals at Recall 2 by previous Dyad Type. Error bars indicate 95% CI.

Intrusions. At Recall 2, individual intrusion scores ranged from 0 to 8 (see Table 2.4 for means). To explore the effect of my experimental manipulations on the number of intrusions recalled by individuals, I performed a 2 x 2 x 2 ANOVA. This ANOVA found no significant main effects, all *F*s < 1.93, all *p*s >.166, and no significant interactions, all *F*s <

2.14, all *p*s >.145. As for Recall 1, I calculated average intrusions as a proportion of total words recalled, and performed another 2 x 2 x 2 ANOVA. This ANOVA also revealed no significant main effects, all *F*s < 0.96, all *p*s >.329, and no significant interactions, all *F*s < 1.32, all *p*s >.252. These results suggest that individuals who previously collaborated were as accurate as individuals who previously recalled alone, and accuracy was consistent across closeness and cognitive need manipulations. As in Recall 1, however, these null findings could be due to a floor effect since I observed generally low rates of intrusions at Recall 2.

Table 2.4
Mean Raw Intrusion Scores at Recall 2 by Closeness, Attention at Recall 1, and Dyad Type

	Non-close		Close	
Condition	M (SD)	95% CI	M (SD)	95% CI
No divided attention				
Nominal[a]	1.13 (1.34)	[0.64, 1.61]	1.28 (1.73)	[0.66, 1.90]
Collaborative[a]	1.47 (2.05)	[0.73, 2.21]	1.63 (1.62)	[1.04, 2.21]
Divided attention				
Nominal[a]	1.28 (1.51)	[0.74, 1.82]	1.31 (1.80)	[0.66, 1.96]
Collaborative[a]	2.03 (2.04)	[1.30, 2.77]	1.06 (1.44)	[0.54,1.58]

Note. CI = confidence interval.
[a]*n* = 32 individuals

Closeness and Cognitive Need Manipulations

Since I found no significant effect of my closeness and cognitive need manipulations on collaborative or post-collaborative performance, I examined: (1) the effectiveness of the rapid intimacy task, (2) individual performance when under divided attention or no divided attention, and (3) the perceived difficulty of recalling for those under divided attention.

Closeness. To test if the rapid intimacy task was effective in increasing closeness, I calculated the average dyad score for each dyad on the 7-point IOS. Average dyad IOS scores

ranged from 1.00 to 5.00. I performed a 2 x 2 x 2 ANOVA, which revealed only a significant main effect of Closeness, $F(1, 120) = 4.15$, $p = .044$, $\eta_p^2 = .03$. This main effect reflects higher average dyad IOS scores for close dyads ($M = 2.82$, $SD = 0.81$) than non-close dyads ($M = 2.73$, $SD = 0.81$). There were no other significant main effects, all Fs < 1.09, all ps > .298, and no significant interactions, all Fs < 2.55, all ps > .113. These findings suggest that the rapid intimacy task was successful in manipulating closeness between stranger pairs, although it was not a strong effect, and that neither subsequent Dyad Type nor Attention at Recall 1 influenced perceived closeness. Given the small difference between the averaged IOS scores in non-close dyads and close dyads, I also ran an exploratory correlation between average dyad IOS scores and the proportion of Recall 1 in the collaborative dyads only. The correlation was very low and not significant, $r = .007$, $p = .955$. The sense of closeness in the collaborative dyads was not associated with collaborative recall performance.

Individual performance under divided attention. To examine if the divided attention task successfully added cognitive load, I examined the individual performance at Recall 1 of the 128 participants in the nominal condition. The proportion of correct words recalled by individuals in the nominal condition at Recall 1 ranged from 0.04 to 0.64. In the divided attention condition, Partner A participants turned the timers, while in the no divided attention condition neither Partner A nor Partner B turned the timer. If the divided attention task successfully added cognitive load, Partner A's performance should be impaired relative to Partner B's performance in the divided attention condition but not in the no divided attention condition. To test for this interaction, I performed a 2 x 2 ANOVA. Partner Allocation (Partner A, Partner B) and Attention at Recall 1 were each entered as independent between-subjects variables and correct recall entered as the dependent variable. This ANOVA found no significant main effects, all Fs < 1.07, ps > .304, and no significant interaction, F =

0.37, $p = .545$. The lack of an interaction suggests that the divided attention task did not add enough cognitive load to impair retrieval.

Difficulty recalling in divided attention condition. Since the divided attention task might not have been challenging enough to impair individual recall performance, I examined difficulty of recall descriptions (see Table 2.5 for frequency of responses). Of the 64 participants who completed the divided attention task at Recall 1, 14.06% described the difficulty of remembering while turning the timers as "very difficult", 35.93% as "difficult", 28.13% as "neither easy nor difficult", 17.19%, as "easy", and 4.68% as "very easy". Given the ordinal nature of this data I conducted a nonparametric test on the proportion of difficulty responses between the nominal and collaborative conditions in the non-close or the close conditions and found no differences, Mann-Whitney U = 98.00, $p = .226$, and Mann-Whitney U = 95.00, $p = .200$ respectively. This suggests that, while the divided attention task may not have been perceived as challenging for half the sample, the nominal and collaborative conditions reported similar levels of perceived difficulty.

Table 2.5
Frequency of Difficulty Recalling Under Divided Attention by Closeness and Dyad Type

Condition	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy
Non-close					
Nominal[a]	4 (25.00%)	7 (43.75%)	2 (12.50%)	2 (12.50%)	1 (6.25%)
Collaborative[a]	0 (0.00%)	8 (80.00%)	7 (43.75%)	1 (6.25%)	0 (0.00%)
Close					
Nominal[a]	2 (12.50%)	3 (18.75%)	4 (25.00%)	6 (37.50%)	1 (6.25%)
Collaborative[a]	3 (18.75%)	5 (31.25%)	5 (31.25%)	2 (12.50%)	1 (6.25%)

[a] $n = 16$ individuals

To explore if there was a difference in the magnitude of collaborative inhibition in dyads in which the partner under divided attention found recalling "very difficult" or "difficult", and dyads in which the timer turner rated the recalling as "neither easy nor difficult", "easy", or "very easy", I split the sample and conducted two analyses. First, I examined the 32 dyads (16 nominal, 16 collaborative) in which the timer turner found recalling under divided attention "very difficult" or "difficult" and a t-test revealed no evidence of collaborative inhibition: collaborative dyads (M = 0.44, SD = 0.15) and nominal dyads (M = 0.46, SD = 0.12) recalled a similar proportion of the words, $t(130) = 0.40$, $p = .693$, d = 0.15. Second, I examined the 32 dyads (16 nominal, 16 collaborative) in which the timer turner found recalling while under divided attention "neither easy nor difficult", "easy", or "very easy". A t-test revealed a non-significant trend towards a collaborative inhibition effect; collaborative dyads (M = 0.43, SD = 0.13) recalled a smaller proportion of the word list than nominal dyads *(*M = 0.51, SD = 0.13), $t(30) = 1.76$, $p = .089$, d = .64. While care needs to be taken interpreting these analyses due to reduced power from splitting the sample, they hint that when those under divided attention reported that recalling was challenging, there was no cost to collaboration. Indeed, collaboration may have been helpful under these challenging circumstances, offering some compensation to the dyad member's recall. When divided attention added little or no cognitive load, however, individuals did not have a need that could be met from a collaborative partner, and thus showed the usual collaborative cost.

Self-Reported Group Strategy Use

Of the 128 participants in the collaborative condition, 53 (41.40%) reported that their group tried to use a strategy to help recall. I calculated the number of pairs in which neither partner, one partner, or both partners reported a group strategy (see Table 2.6). Chi Square tests found no difference in the proportion of dyad members reporting a group strategy across the experimental conditions, all χ^2s < 4.4, all ps > .109. This finding suggests, somewhat

surprisingly, that the closeness and cognitive need manipulations did not influence how individuals in collaborative dyads perceived coordination during recall.

Self-reported group strategy use and Recall 1 performance. I explored the association between self-reported group strategy use and the proportion of the list recalled at Recall 1 (see Table 2.5 for means). I only analysed Recall 1 performance because this was when collaboration occurred. A one-way ANOVA revealed a significant effect of self-reported group strategy on Recall 1 performance, $F(2, 61) = 4.95$, $p = .010$, $\eta_p^2 = .14$. Follow-up Helmert contrasts indicated that pairs in which neither dyad member self-reported group strategies recalled a smaller proportion of the list than pairs in which one dyad member or both dyad members self-reported a group strategy, $t(61) = 2.84$, $p = .006$. The contrast also revealed a marginal trend for higher recall performance in dyads in which both dyad members self-reported a group strategy compared to dyads in which only one dyad member self-reported a group strategy, $t(61) = 1.85$, $p = .069$. These findings suggest that collaborative recall was lowest when there was no indication that the group tried to coordinate their retrieval, and highest when both dyad members reported an attempt to coordinate their retrieval.

Table 2.6
Mean Proportion of Word List Recalled at Recall 1 by Number of Members in Dyad Self Reporting a Group Strategy

Strategy reported	*M* (*SD*)	95% CI
Neither dyad member[a]	.37 (.11)	[.33, .41]
One dyad member[a]	.42 (.13)	[.37, .48]
Two dyad member[b]	.49 (.11)	[.43, .56]

Note. CI = confidence interval.
[a] $n = 25$ dyads
[b] $n = 15$ dyads

Helpfulness of Collaboration

During collaboration. The majority (88.19%) of those in the collaborative condition rated recalling with the other dyad member as "helpful" or "very helpful" (see Table 2.7 for frequency of responses). Due to the ordinal nature of the data, to test for differences in the proportion of responses between conditions I conducted non-parametric tests. A test for differences in the distribution of responses between those in the no divided attention and divided attention conditions revealed a non-significant result, Mann-Whitney U = 408.00, p = .119. I split the sample and considered the non-close and close conditions separately, and still found no significant difference in the distribution of responses, Mann-Whitney U = 471.50, p = .524, and Mann-Whitney U = 481.50, p = .604 respectively. These results suggest that, despite finding the typical collaborative inhibition effect, most participants thought collaborating on the task was helpful, but neither the closeness nor cognitive manipulation influenced this perception of helpfulness.

Table 2.7
Frequency of Helpfulness During Collaboration Responses by Closeness and Attention at Recall 1

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
Non-close					
No divided attention[a]	0 (0.00%)	2 (6.25%)	3 (9.38%)	22 (68.75%)	5 (15.63%)
Divided attention[a]	0 (0.00%)	2 (6.3 %)	3 (9.4%)	19 (59.4%)	8 (25.00%)
Close					
No divided attention[a]	0 (0.00%)	1 (3.13%)	2 (6.25%)	24 (75.00%)	5 (15.63%)
Divided attention[a]	0 (0.00%)	0 (0.00%)	3 (9.38%)	22 (68.75%)	7 (21.88%)

[a] n = 32 individuals

In everyday life. The majority (83%) of participants described recalling with others in everyday life as "helpful" or "very helpful" (see Table 2.8 for frequency of responses). Given the ordinal nature of the data I conducted non-parametric tests to examine the difference in the proportion of responses between those in the nominal and collaborative condition. Notably, a greater proportion of those in the collaborative condition than in the nominal condition described collaboration as "very helpful", Mann-Whitney U = 6817.00, $p = 0.025$. This finding suggests that undertaking a collaborative task increased the endorsement of collaboration as very helpful in an everyday context.

Table 2.8
Frequency of Helpfulness of Collaboration in Everyday Life Responses by Dyad Type

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
Nominal[a]	1 (0.8%)	8 (6.3%)	17 (13.5%)	68 (54.0%)	32 (25.4%)
Collaborative[b]	0 (0.0%)	1 (0.8%)	16 (12.6%)	64 (50.40%)	46 (36.2%)

[a] $n = 126$ individuals
[b] $n = 127$ individuals

Discussion

This experiment was the first step in my empirical program, and aimed to extend existing collaborative recall research by experimentally manipulating and examining the influence of closeness and cognitive need on collaborative recall performance. Consistent with previous collaborative recall studies, I found the typical robust collaborative inhibition effect: collaborative dyads recalled a smaller proportion of the word list than nominal dyads (Basden et al., 1997; Weldon & Bellinger, 1997). On a subsequent individual test I found a post-collaborative benefit: individuals who previously collaborated recalled a greater proportion of the word list than individuals who previously recalled alone (Barber & Rajaram, 2011b; Blumen & Rajaram, 2008, 2009; Blumen et al., 2014; Congleton & Rajaram, 2011,

2014; Henkel & Rajaram, 2011). Also consistent with previous findings, I found collaborative dyads were more accurate than nominal dyads (Congleton & Rajaram, 2011; Harris et al., 2012, 2013; Hyman et al., 2013; Ross et al., 2008), although this increased accuracy did not flow on to the subsequent individual test. Contrary to my hypotheses, however, the magnitude of all these collaborative costs and benefits was not influenced by closeness, cognitive need, or the combination of these factors.

Consistent with previous studies, I found a positive association between reporting a group strategy and collaborative recall performance (Harris et al., 2013). My findings suggest that, for pairs of strangers, collaborative performance is better if at least one person has an explicit group strategy in mind. This echoes the scaffolding literature described in Chapter 1. In these young, healthy adults, those groups who were able to get on the same page found more of a benefit to collaboration than those who were less able to coordinate their recall. Despite finding the typical collaborative inhibition effect, most of those in the collaborative condition thought that collaborating on the task was helpful. Also consistent with previous studies, those who previously collaborated were more likely to endorse collaborating in everyday life as very helpful (Henkel & Rajaram, 2011). This lends some support to collaboration being about more than the pure output of the group. The experiential quality of recalling together seems to be different from recalling alone.

The sense of closeness generated by the rapid intimacy task did not influence collaborative group performance, post-collaborative individual performance, or self-reports of group level strategies. There are two possible explanations for these null findings. First, it may be the case that while the rapid intimacy task did generate a greater sense of closeness, my shorter version of the original task was a weak manipulation. It could be that collaborative benefits can only be seen in intimate groups if some criterion of closeness is met, and the small amount of closeness generated by the rapid intimacy task was not sufficient. Thus, the

dyads may not have sought help from, or responded anymore sensitively to, the other dyad member since experientially they felt like they were recalling with a stranger. Second, as suggested in Transactive Memory theories, transient intimacy without a shared past may be insufficient to modify how groups collaborate (Wegner, 1987; Wegner et al., 1991; Wegner et al., 1985). Naturally occurring familiar, close dyads (such as friends and romantic partners) have opportunities to engage in, and practice, remembering together. This exposure to shared remembering overtime may help coordinate shared remembering, making collaboration less disruptive and reducing collaborative inhibition. This is analogous to the teamwork literature, which highlights the importance of letting teams learn together rather than training in parallel (e.g., Liang et al., 1995), and that cohesion interventions are more effective than closeness interventions (Rosh, Offermann, & Van Diest, 2012). Practice encoding and recalling together might be important for close pairs to benefit most from collaborative enhancing mechanisms and reduce the impact of the collaborative processes that impair recall. However, even if I had included dyads with some form of shared history in the present study, it should be noted that a word list task of the kind used in the present study may not best reflect how familiar groups typically recall together since previous experience remembering in everyday settings may not be generalisable to this less context-rich type of memory task (Andersson & Rönnberg, 1995).

The cognitive need manipulation also was not sufficient to drive collaborative facilitation. I thought that having one participant under additional cognitive load at Recall 1 might reduce collaborative inhibition and perhaps boost post-collaborative recall. Instead, the divided attention task had no significant effect on performance at either recall point. I also expected that the divided attention task might result in more participants self-reporting a group level strategy than in the no divided attention condition, as this would suggest that the challenge of the task made individuals look outside themselves for assistance, and made the other dyad member proactive in providing structure to the recall. Again, I found no evidence

to support this hypothesis. It is possible that, in contrast to theoretical assumptions implicit in scaffolding work, an asymmetrical sense of cognitive need is not related to collaborative recall in healthy adults. It is also possible, however, that my cognitive need manipulation was simply insufficient in generating sufficient need in the majority of participants since I found no impairment in individual recall for those completing the divided attention task. Further, only half of those under divided attention rated recalling while monitoring the timers as "difficult" or "very difficult". Thus, one limitation of my analysis of the impact of divided attention was that I only asked those who completed the timer task how difficult it was to recall. If I asked all participants how difficult it was to recall then I could compare difference in difficulty ratings between partners in the no divided attention and in the divided attention task. It is possible that (relative to their partners who were not under divided attention) those completing the timer task found recalling difficult. I did find one hint, however, that collaboration was beneficial when participants felt a sense of cognitive load. When the person under divided attention reported difficulty recalling, collaborative dyads and nominal dyads recalled the same amount; in other words collaborative inhibition was abolished. However, if the person under divided attention reported less difficulty recalling, I saw the typical collaborative inhibition effect. This difference in the pattern of collaborative inhibition suggests that when the retrieval context is challenging enough, a group member may look for external assistance outside their own memory systems, or their recall partner may recognise the need to provide assistance, and collaboration can compensate.

This experiment was my first step in extending the collaborative paradigm in an attempt to bridge the gap between cases of everyday group remembering and the canonical laboratory paradigm by manipulating the sense of closeness and cognitive need in young adults. I successfully generated a sense of closeness between members of previously unacquainted dyads, although this did not effect the magnitude of collaborative inhibition.

This lack of effect may be because the closeness generated was too weak, or because a shared history is integral to close collaborative groups being able to optimally recall together. Thus, in Experiment 2 I recruited participants in established relationships who not only have a higher degree of closeness, but also have shared knowledge and experiences. Although my results suggest that my cognitive need manipulation may also have been too weak, when it did successfully make recall difficult there was a hint it reduced the magnitude of collaborative inhibition. To further explore the role of cognitive need in collaborative performance and processes, in Experiment 2 I increased the difficulty of the timer task. Finally, despite the persistence of collaborative inhibition, participants generally found collaboration helpful, and when group members reported using a group strategy they recalled more together than when no attempt to coordinate was reported. As the scaffolding literature would suggest, "getting on the same page" is crucial to collaborative recall performance. I continue to explore this in Chapter 3.

Chapter 3

Experiment 2

Closeness, Cognitive Need, and Strategies: A Laboratory Examination of Romantic Couples' and Close Friends' Collaborative Recall

In this experiment, as in Experiment 1, I aimed to explore the roles of closeness and cognitive need in the costs and benefits of collaborative recall. Given the lack of findings for closeness or cognitive need in Experiment 1 I made three changes to the method to increase potential differences between dyads and offer a stronger test of these important parameters. First, instead of experimentally generating a sense of closeness amongst strangers, I recruited romantic couples and pairs of close friends, as these established groups already have a much stronger sense of closeness. Second, in addition to a word list task, I asked participants to complete a non-personally relevant semantic memory task and a personally relevant semantic task. The purpose of these two new tasks was to explore if tasks that provided more opportunity for the couples and close friends to tap into shared knowledge and experiences influenced costs or benefits of collaboration. Third, given that some participants did not find the original divided attention task difficult, I increased cognitive need by increasing the difficulty of the divided attention task.

In the previous chapter, I discussed how the findings of Experiment 1 can be interpreted in multiple ways. While it is possible that closeness does not influence collaborative performance, it is also possible that the sense of closeness generated by my rapid intimacy task was too weak. Although participants in the close condition reported greater closeness than those in non-close condition, it is possible that, instead of a linear effect of closeness, there is some kind of closeness threshold that this manipulation did not meet. It is possible also that the closeness manipulation might not have had an effect on the costs and benefits of collaborative recall because it is not closeness alone, but rather in combination with shared experiences and metacognitive knowledge, that help groups work effectively together (Wegner, 1987; Wegner et al., 1991; Wegner et al., 1985). If a greater sense of closeness helps groups respond sensitively to each other's contributions, and structure or coordinate their retrieval, then the magnitude of collaborative inhibition may be reduced and

accuracy and post-collaborative benefits may be increased for romantic partners and close friends.

If shared knowledge is also important, then the type of memory task may be crucial. Specifically, shared knowledge in familiar groups may be most useful to collaboration when the content of the task offers an opportunity to use it. For instance, discussing semantic information that is personally relevant may offer more opportunities for familiar pairs to use their shared knowledge compared to a word list task. To explore if different types of memory tasks influence the magnitude of collaborative inhibition, in this experiment I asked participants to recall non-personally relevant semantic information (the countries in Europe), and personally relevant semantic information (names of their shared friends and acquaintances) in addition to the same word list as in Experiment 1. I predicted that the magnitude of collaborative inhibition might be smaller if familiar young adult dyads can use their shared knowledge and experiences to minimise collaborative costs and maximise collaborative benefits. Collaborative inhibition might also be minimised for the semantic European countries task, since previous research with couples has found an attenuation of collaborative inhibition on semantic tasks (Johansson et al., 2005). If familiar young adult dyads can use their shared knowledge and experiences to minimise collaborative costs and maximise collaborative benefits, this might only occur in tasks that allow opportunities for their shared knowledge and experiences to be useful to the task content.

As in Experiment 1, I again wanted to explore how asymmetrical cognitive need affects collaborative recall. Since only 50% of the timer turners in Experiment 1 described the difficulty of recalling while under divided attention as “very difficult” or “difficult”, I increased the difficulty of the divided attention task in the current experiment by using timers that needed to be turned over more frequently. I expected that in familiar young adult dyads, asymmetrical cognitive need in one partner at retrieval may encourage the use of

collaborative strategies to scaffold recall, reducing the magnitude of collaborative inhibition and increasing accuracy. I also expected that individuals who previously collaborated while they or their partner were experiencing cognitive need would increase any post-collaborative benefit to subsequent individual recall.

In addition to the measures of recall, as in Experiment 1, I was interested in self reports of group strategy use. If, in familiar young adult dyads, asymmetrical cognitive need at retrieval increases sensitive and responsiveness, and helps coordinate retrieval, then I expected that more participants in the divided attention condition would report that their group had a strategy and that it was helpful to their recall.

Method

Participants and Design

Participants included 32 romantic couples and 32 pairs of close friends (n = 128) recruited from the Macquarie University community in Sydney, Australia tested in a 2 x 2 (Attention at Recall 1 (no divided attention, divided attention) x Dyad Type (nominal, collaborative)) between-subjects experiment. Participants received course credit or payment of AU$15 per hour. All couples had been in a romantic relationship for at least one year and all close friends had been friends for at least one year. The age of participants in romantic couples ranged from 17 to 43 years (M = 21.36, SD = 5.30), with length of relationship ranging from 1 to 12.83 years (M = 2.74; SD = 2.58). All were heterosexual couples. The age of participants in close friendships ranged from 18 to 28 years of age (M = 19.52, SD = 2.16), with length of relationship ranging from 1 to 13.50 years (M = 5.06; SD =3.09). Close friend dyads were comprised of 1 male-female, 8 male-male, and 23 female-female dyads.

Materials

Materials used in the experiment included: (1) the Personal Assessment of Intimacy in Relationships (PAIR) questionnaire, (2) a categorised word list, and (3) a post-experiment questionnaire.

Personal Assessment of Intimacy in Relationships (PAIR) questionnaire. The PAIR is a measure of relationship intimacy in romantic couples (Schaefer & Olson, 1981). To ensure the scale was appropriate for both couples and close friends, I removed the sexual intimacy subscale. The adapted version contained a total of 30 items and included five subscales: (1) emotional intimacy, (2) social intimacy, (3) intellectual intimacy, (4) recreational intimacy, and (5) conventionality (to measure idealisation of the relationship). Each subscale included six statements, such as "My partner/friend listens to me when I need someone to talk to". Participants rated their agreement with each statement based on their relationship "as it is now" on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Items are summed (with reverse scoring as appropriate) to create each subscale score.

Word list. I used the same list of 45 words as in Experiment 1 (Chapter 2). As in Experiment 1, I presented the words in lowercase, one at time, in black Arial 24 point font on a white screen using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). The presentation order of the words was randomised, and every participant saw the list in a different random order.

Post-experiment questionnaire. Participants completed a short questionnaire (presented using the Qualtrics online survey platform (Qualtrics, Provo, UT)) that asked for four kinds of information. First, the questionnaire asked participants to report their basic demographic information (age, gender) and the length or relationship with their partner or friend. Second, the questionnaire included the Inclusion of Other in Self (IOS) scale (Aron, Aron, & Smollan, 1992) as a measure of closeness (as in Experiment 1, see Appendix D).

Third, those in the collaborative condition answered an open-ended question about group strategy use ("Did you and your partner adopt any strategies to help you recall?") for each memory task as a self-report measure of group coordination (as in Experiment 1). Fourth, participants described the helpfulness of recalling with others in everyday life as a measure of beliefs about the effectiveness of collaboration during everyday remembering (as in Experiment 1). Those in the collaborative condition also described the helpfulness of recalling with their partner or friend on each task as a measure of beliefs about the effectiveness of collaboration during the memory tasks (as in Experiment 1). Finally, those who completed the divided attention task described how difficult it was to recall as a self-report measure of task difficulty (as in Experiment 1).

Procedure

The experiment consisted of five phases: (a) completing the PAIR, (b) study and elicitation, (c) Recall 1, (d) Recall 2, and (e) post-experiment questionnaire. I tested each dyad together, thus there were no post-hoc nominal dyads.

Completing the PAIR. Participants sat at individual tables, each with a computer and completed the PAIR. I presented the PAIR using Qualtrics (Qualtrics, Provo, UT). I asked participants to complete the questionnaire independently without discussing their answers with their partner or friend.

Study and elicitation. Participants completed three tasks independently: (a) study a word list, (b) elicit the names of countries in Europe, and (c) elicit the names of shared friends and acquaintances.[1] An elicitation phase was included for the European countries task to

[1] I also asked participant to list shared weekend outings. However, I found the interpretation of this task varied considerably. For example, some participants gave very detailed descriptions of each outing, while others wrote vague descriptions (e.g., went to movies). This made it difficult to compare and pool responses. As a consequence, I do not report performance on this task.

establish a baseline measurement of this geographical knowledge, and for the shared friends task to establish a baseline measurement of the number of shared friends. I counterbalanced the order of these tasks.

Study word list. I told participants they would see a list of words presented sequentially on the computer monitor and their task was to try to remember these words as best they could. Each word appeared for 5 seconds with an interstimulus interval of 1 second. The verbatim instructions were the same as in Experiment 1.

List the countries in Europe. I asked participants to independently write down a list of as many countries in Europe as possible in 3 minutes. The verbatim instructions were:

> I would like you to list all of the countries in Europe. That is, try to list as many countries in Europe as you can think of. Please write them down on this piece of paper. I will give you 3 minutes to do this task.

List shared friends and acquaintances. I asked participants to independently write down the first and last names of as many mutual friends and acquaintances as possible in 3 minutes. The verbatim instructions were:

> I would like you to write down a list of all of your mutual friends and acquaintances that you share with each other. In other words, I want you to write down all of the people that you both know. Please only list the people for whom you know both their first names and last names. If you do not know their last name, please do not mention them. Also, please do not say their relationship to others, so for example write “John Smith”, rather than “my friend's boyfriend”. Also, please do not include your own or the other participant’s family members on your list. I will give you 3 minutes to do this task.

If participants asked for clarification about who counted as a mutual friend or mutual acquaintance I told them that they both had to have had met the person, although the friend or

acquaintance may know one of them better than the other. For example, Partner A might be good friends with John Smith. If Partner B had never met John Smith, then neither participant could include John Smith. If, however, Partner B had met John Smith then both participants could include John Smith on their list.

Distractor task. I asked participants to solve as many multiplication problems as possible in 3 minutes.

Recall 1. Immediately following the distractor task, I randomly allocated participants to one of four conditions: nominal no divided attention, nominal with divided attention, collaborative with no divided attention, or collaborative with divided attention (as in Experiment 1). I then asked participants to complete three recall tasks by: (a) recalling the word list, (b) listing the names of countries in Europe, and (c) listing the names of shared friends and acquaintances. Participants completed these tasks in the same order as they had been administered during the study and elicitation phase. In the nominal conditions participants completed all tasks individually at separate tables and were not able to see the other participant's recall sheet, and in the collaborative condition participants completed all tasks together sitting at the same table. In the collaborative conditions, Partner A always acted as scribe.

In the no divided attention condition, I asked neither participant to complete an additional task, and in divided attention conditions I asked Partner A to complete an additional task during recall (see Figure 3.1 for an overview of the possible allocation of roles during Recall 1 for Partner A and Partner B). The divided attention task involved monitoring two sand timers (one 10 s timer, and one 30 s timer) while they were completing each recall task; turning them over every time the sand was about to run out. A small pilot study with a 10 s and a 30 s timer found that pilot participants did not perform at ceiling on the divided attention task, and self-reports suggested that the task made recall challenging, but

participants were still able to engage in conversational norms with their partner. I placed the timers behind a small screen so that only Partner A could see the timers. For the first Recall 1 task, the instructions were the same as in Experiment 1. Because in the present study more than one recall task was completed under divided attention, following the recall task instructions for each subsequent memory task, I told participants:

> In addition, you [Partner A] have again been assigned to complete an additional task at the same time as you are recalling. Just like last time your extra task involves turning over these hourglasses just before the sand runs all the way out. Please keep the timers behind this screen. Just like last time your performance on both the recall task and the hourglass tasks are equally important. Please try to split your attention and effort equally between turning the hourglasses and recalling. I will point out your error if you forget to turn over an hourglass, or if you turn an hourglass over too soon.

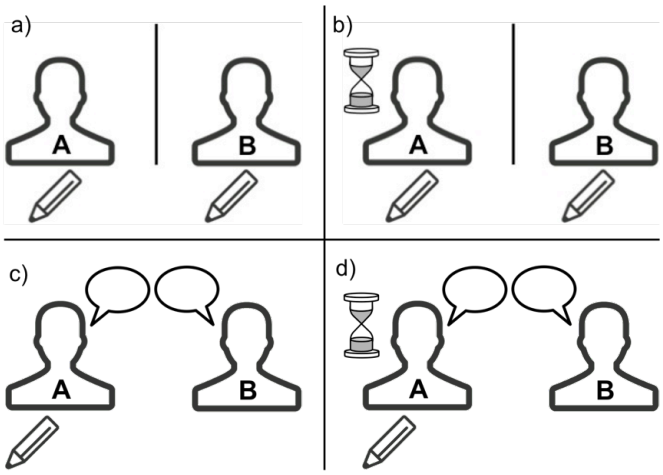

Figure 3.1. Role of Partner A and Partner B during Recall 1 by dyad type and divided attention condition: (a) nominal no divided attention; (b) nominal divided attention; (c) collaborative no divided attention; (d) collaborative divided attention. The pencil icon indicates dyad members who were asked to write down recalled items, in (c) and (d) the scribe role was always allocated to Partner A. The timer icon indicates dyad members who were required to complete the divided attention task.

Recall word list. I asked participants to recall as many words as they could from the word list. I gave participants 4 minutes to recall as many words as possible, but allowed them to stop recalling earlier if they felt they exhausted their memory. The verbatim instructions were the same as in Experiment 1 for both the nominal and collaborative conditions.

List the countries in Europe. I asked participants to once again list as many countries in Europe as they could in 3 minutes. In the nominal conditions, the verbatim instructions were:

> I would like you again to list all of the countries in Europe, giving it a fresh go. That is, try to remember as many countries in Europe as you can. Again, I will give you 3 minutes to do this task.

In the collaborative conditions the verbatim instructions were:

> I would like you to work together to list all of the countries in Europe, giving it a fresh go. That is, try to remember as many countries in Europe as the two of you can together. Again, I will give you 3 minutes to do this task. Could you [Partner A] write down the countries you both agree are in Europe. Place the recall sheet where your partner can also see it. For each country that is remembered, you should only write it down if you both agree that it is in Europe.

List shared friends and acquaintances. I asked participants to once again list the first and last names of as many mutual friends and acquaintances as they could in 3 minutes, giving the task "a fresh go". In the nominal conditions the verbatim instructions were:

> Next, I would like you to again recall a list of all of your mutual friends and acquaintances, giving it a fresh go. In other words, I want you to write down all of the people that you both know. As I said previously, please only list the people for whom you know both their first and last names and do not include family members in your list. I will give you 3 minutes to do this task.

In the collaborative conditions the verbatim instructions were:

> I would like you to work together to recall a list of all of your mutual friends and acquaintances that you share with one another, giving it a fresh go. In other words, I want you to write down all of the people that you both know. I will give you 3 minutes to do this task. As I said previously, please only list the people for whom you know both their first and last names and do not include family members in your list. I will give you 3 minutes to do this task.

If participants asked if both members of the dyad had to know the first and last name of each friend I told them they could work together to remember the full name of the person as long as they both agreed they knew the person.

Recall 2. Following Recall 1, I removed the timers and small screen from those in the divided attention conditions, and asked those in the collaborative conditions to return to their individual tables. All participants then immediately completed the three memory tasks independently, in the same order as they had been administered previously. The verbatim instructions for all tasks were the same as the nominal instructions during Recall 1.

Post-experiment questionnaire. Following Recall 2, participants independently completed a short questionnaire, as described above. The verbatim instructions were modified from Experiment 1 to reflect the relationship between the dyad members:

> This questionnaire is about you, your relationship with your partner/friend, and the tasks you have done today. Please answer every question, even if it doesn't apply to you that well. Answer as honestly as you can what is true for you. Please do not select something because it seems the right thing to say. Please do not discuss your answers with your partner/friend.

At the end of the experimental session, participants were fully debriefed, given an opportunity to ask questions about the experiment, and thanked for their time.

Scoring and Coding

Word list. At Recall 1, my unit of analysis was dyad performance and at Recall 2 my unit of analysis was individual performance, as I was interested in the costs or benefits to individuals following collaboration, and not exploring the collective or shared memory overlap of the dyad unit following collaboration. I calculated the proportion of correctly recalled words, number of intrusions, and proportion of intrusions at Recall 1 for each dyad as in Experiment 1. I calculated the proportion of correctly recalled words, number of intrusions, and proportion of intrusions at Recall 2 for each individual as in Experiment 1.

European countries. I scored correct responses using the United Nations list of European countries (United Nations, 2014). At Recall 1, my unit of analysis was dyad performance and at Recall 2 my unit of analysis was individual performance, as I was interested in the costs or benefits to individuals following collaboration, and not exploring the collective or shared memory overlap of the dyad unit following collaboration. I wanted to examine the change in dyad performance from Elicitation to Recall 1, and the change in individual performance from Elicitation to Recall 2. Thus, I calculated two baseline measurements at Elicitation: (1) the pooled non-redundant number of European countries listed by each dyad, and (2) and the number of European countries listed by each individual. At Recall 1, I calculated the pooled non-redundant number of European countries listed by nominal dyads and counted the number of European countries listed by collaborative dyads. At Recall 2, I simply counted the number of European countries listed by individuals.

Shared friends and acquaintances. To score correct responses I counted the number of people with both first and last name listed. At Recall 1, my unit of analysis was dyad performance and at Recall 2 my unit of analysis was individual performance as I was interested in the costs or benefits to individuals following collaboration, and not exploring the collective or shared memory overlap of the dyad unit following collaboration. I wanted to

examine the change in dyad performance from Elicitation to Recall 1 and the change in individual performance from Elicitation to Recall 2. Thus, I calculated two baseline measurements at Elicitation: (1) the pooled non-redundant number of names listed by each dyad, and (2) and the number of names listed by each individual. At Recall 1, I calculated the pooled non-redundant number of names listed by nominal dyads and counted the number of names listed by collaborative dyads. At Recall 2, I simply counted the number of names listed by individuals.

Average PAIR dyad scores. I created dyad PAIR scores by averaging Partner A and Partner B's scores on each subscale. It should be noted that these average dyad PAIR might not reflect the closeness score of both dyad members. For example, if a dyad scored 20, Partner A may have a score of 10 and Partner B a score of 30, or both partners may have a score of 20. The intimacy within the first example and the second example is not the same. While this is not how the PAIR scale is typically used, since I planned to correlate PAIR scores with dyadic recall performance, this was the most effective way to create a dyad level score from the individual questionnaire data.

Coding of self-reported group strategy use. To explore self-reported group recall strategies, I examined responses from participants in the collaborative condition to three open ended questions relating to each memory task: "Did you and your partner adopt any strategies to help you recall the word list/European countries/your mutual friends and acquaintances?". I used the same coding scheme as in Experiment 1 to reflect my interest in the report of participants' belief that their group used a strategy, and to keep my approach to these two similar experiments as consistent as possible. As in Experiment 1, I made no judgment of the effectiveness of the reported strategy.

Collaborative Processes. As in Experiment 1, in the present experiment I tested many more dyads than are typically tested in studies that use detailed collaborative process coding.

Given my unsuccessful attempt at coding only the top performing collaborative dyads in Experiment 1, I was reluctant to try coding the top five performers on each task in the present experiment. The memory tasks in the present experiment were relatively simplistic and may not have provided much opportunity for collaborative processes such as elaboration to be easily scored. Thus, I do not report any collaborative process coding for this experiment.

Results

I present a series of five analyses: (1) costs and benefits during collaboration, (2) costs and benefits post collaboration, (3) level of closeness and effectiveness of cognitive need manipulation, (4) self-reported group strategy use in collaborative dyads, and (6) helpfulness of collaboration responses.

One participant did not follow task instructions on the European countries task and another participant did not follow task instructions on the shared friends task. I therefore removed these participants and their recall partners from all analyses relating to the appropriate recall task.

Although my intention was to consider romantic couples and close friends together, as both are examples of close and familiar pairs, I also tested for differences between these samples by including relationship type as a variable in all analyses I report below. Where there was any indication of a difference between the couples and close friends I report not only the combined findings, but separate analyses for each relationship type. When there was no indication of a difference between the couples and close friends I report only the combined findings. In addition, since couples were significantly older than close friends, and their relationships were significantly shorter, I ran all the analyses I report below with age (individual age for individual performance, mean age of dyad for dyad performance) included as a covariate, and with relationship length included as a covariate. All these analyses showed

no change to significant effects, thus I do not report the analyses with these covariates included.

Since I counterbalanced task order, I also conducted preliminary tests in which task order (first, second, last) was entered as a between-subjects factor in all analyses described below. I found no evidence that the order of tasks influenced participants' performance on any task. Therefore, I did not include task order in my final analyses.

To ensure that dyads had similar productivity prior to my manipulations, I also conducted preliminary analyses of the dyad Elicitation scores and preliminary analyses of the individual Elicitation scores on both the European countries task and the shared friends task to test for any differences between conditions. I found no evidence to suggest any of these baseline scores differed, all Fs < 2.93, all ps > 0.133.

Costs and Benefits During Collaboration

Amount recalled. ***Word list.*** At Recall 1, the proportion of the word list correctly recalled by dyads ranged from .22 to .84 (see Table 3.1 for means). I conducted a 2 x 2 ANOVA. Attention at Recall 1 (no divided attention, divided attention) and Dyad Type (nominal, collaborative) were each entered as independent between-subjects variables and proportion of the 45-word list correctly recalled was entered as the dependent variable. I found only a significant main effect for Dyad Type, $F(1, 60) = 4.91$, $p = .031$, $\eta_p^2 = .07$. This finding reflects collaborative inhibition: collaborative dyads recalled a smaller proportion of the word list than nominal dyads (see Figure 3.2). I found no significant main effect of Attention at Recall 1, $F(1, 60) = 0.01$, $p = .980$, and no significant interaction, $F(1, 60) = 0.39$, $p = .536$. These results suggest that in this sample of close and familiar young adults, the only cost to dyadic recall of the word list was the typical collaborative inhibition effect.

Table 3.1
Dyads' Mean Pooled Elicitation and Mean Recall 1 Performance by Attention at Recall 1, and Recall Dyad at Recall 1

	Pooled Dyad Elicitation		Dyad Recall 1	
Condition	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
		Word list proportion of total correct		
No divided attention				
Nominal[a]	-	-	0.51 (0.10)	[0.46, 0.56]
Collaborative[a]	-	-	0.43 (0.09)	[0.38, 0.48]
Divided attention				
Nominal[a]	-	-	0.49 (0.13)	[0.42, 0.56]
Collaborative[a]	-	-	0.45 (0.11)	[0.39, 0.51]
		European countries recalled		
No divided attention				
Nominal[a]	22.56 (9.20)	[17.66, 27.47]	24.44 (9.08)	[19.60, 29.27]
Collaborative[b]	17.47 (7.76)	[13.17, 21.77]	16.80 (7.41)	[12.70, 20.90]
Divided attention				
Nominal[a]	18.63 (6.71)	[15.05, 22.20]	20.44 (6.95)	[16.74, 24.14]
Collaborative[a]	18.56 (4.99)	[15.90, 21.22]	18.94 (4.89)	[16.33, 21.54]
		Shared friends recalled		
No divided attention				
Nominal[a]	24.63 (11.32)	[18.59, 30.66]	28.38 (14.22)	[20.80. 35.95]
Collaborative[a]	25.13 (7.26)	[21.26, 28.99]	24.94 (5.63)	[21.94, 27.94]
Divided attention				
Nominal[b]	20.87 (9.75)	[15.47, 26.26]	22.87 (9.80)	[17.44. 28.29]
Collaborative[a]	26.75 (11.77)	[20.48, 33.02]	23.63 (8.58)	[19.05, 28.20]

Note. CI = confidence interval.
[a]*n* = 16 dyads
[b]*n* = 15 dyads

European countries. The number of European countries generated by dyads ranged from 8 to 43 at Elicitation, and from 7 to 44 at Recall 1 (see Table 3.1 for means). I conducted a (2) x 2 x 2 mixed ANOVA to test for gains and losses in the number of European countries recalled by dyads between Elicitation and Recall 1. Time (Elicitation, Recall 1) was entered as a within-subject variable, Attention at Recall 1, and Dyad Type were both entered as independent between-subjects variables, and the number of European countries recalled was entered as the dependent variable. I found a significant main effect of Time, $F(1, 59) = 7.41$, $p = .009$, $\eta_p^2 = .11$, and a significant Time x Dyad Type interaction, $F(1, 59) = 10.17$, $p = .002$, $\eta_p^2 = .15$. This finding reflects a collaborative inhibition effect: collaborative dyads overall gained fewer countries than nominal dyads from Elicitation to Recall 1 (see Figure 3.3). I found no other significant main effects, all Fs < 3.91, all ps > .053, and no other significant interactions, all Fs < 7.83, all ps > .380. These results suggest that, in this sample of close and familiar young adults, the only cost to dyadic recall of the European countries was the typical collaborative inhibition effect.

Shared friends. The number of shared friends generated by dyads ranged from 5 to 56 at Elicitation, and from 2 to 51 at Recall 1 (see Table 3.1 for means). As for European countries, I conducted a (2) x 2 x 2 mixed ANOVA to test for gains and losses in the number of shared friends recalled by dyads between Elicitation and Recall 1. I found again only a significant Time x Dyad Type interaction, $F(1, 59) = 13.74$, $p < .001$, $\eta_p^2 = .19$. This finding reflects a collaborative inhibition effect: collaborative dyads overall gained fewer names of friends than nominal dyads from Elicitation to Recall 1 (see Figure 3.4). I also found a marginal Time x Attention at Recall 1 interaction, $F(1, 59) = 3.67$, $p = .060$, $\eta_p^2 = .06$. Although the effect size is small, this finding hints at a divided attention cost: dyads in the divided attention condition lost names of shared friends from Elicitation to Recall 1 and those in the no divided attention condition gained names (see Figure 3.5). I found no other

significant main effects, all *F*s < 0.99, all *p*s > .323, and no significant 3-way interaction, $F(1, 59) = 0.24$, $p = .629$. These results suggest that there was both a typical collaborative inhibition cost to recalling personal semantic items with a partner or close friend, and a hint of a cost from the divided attention task. The divided attention task did not, however, influence the magnitude of collaborative inhibition.

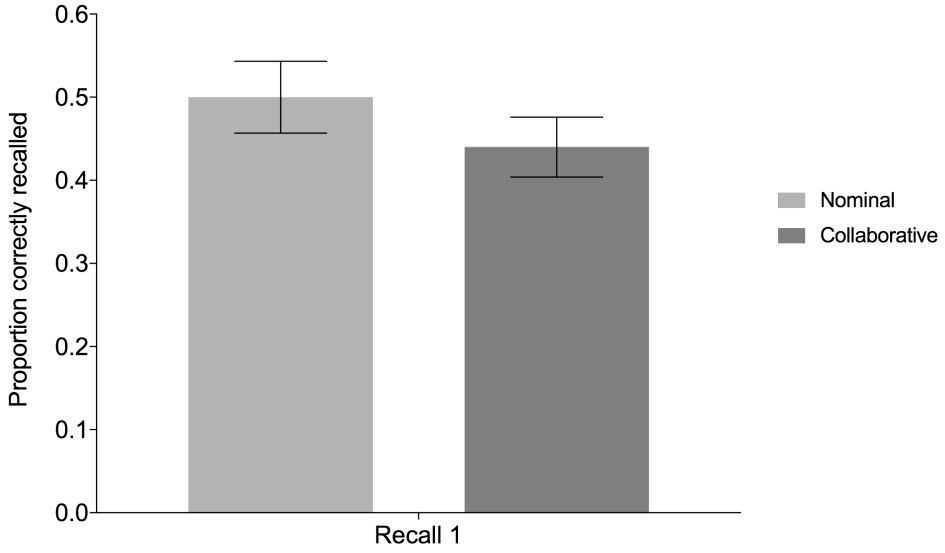

Figure 3.2. Mean proportion of word list correctly recalled by nominal and collaborative dyads at Recall 1. Error bars indicate 95% CI.

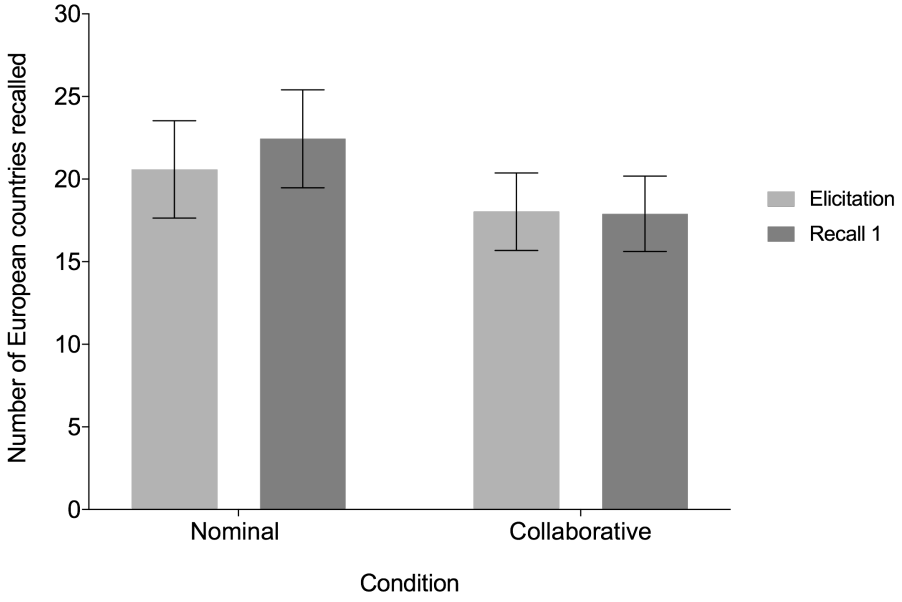

Figure 3.3. Mean number of European countries recalled by nominal and collaborative dyads at Elicitation and Recall 1. Error bars indicate 95% CI.

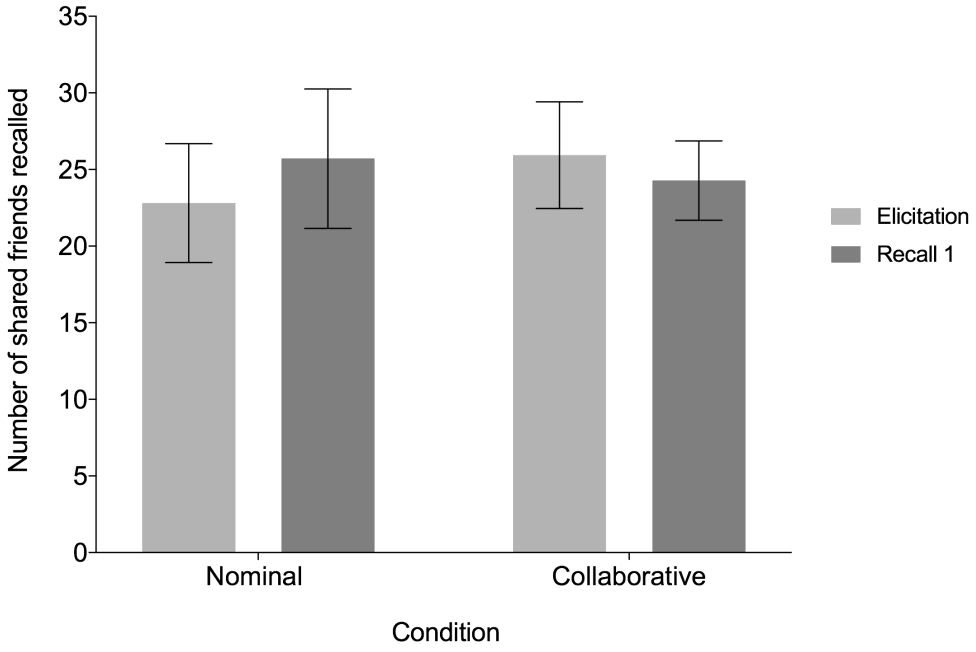

Figure 3.4. Mean number of shared friends recalled by nominal and collaborative dyads at Elicitation and Recall 1. Error bars indicate 95% CI.

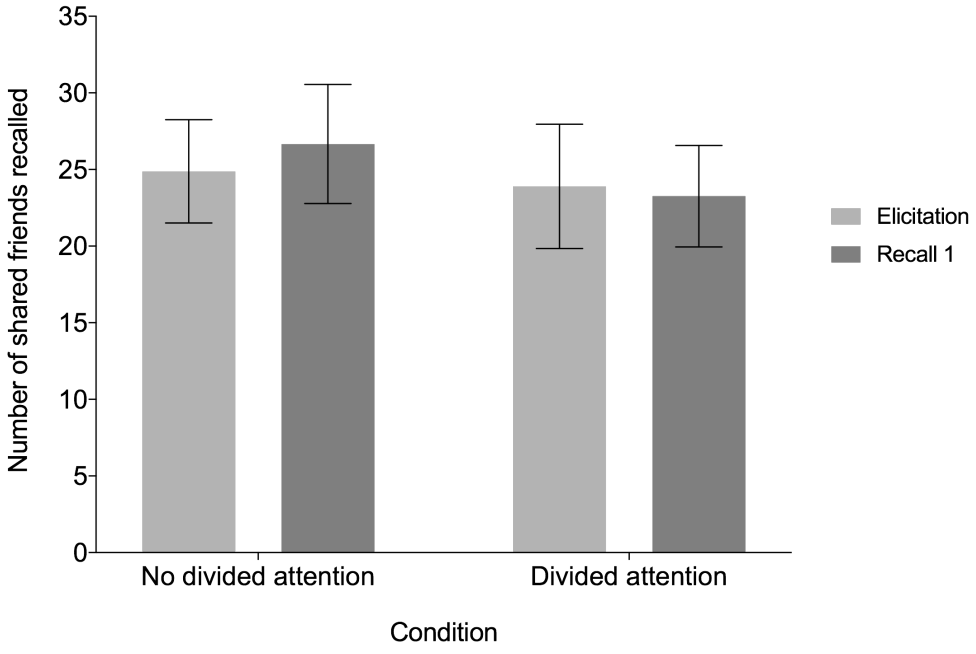

Figure 3.5. Mean number of shared friends recalled by nominal and collaborative dyads at Elicitation and Recall 1. Error bars indicate 95% CI.

As mentioned above, I tested for differences in performance between couples and close friends on all recall tasks by adding Relationship Type (couple, close friend) as an additional independent between-subjects variable. On the shared friend task a (2) x 2 x 2 x 2 mixed ANOVA revealed a significant Time x Relationship Type x Attention at Recall 1 interaction, $F(1, 55) = 6.51$, $p = .014$, $\eta_p^2 = .11$. To explore how couples and close friends may have performed differently on this task, I conducted two post hoc analyses. First, I used a (2) x 2 x 2 mixed ANOVA (as above) to test for gains and losses in the number of shared friend recalled by couple dyads ($n = 31$ dyads) between Elicitation and Recall 1. This analysis revealed no significant main effects, all Fs < 0.31, all ps > .583, and no significant interactions, all Fs < 2.80, all ps > .106. Second, I used a (2) x 2 x 2 mixed ANOVA (as above) to test for gains and losses in the number of shared friends recalled by friend dyads ($n = 32$ dyads) between Elicitation and Recall 1. I found a significant Time x Dyad Type interaction, $F(1, 28) = 16.44$, $p < .001$, $\eta_p^2 = .37$. This finding reflects a collaborative inhibition effect: collaborative close friend dyads lost names ($M = -2.00$, $SD = 5.89$), but nominal close friend dyads gained names ($M = 4.06$, $SD = 4.04$) between Elicitation and Recall 1. I also found a significant main effect of Attention at Recall 1, $F(1, 28) = 4.99$, $p = .034$, $\eta_p^2 = .15$, and a significant Time x Attention at Recall 1 interaction, $F(1, 28) = 12.62$, $p = .001$, $\eta_p^2 = .31$. This interaction reflects a cost of divided attention: friends in the divided attention condition ($M = -1.63$, $SD = 6.31$) lost names of shared friends, while friends in the no divided attention condition ($M = 3.69$, $SD = 3.96$) gained names of shared friends between Elicitation and Recall 1. I found no other significant main effects, all Fs < 1.90, all ps > .179, and no significant 3-way interaction, $F(1, 28) = 2.14$, $p = .155$. While care needs to be taken when interpreting these analyses due to the reduction in power by splitting the sample (although both significant findings in the close friends sample indicate medium to large effects), these post hoc analyses suggest that there was no cost of collaboration or divided

attention in the couple dyads, whereas there was both a cost of collaboration and a cost of divided attention for close friend dyads when recalling personally relevant semantic information.

Intrusions. At Recall 1, dyad intrusion scores on the word list task ranged from 0 to 9 (see Table 3.2 for means). As above for the analysis of the proportion of the word list correctly recalled, I conducted a 2 x 2 ANOVA on dyad intrusion scores. This ANOVA revealed only a significant main effect of Dyad Type, $F(1, 60) = 7.01$, $p = .001$, $\eta_p^2 = 1.05$. This finding reflects a collaborative benefit: collaborative dyads recalled fewer intrusions ($M = 1.09$, $SD = 1.91$) than nominal dyads ($M = 2.53$, $SD = 2.40$). I found no other significant main effect, $F(1, 60) = 1.33$, $p = .254$, and no significant interaction, $F(1, 60) = 0.33$, $p = .567$. Since the lower number of intrusions could reflect the overall lower number of words recalled by collaborative dyads, I also conducted a 2 x 2 ANOVA on the proportion of recall containing errors and, as above, found only a significant main effect of Dyad Type, $F(1, 60) = 4.41$, $p = .040$, $\eta_p^2 = .068$. These results suggest that only collaboration offered an accuracy benefit on the word list task in these close and familiar dyads.

Table 3.2
Dyads' Mean Number of Intrusions at Recall 1 by Attention at Recall 1 and Dyad Type

Condition	*M* (*SD*)	95% CI
No divided attention		
Nominal[a]	2.38 (2.31)	[1.15, 3.60]
Collaborative[a]	0.63 (0.89)	[0.15, 1.10]
Divided attention		
Nominal[a]	2.69 (2.55)	[1.33, 4.05]
Collaborative[a]	1.56 (2.50)	[0.23, 2.90]

Note. CI = confidence interval.
[a]*n* = 16 dyads

Costs and Benefits Post Collaboration

Amount recalled. ***Word List.*** At Recall 2, the proportion of the word list correctly recalled by individuals ranged from 0.11 to 0.80 (see Table 3.3 for means). As at Recall 1, I conducted a 2 x 2 ANOVA on the proportion of the 45-word list correctly recalled by individuals. This ANOVA revealed only a significant main effect of Dyad Type, $F(1, 124) = 6.93$, $p = .001$, $\eta_p^2 = .05$. This finding reflects a post-collaborative benefit: individuals who previously collaborated recalled a greater proportion of the word list than individuals who previously recalled in nominal groups (see Figure 3.6). I did not find a significant main effect for attention at Recall 1, $F(1, 124) = 0.44$, $p = .505$, or a significant interaction, $F(1, 124) = 0.11$, $p = .739$. These findings suggest that the post-collaborative benefit was consistent across the cognitive need manipulation.

European countries. The number of European countries recalled by individuals ranged from 1 to 37 at Elicitation, and from 9 to 45 at Recall 2 (see Table 3.3 for means). I conducted a (2) x 2 x 2 mixed ANOVA to test for gains and losses from Elicitation to Recall 2. Time (Elicitation, Recall 2) was entered as a within-subject variable, Attention at Recall 1, and Dyad Type were entered as independent between-subjects variable, and number of European countries recalled by individuals was entered as the dependent variable. I found a significant main effect of Time, $F(1, 122) = 175.20$, $p < .001$, $\eta_p^2 = .59$, and a significant Time x Dyad Type interaction, $F(1, 122) = 14.13$, $p < .001$, $\eta_p^2 = .10$. This interaction reflects a post-collaborative benefit: individual performance at Recall 2 increased more from individual Elicitation performance in the collaborative condition than in the nominal condition (see Figure 3.7). I also found a significant Time x Attention at Recall 1 interaction, $F(1, 122) = 6.01$, $p = .016$, $\eta_p^2 = .05$. This interaction reflects a post divided attention benefit: individual performance at Recall 2 increased more from individual Elicitation performance in the divided attention condition than in the no divided attention condition (see Figure 3.8). I

found no other significant main effects, all Fs < 0.64, all ps > .424, and no significant three-way interaction, $F(1, 122) = 0.010$, $p = .922$. These findings suggest that couples and close friends showed a benefit of collaboration on the subsequent individual semantic recall task, and also appeared to have experience a rebound effect from the removal of the divided attention task, but this did not influence the magnitude of the post-collaborative benefit.

Shared friends and acquaintances. The number of shared friends recalled by individuals ranged from 0 to 39 at Elicitation, and ranged from 0 to 43 at Recall 2 (see Table 3.3 for means). As for European countries, I conducted a (2) x 2 x 2 mixed ANOVA to test for gains and losses between Elicitation and Recall 2. This ANOVA revealed significant main effects of both Time, $F(1, 122) = 141.25$, $p < .001$, $\eta_p^2 = .54$, and Dyad Type, $F(1, 122) = 6.59$, $p = .011$, $\eta_p^2 = .05$, as well as a significant Time x Dyad Type interaction, $F(1, 122) = 14.51$, $p < .001$, $\eta_p^2 = .11$. This interaction reflects a post-collaborative benefit: individuals who previously collaborated gained more names of shared friends than individuals who previously recalled alone (see Figure 3.9). I found no significant main effect of Attention at Recall 1, $F(1, 122) = .525$, $p = .470$, and no other significant interactions, all Fs < 1.06, all ps > .3042. These results suggest that the only benefit to individual personal semantic recall was the opportunity to previously collaborate with a romantic partner or close friend.

Table 3.3
Individuals' Mean Elicitation and Recall 2 Performance by Attention at Recall 1, and Dyad Type at Recall 1

Condition	Individual Elicitation		Individual Recall 2	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI
		Word list proportion of total correct		
No divided attention				
Nominal[a]	-	-	0.31 (0.10)	[0.27, 0.35]
Collaborative[a]	-	-	0.36 (0.09)	[0.32, 0.39]
Divided attention				
Nominal[a]	-	-	0.32 (0.14)	[0.27, 0.37]
Collaborative[a]	-	-	0.38 (0.13)	[0.33, 0.42]
		European countries recalled		
No divided attention				
Nominal[a]	16.06 (9.29)	[12.71, 19.41]	17.72 (9.62)	[14.25, 21.19]
Collaborative[b]	12.03 (7.25)	[9.33, 14.74]	15.53 (7.04)	[12.91, 18.16]
Divided attention				
Nominal[a]	12.72 (6.39)	[10.41, 15.02]	15.59 (7.16)	[13.01, 18.18]
Collaborative[a]	12.88 (5.12)	[11.03, 14.72]	17.50 (5.97)	[15.35, 19.65]
		Shared friends recalled		
No divided attention				
Nominal[a]	16.75 (7.79)	[13.94, 19.56]	19.56 (16.22)	[16.22, 22.90]
Collaborative[a]	17.44 (5.95)	[15.29, 19.58[	22.94 (20.99)	[20.99, 24.88]
Divided attention				
Nominal[b]	14.20 (7.38)	[11.44, 16.96]	17.47 (8.09)	[14.45, 20.49]
Collaborative[a]	17.44 (8.16)	[14.50, 20.38]	23.75 (8.90)	[20.54, 26.96]

Note. CI = confidence interval.
[a]*n* = 32 individuals
[b]*n* = 30 individuals

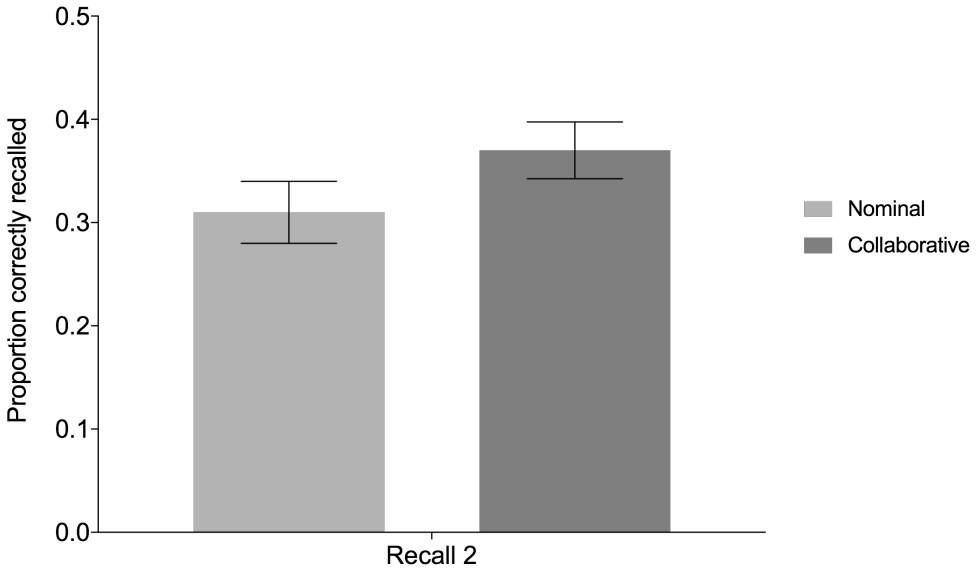

Figure 3.6. Mean proportion of word list correctly recalled by individuals at Recall 2 by previous Dyad Type. Error bars indicate 95% CI.

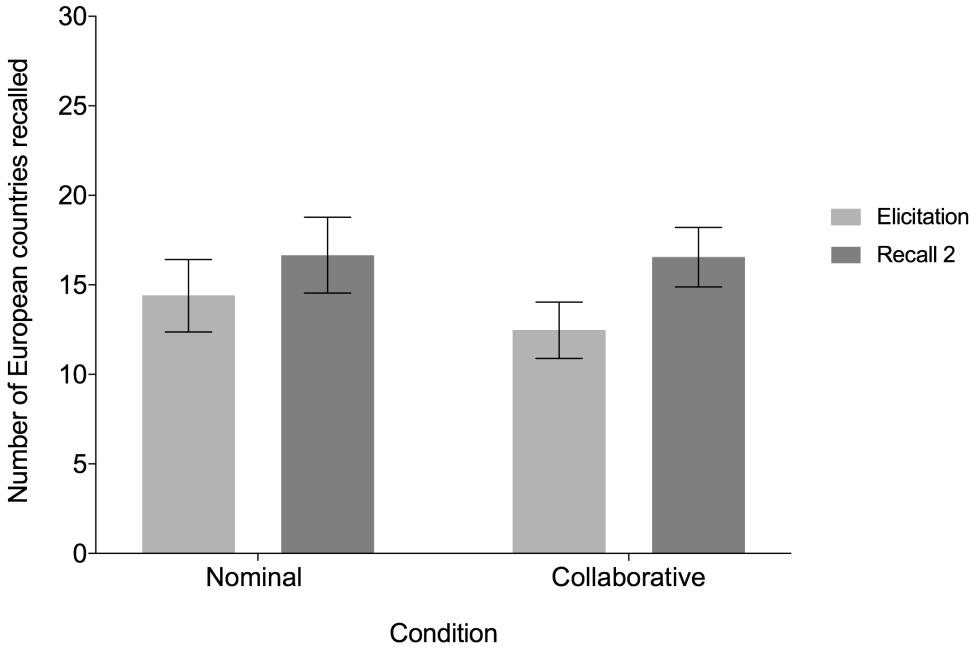

Figure 3.7. Number of European countries recalled by individuals at Elicitation and Recall 2 by previous Dyad Type. Error bars indicate 95% CI.

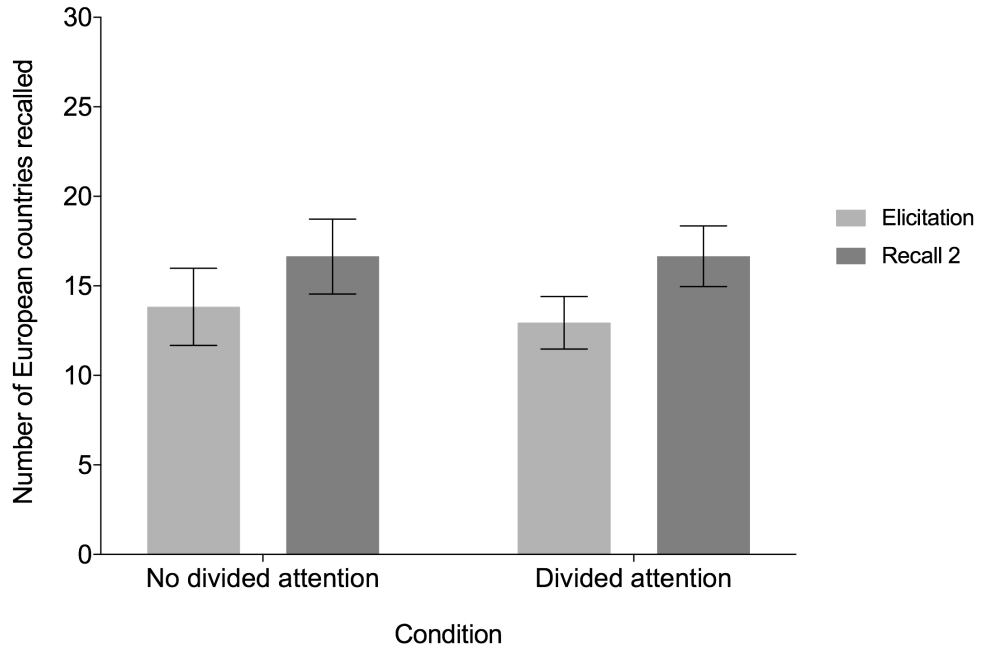

Figure 3.8. Number of European countries recalled by individuals at Elicitation and Recall 2 by Attention at Recall 1. Error bars indicate 95% CI.

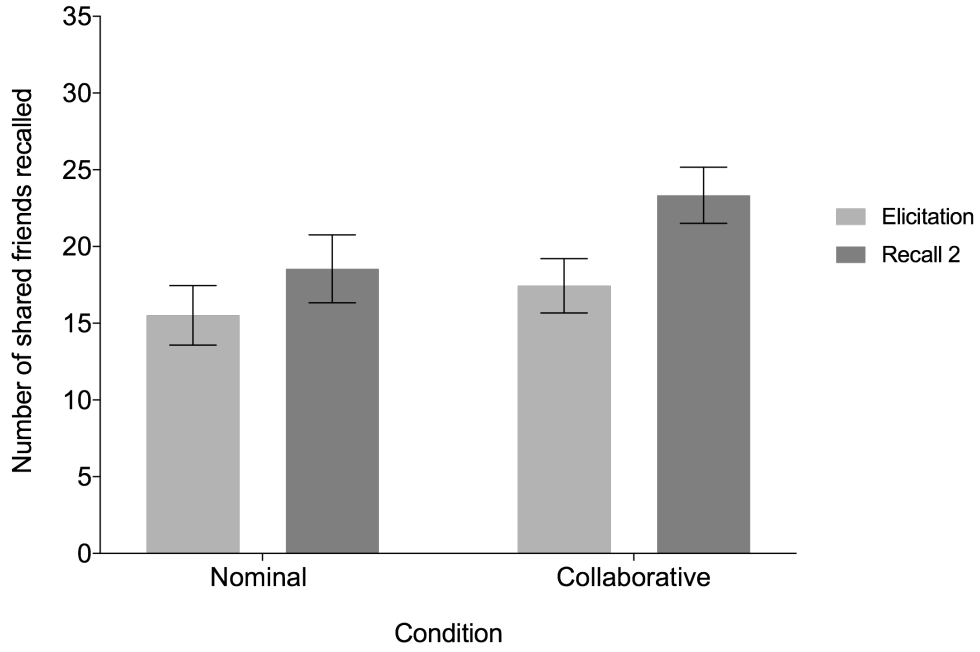

Figure 3.9. Number of shared friends recalled by individuals at Elicitation and Recall 2 by previous Dyad Type. Error bars indicate 95% CI.

Intrusions. At Recall 2, individual intrusion scores on the word list task ranged from 0 to 10 (see Table 3.4 for means). As for the proportion of the word list correctly recalled, I conducted a 2 x 2 ANOVA on individual intrusion scores. This ANOVA revealed only a significant main effect for Attention at Recall 1, $F(1, 124) = 9.15$, $p = .003$, $\eta_p^2 = .07$. Individuals previously in the no divided attention condition ($M = 0.92$, $SD = 1.20$) recalled fewer intrusions than individuals previously in the divided attention condition ($M = 1.95$, $SD = 2.45$). I found no main effect for Dyad Type, $F(1, 124) = 1.21$, $p = .274$, and no significant interaction, $F(1, 124) = 0.411$, $p = .522$. To determine if these results may be due in part to differences in the total number of items recalled, I conducted another 2 x 2 ANOVA on the proportion of recall containing errors. I found not only a significant main effect of Attention at Recall 1, $F(1, 124) = 3.98$, $p = .048$, $\eta_p^2 = .03$, but also a significant main effect for Dyad Type, $F(1, 124) = 6.32$, $p = .013$, $\eta_p^2 = .05$. This latter finding reflects a post-collaborative benefit: individuals who previously collaborated recalled a lower proportion of intrusions ($M = 0.07$, $SD = 0.10$) than individuals who previously recalled alone ($M = 0.11$, $SD = 0.14$). It should be noted that all effect sizes were very small and that intrusion scores generally were low. However, these findings suggest that if one member in a dyad had previously had divided attention, then accuracy decreased on a subsequent individual word list recall task when the divided attention had been removed. Conversely, there was a hint that recalling previously with a romantic partner or close friend increased accuracy on a subsequent individual word list recall task, but this did not influence the magnitude of the cost of prior divided attention.

Table 3.4
Individuals' Mean Number of Intrusions at Recall 2 by Attention at Recall 1 and Dyad Type

Condition	*M* (*SD*)	95% CI
No divided attention		
Nominal[a]	1.22 (1.41)	[0.71, 1.73]
Collaborative[a]	0.63 (0.87)	[0.31, 0.94]
Divided attention		
Nominal[a]	2.03 (2.43)	[1.16, 2.91]
Collaborative[a]	1.88 (2.50)	[0.97, 2.78]

Note. CI = confidence interval.
[a]*n* = 32 individuals

Closeness and Cognitive Need Manipulations

I examined PAIR and IOS scores in the couples and friends, and tested for correlations between these measures of closeness and collaborative recall. I tested the effectiveness of the divided attention task in generating a sense of cognitive need, and examined difficulty responses for recalling while turning the timers in each memory task.

Closeness measurements. The dyad average PAIR subscale scores ranged from 18.50 to 29.50 for Emotional intimacy, 18.50 to 29.50 for Intellectual intimacy, 18.50 to 29.00 for Recreational intimacy, 13.50 to 28.50 for Social intimacy, and 15.00 to 28.50 on the Conventionality measure (see Table 3.5 for means). The dyad average IOS scores ranged from 2.50 to 7.00 (see Table 3.5 for means). The only significant difference in closeness measures between couples and close friend dyads was on the Social subscale, $F(1, 62) = 8.52$, $p = .005$, $\eta_p^2 = .12$. Couples ($M = 20.94$, $SD = 3.88$) scored lower than close friends ($M = 23.44$, $SD = 2.91$). These analyses suggest that couples and close friend dyads mostly had similar levels of intimacy. The lower mean Social intimacy score, however, suggests couples had fewer common friends and spent less time socialising with friends together than close friend dyads. This might help explain the differences I found between couples and close

friends and the effect of collaboration in the shared friends task. If couples have fewer common friends, then the people they both know may be more differentiated (and thus likely to benefit from collaboration) than close friends who spend more time socialising with common friends together.

For the collaborative condition only, I analysed the correlations between Recall 1 performance and the dyad average PAIR subscale scores. After Bonferoni adjustment (α = 0.05/5 = 0.01), I found: no significant correlations between the proportion of word list recalled at Recall 1 and dyad average PAIR subscale scores, all *p*s > .522; no correlation between the overall gains/losses in European countries from Elicitation to Recall 1, all *p*s > .065; and no correlation between the overall gains/losses in shared friends from Elicitation to Recall 1, *p*s > .027. Due to the differences I observed between couples and close friend dyads in the effect of collaboration on the shared friends task, I also considered couples and close friends separately. After Bonferoni adjustment (α = 0.05/5 = 0.01), I found no significant correlations between dyad average PAIR subscales and the difference score in the collaborative couple dyads, or in the collaborative friend dyads, all *p*s > .009, and all *p*s > .326 respectively. These findings suggest that couples and close friends rated their intimacy levels as high, but level of intimacy was not associated with their performance when recalling together, even on the more personal shared friends task.

Divided attention manipulation. I explored the effect of the divided attention manipulation in two ways. First, to examine if concurrently turning a timer reduced individual recall performance I tested the individual performance of participants in the nominal conditions. As in Experiment 1, in the divided attention condition, Partner A participants were under divided attention; while in the no divided attention condition, neither Partner A nor Partner B were under divided attention. If the divided attention task successfully added cognitive load, Partner A's performance should be impaired relative to Partner B's

performance in the divided attention condition but not in the no divided attention condition. Second, I examined the difficulty responses for participants who completed the divided attention task.

Table 3.5
Mean Dyad Average PAIR Scores and Dyad Average IOS Scores

Condition	*M* (*SD*)	95% CI
PAIR subscale		
Emotional[a]	25.31 (2.62)	[24.66, 25.97]
Intellectual[a]	24.44 (2.27)	[23.87, 25.01]
Recreational[a]	24.09 (2.22)	[23.54, 24.65]
Social[a]	22.19 (3.62)	[21.28, 23.09]
Conventionality[a]	22.92 (3.52)	[22.04, 23.80]
IOS[a]	5.12 (1.18)	[4.82, 5.41]

Note. CI = confidence interval.
[a]*n* = 64 dyads

Word list. I used a 2 x 2 ANOVA to test for differences in the amount recalled at Recall 1 for the 64 participants in the nominal condition. Partner Allocation (Partner A, Partner B) and Attention at Recall 1 were entered as independent between-subject variables and the proportion of the word list correctly recalled by individuals was entered as the dependent variable. This ANOVA revealed no significant main effects, all Fs < 0.181, all ps > .672, and no significant interaction, $F(1, 60) = 0.377$, $p = .541$. Next, I considered the distribution of difficulty recalling responses of the 32 participants who completed the timer task (see Table 3.6 for frequency of responses). Given the ordinal nature of this data, I conducted a nonparametric test on the proportion of difficulty responses between the nominal and collaborative conditions and found no difference, Mann-Whitney U = 109.50, $p = .441$. This finding reflects that those in the collaborative condition found recalling while under

divided attention as difficult as those recalling alone. The majority of individuals completing the divided attention task perceived recalling as difficult, but they still performed as well as individuals who were not under divided attention. Thus, the lack of an effect of divided attention on collaborative word list performance (as reported above) might be explained by a lack of sufficient cognitive need generated by the divided attention task.

European countries. I conducted a (2) x 2 x 2 mixed ANOVA to test for differences in the individual recall performance from elicitation to Recall 1 for the 64 participants in the nominal condition. Time was entered as within-subject variable, Partner Allocation, and Attention at Recall 1 were entered as independent between-subject variables, and the number of European countries recalled by individuals was entered as the dependent variable. This ANOVA revealed a significant main effect of Time, $F(1, 60) = 35.48$, $p < .001$, $\eta_p^2 = 0.37$, and a significant Time x Partner Allocation interaction, $F(1, 60) = 6.52$, $p = .013$, $\eta_p^2 = 0.10$, but no significant three-way interaction, $F(1, 60) = 0.369$, $p = .546$. The lack of a three-way interaction suggests that although Partner As ($M = 0.88$, $SD = 1.98$) tended to gain fewer countries from Elicitation to Recall 1 than Partner Bs ($M = 2.19$, $SD = 2.12$), this was regardless of whether they were under divided attention or not. Thus, the divided attention task does not explain the lower performance of Partner As compared to Partner Bs.

Next, I considered the distribution of difficulty recalling responses of the 32 participants who completed the timer task (see Table 3.6 for frequency of responses). Given the ordinal nature of this data, I conducted a nonparametric test on the proportion of difficulty responses between the nominal and collaborative conditions and found no difference, Mann-Whitney U = 111.00, $p = .507$. This finding reflects that those in the collaborative condition found recalling while under divided attention as difficult as those recalling alone. About half of the individuals completing the divided attention task perceived recalling as difficult, and they still gained a similar number of European countries from Elicitation to Recall 1 as

individuals who were not under divided attention. Thus, the lack of an effect of divided attention on collaborative performance on the European countries task (as reported above) might be explained by a lack of sufficient cognitive need generated by the divided attention task.

Table 3.6
Frequency of Difficulty Recalling Under Divided Attention by Dyad Type

Condition	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy
			Word list		
Nominal[a]	6 (37.50%)	8 (50.00%)	1 (6.25%)	1 6.25%)	0 (0.00%)
Collaborative[a]	4 (25.00%)	9 (56.25%)	2 (12.50%)	1 6.25%)	0 (0.00%)
			European countries		
Nominal[a]	4 (25.00%)	6 (37.50%)	2 (12.50%)	4 (25.00%)	0 (0.00%)
Collaborative[a]	3 (18.75%)	4 (25.00%)	5 (31.25%)	4 (25.00%)	0 (0.00%)
			Shared friends		
Nominal[b]	1 (6.67%)	3 (20.00%)	6 (40.00%)	4 (26.67%)	1 (6.67%)
Collaborative[a]	3 (18.75%)	5 (31.25%)	5 (31.25%)	3 (18.75%)	0 (0.00%)

[a]*n* = 16 individuals
[b]*n* = 15 individuals

Shared friends and acquaintances. As for European countries, I conducted a (2) x 2 x 2 mixed ANOVA to test for differences in the individual recall of shared friends from elicitation to Recall 1 for the 64 participants in the nominal condition. This ANOVA revealed only a significant three-way interaction, $F(1, 58) = 12.29$, $p = .001$. Using follow up pairwise contrasts with alpha set at 0.0125 (i.e. 0.05 /4 contrasts) I found a significant effect of Partner

Allocation in the divided attention condition, $p = .001$, but no significant effect of Partner Allocation in the no divided attention condition, $p = .134$, and a significant effect of Attention at Recall 1 for Partner As, $p = .005$, but no significant effect of Attention at Recall 1 for Partner Bs, $p = 0.43$. These contrasts reflect that participants who were under divided attention ($M = -0.27$, $SD = 3.31$) lost shared friends, but their partner or close friend ($M = 3.2$, $SD = 2.51$) who was not under divided attention gained shared friends from Elicitation to Recall 1. This difference in partner performance appears to be related to the divided attention task, since Partner As ($M = 2.63$, $SD = 3.28$) in the no divided attention condition gained shared friends from Elicitation to Recall 1. Given the differences I found between couple dyads and friend dyads on the shared friends task, I also tested couples and close friends separately and found the same pattern of significance in both samples. Next, I considered the distribution of difficulty recalling responses of the 31 participants who completed the timer task. The shared friend task was described as the easiest memory task to complete while under divided attention, with just over one third of participants responding that it was "very difficult" or difficult" (see Table 3.6 for frequency of responses). Given the ordinal nature of this data, I conducted a nonparametric test on the proportion of difficulty responses between the nominal and collaborative conditions and found no difference, Mann-Whitney U = 85.00, $n_1 = 15$, $n_2 = 16$, $p = .150$. This finding reflects that those in the collaborative condition found recalling while under divided attention as difficult as those recalling alone. Taken together, these findings provide an interesting disconnect between perception of difficulty and recall performance. Those under divided attention task described the difficulty of recalling on the shared friends task as relatively easy compared to the word list and the European countries task. Despite this relative perception of ease of recall, however, being under divided attention impaired individual recall of personal semantic information. This latter finding provides evidence that the divided attention task added cognitive load for the shared friends task.

Self-Reported Group Strategy Use

Those in the collaborative condition reported a similar rate of group strategy use for all three recall tasks. For the word list task, 46/64 (71.88%) individuals mentioned using a group strategy: resulting in 17 (53.13%) dyads in which both partners mentioned a group strategy, 12 (37.50%) dyads in which one partner mentioned a group strategy, and 3 (9.38%) dyads in which neither partner mentioned a group strategy. For the European countries task 45/62 (70.30%) individuals mentioned using a group strategy: resulting in 16 (51.61%) dyads in which both partners mentioned a group strategy, 13 (41.94%) dyads in which one partner mentioned a group strategy, and 3 (9.68%) dyads in which neither partner mentioned a group strategy. For the shared friends task, 45/64 (70.31%) individuals mentioned using a group strategy: resulting in, 16 (50.00%) dyads in which both partners mentioned a group strategy, 13 (40.63%) dyads in which one partner mentioned a group strategy, and 3 (9.38%) dyads in which neither partner mentioned a group strategy. Chi square tests revealed no differences in the proportion of self-reported group strategy use in the no divided attention condition and the divided attention condition, $\chi^2 = 1.24$, $p = .266$. The very high rate of reporting that they and their partner or friend used a strategy to help recall is interesting given the persistent collaborative inhibition effect across on all three recall tasks. These results suggest again that there is a disconnect between perceptions of coordination during recall and actual performance, or perhaps the strategies these close dyads engaged in did not coordinate recall sufficiently to counter the costs of collaborative inhibition.

Helpfulness of Collaboration

During collaboration. Almost all of the collaborative dyads participants reported that recalling with their partner or close friend was helpful (see Table 3.7 for frequency of responses for each recall task). I found no difference in the proportion of responses between dyads in the no divided attention condition and dyads in divided attention condition on the

word list task, Mann-Whitney U = 408.00, p = .119, the European countries task, Mann-Whitney U = 437.00, p = .521, or the shared friends task, Mann-Whitney U = 442.00, p = .311. As for the self-reported group strategy use findings, these findings suggest that despite collaborative costs to group recall performance, recalling with a partner or close friend was perceived as a helpful activity.

Table 3.7
Frequency of Helpfulness During Collaboration Responses by Attention at Recall 1

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
			Word list		
No divided attention[a]	0 (0.00%)	0 (0.00%)	2 (6.25%)	16 (50.00%)	14 (43.75%)
Divided attention[a]	0 (0.00%)	2 (6.25%)	3 (9.38%)	18 (56.25%)	9 (28.13%)
			European countries		
No divided attention[b]	1 (3.33%)	2 (6.67%)	3 (10.00%)	11 (36.67%)	13 (43.33%)
Divided attention[a]	0 (0.00%)	2 (6.25%)	8 (25.00%)	10 (31.25%)	12 (37.50%)
			Shared friends		
No divided attention[a]	0 (0.00%)	0 (0.00%)	8 (25.00%)	7 (21.87%)	17 (53.13%)
Divided attention[a]	0 (0.00%)	1 (3.13%)	3 (9.38%)	19 (59.38%)	9 (28.13%)

[a] n = 32 individuals
[b] n = 30 individuals

In everyday life. Again, most participants described recalling with others is everyday life as "helpful" or "very helpful" (see Table 3.8 for frequency of responses). Due to the ordinal nature of this data, I used a nonparametric test to examine the difference in the response proportions between those who had been in the nominal condition and those who had been in the collaborative condition. Notably, a greater proportion of participants who

collaborated described recalling with others as "very helpful" compared to participants who did not collaborate during the experiment, Mann-Whitney U = 1604.00, p = .020. Interestingly, when I split the sample and compared those in the no divided attention conditions and those in the divided attention conditions separately, I found a difference in responses between the nominal and collaborative conditions in the no divided attention condition, Mann-Whitney U = 353.00, p = .017. When neither member of the dyad had been under divided attention, participants who collaborated described collaborating in everyday life as "very helpful" more often than participants who recalled alone. However, when one member in the dyad had been under divided attention, participants who collaborated described collaborating in everyday life as "very helpful" no more often than participants who recalled alone. This difference between the two conditions could be because those who recalled alone in the divided attention condition perceived collaboration as more helpful than those who recalled alone in the no divided attention condition.

Table 3.8
Frequency of Helpfulness of Collaborating in Everyday Life Responses by Attention at Recall 1 and Dyad Type

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
No divided attention					
Nominal[a]	1 (3.10%)	1 (3.10%)	1 (3.10%)	21 (65.60%)	8 (25.00%)
Collaborative[a]	0 (0.00%)	0 (0.00%)	2 (6.30%)	12 (37.50%)	18 (56.25%)
Divided attention					
Nominal[a]	0 (0.00%)	1 (3.10%)	4 (12.50%)	14 (43.75%)	13 (40.60%)
Collaborative[a]	0 (0.00%)	0 (0.00%)	4 (12.50%)	11 (34.38%)	17 (53.10%)

[a] n = 32 individuals

Discussion

The aim of this experiment was to determine the influence of closeness and cognitive need on collaborative recall in younger adult romantic couples and close friend dyads. I expected that these close and familiar dyads may demonstrate a reduction in the costs of collaboration, particularly on tasks that tapped into their shared knowledge and experiences. However, I found evidence of collaborative inhibition across all three memory tasks, which is consistent with Experiment 1 findings and with previous studies with younger couples (Ross et al., 2008) and younger adult friends (Andersson & Rönnberg, 1995; Harris et al., 2013). As in Experiment 1, and consistent with previous research, in all three memory tasks I also found benefits of previous collaboration on the amount recalled subsequently as an individual (Barber & Rajaram, 2011b; Blumen & Rajaram, 2008, 2009; Blumen et al., 2014; Congleton & Rajaram, 2011, 2014; Henkel & Rajaram, 2011; Wissman & Rawson, 2015). The European Countries task was designed to test semantic knowledge of geography and did not require personal information to complete the task (unlike the shared friends task). It should be noted, however, that a few participants reported using their own or a friend's travel experiences to help them recall the names of countries. Although not systematically asked of participants, none of the couples, and only one close friend dyad volunteered that they had travelled in Europe together. As such, although some may have found the European countries task to have some personal relevance, for most participants it had minimal personal relevance. Unlike Experiment 1, in the present study my cognitive need manipulation had some impact on remembering. First, individual recall performance in the shared friends task was impaired for the person under divided attention, suggesting that divided attention added cognitive load. Second, in the close friend dyads, dyad recall performance in the shared friends task was impaired if one person was under divided attention. As in Experiment 1, and consistent with previous studies (Congleton & Rajaram, 2011; Harris et al., 2012, 2013; Hyman et al., 2013;

Ross et al., 2008), collaborative dyads produced fewer intrusions than nominal dyads. Interestingly, on subsequent individual recall of the word list, I found lower accuracy if one member in the dyad had previously been under divided attention than if neither dyad member had previously had this additional cognitive load, which suggests that the divided attention task may have had an effect on subsequent source monitoring.

I expected close friends and romantic couples to coordinate their retrieval because they have shared knowledge and past experiences of recalling together. I did find high rates of self-reported group strategy use, suggesting the majority of participants perceived at least an attempt to get on the same page and coordinate their collaborative recall. Despite this high rate of self-reported group strategy use, as noted above, I found a persistent pattern of collaborative inhibition on all memory tasks. This is somewhat contrary to my findings with stranger dyads reported in Experiment 1. In Experiment 1, I found that collaborative dyads in which at least one member reported the use of a group strategy recalled more words than dyads in which neither member reported the use of a group strategy. With couples and close friends in the current experiment, however, it is possible that group strategies helped collaborative recall although not enough to override the costs of collaboration. It is possible also that couples and close friends may be more likely than strangers to perceive coordination due to the comfort and ease they feel when recalling together. This is reflected in the high helpfulness responses couples and close friends reported. For example, more than half of the couples and close friends in the collaborative condition described remembering with others in everyday life as “very helpful” compared to just over a third of the strangers in the collaborative condition in Experiment 1. This suggests that the experience of collaborating with a close other may feel more useful than collaborating with a stranger.

Another consideration is that these young adults may still be developing ways of working together if their everyday lives are not particularly enmeshed. Few of the friends or

couples lived together. Thus, they may not have had cause to be reliant on each other to remember together in daily life, and the ways they have developed of remembering together may meet goals other than the output goals I measured in this experiment. For example, they may use scaffolding or have developed a transactive memory system to maintain intimacy. Alternatively, it is possible that there is variation in the development of shared remembering processes, and these individual differences make it challenging to find overall collaborative benefits. Even the older adult couples in Harris et al.'s (2011) study, who had been married on average for over 50 years, varied in their tendency to engage in processes that were positively associated with amount recalled together. Finally, it is also possible that by prescribing who would be scribe in the collaborative condition and who would turn the timer in the divided attention condition, I may have disrupted the way the couples and close friends would have naturally allocated those tasks within the dyad (Johansson et al., 2005).

While I found the same collaborative inhibition pattern in the couples and close friend dyads in both the word list task and the European countries task, I found collaborative inhibition in the shared friends task only in the close friends dyads. In addition, close friend dyads in which one dyad member was under divided attention also showed impaired performance on the shared friends task, although this did not influence the magnitude of collaborative inhibition. Care needs to be taken with these findings due to the reduction in power from splitting the sample, but it hints at complexities across different types of groups and remembering tasks. The lower social intimacy scores for couple dyads compared to close friend dyads could help explain why collaborative inhibition was only found in the close friend dyads. The PAIR Social subscale measures the overlap of social networks and the amount of time dyads spend together socialising with other people. As such it seems likely that couple dyads may have been more likely to list the names of people they both knew but that one partner had a closer relationship to, while close friend dyads may have been trying to

recall names of the people that they both knew equally well. That is, there was likely greater differentiation in "expertise" for names in the couple dyads than in the close friend dyads who were mutual "experts" on their social group. Couples may have been able to use a categorical approach to recalling the names, for example recalling "my friends" and then "your friends", whereas close friend dyads were recalling from one category, "our friends". Previous research has found greater division of responsibility in couples is associated with the elimination of collaborative inhibition (Johansson et al., 2005).

Increasing the difficulty of the divided attention task from Experiment 1 appeared to create a greater sense of cognitive load, although difficulty of recalling responses varied across the three memory tasks. Unlike in Experiment 1, the majority of those who competed the divided attention task described recalling the word list as "very difficult" or "difficult". But on the European task, only half reported recalling as "very difficult" or "difficult", and on the shared friends task just over a third reported recalling as "very difficult" or "difficult". As in Experiment 1, however, I only asked those who completed the timer task to provide a rating, and thus have no way to compare relative difficulty experienced by partners in the no divided and divided attention conditions. In addition to the impairment observed in close friend dyad recall on the shared friends task (described above), when I looked at individual performance in the nominal condition I found that being under divided attention impaired recall performance on the shared friends task. This latter finding suggests a disconnect between the perceived difficulty and actual recall performance on this task. I also found one cost and one benefit of the divided attention task on subsequent individual recall. First, although I found no cost of divided attention on recall of the European countries, I found that individuals who previously were in the divided attention condition showed a benefit on their subsequent individual recall. This suggests that once the additional load of the divided attention task was removed, individuals experienced a rebound-like effect to their recall of the

countries. Second, I found higher intrusion rates in individual recall of the word list for individuals who previously were in the divided attention condition compared to individuals who previously were in no divided attention condition. It is possible that the divided attention task at Recall 1 made source monitoring harder on subsequent recall, such that words considered but not written down under divided attention were incorrectly listed at the subsequent recall. It should be noted, however, that intrusion rates were low, so care should be taken when considering this finding.

This experiment was the second step in my empirical program and aimed to extend the collaborative paradigm to examine the effects of cognitive need on the costs and benefits when romantic couples and close friend dyads remember together. Couples and close friends in this experiment had much higher levels of closeness than strangers in Experiment 1, however collaborative inhibition persisted, even on tasks that may have benefited from these close dyads' shared knowledge. Only when couples, but not close friends, recalled their shared friends did I manage to shift the magnitude of collaborative inhibition. As in Experiment 1, despite the persistence of collaborative inhibition, participants generally found collaboration helpful. I also found high rates of self-reported strategy use on all tasks. Why do couples and close friends experience collaboration as helpful yet we see little evidence of this benefit, at least in terms of the amount recalled? Perhaps they choose strategies that are not sufficiently useful or used enough to shift collaborative inhibition. Or perhaps they perceive other aspects or outcomes of the collaboration as "helpful". To explore these issues, in my next two experiments I directly manipulated strategy use by asking dyads to explicitly agree on and use a strategy, in the hope that it may eliminate or reduce collaborative inhibition.

Chapter 4

Experiment 3

Getting on the Same Page:

A Laboratory Examination of Explicit Strategy Agreement at Retrieval on Strangers' Collaborative Recall

In Experiments 1 and 2, I found that many dyads reported using a group memory strategy, and some evidence that this was positively associated with collaborative memory performance, although not helpful enough to eliminate collaborative inhibition. In Experiment 1, I found evidence to suggest that stranger dyads recalled more together when at least one member self-reported a group strategy. In Experiment 2, I found a very high rate of self-reported group strategies in dyads of couples and close friends, yet also found a consistent pattern of collaborative inhibition. Instructing dyads to explicitly agree on a retrieval strategy, rather than leaving its development to chance may ensure that all groups coordinate their recall. So in Experiment 3, I recruited pairs of strangers and instructed collaborative dyads to discuss and agree on a recall strategy. I was interested in how a strategy instruction may change group performance across a number of recall occasions—do they learn to use the strategy and implement even when not told to? To examine this, I asked participants to study and then recall three different categorised word lists. It is possible, as predicted by theories such as transactive memory, that repeatedly practicing the task together may help groups to become more sensitive and responsive to each other, or gain metacognitive knowledge about each other and their group processes (Liang et al., 1995; Wegner, 1987).

There is some evidence that the strategies groups use to approach remembering together are associated with collaborative performance. For example, as mentioned in Chapter 1, Meade et al. (2009) noted that the top performing expert pilots used repetitions, restatements, and elaborations of their partner's statements. These types of communication strategies were less prevalent in the top performing novice and non-pilots. The authors note that the expert pilots' years of training in communication strategies may have played an important role in helping pilots to coordinate their retrieval and remain on the same page throughout the recall sessions. Similarly, Harris et al. (2011) found that older couples who recalled best together communicated in ways that suggested they were well attuned to each

others' contributions. For example, they repeated what their partner said or offered cues that successfully produced new information. In contrast, couples that recalled less well together instead communicated in ways that suggested they were less well attuned. For example, they disagreed about how to do the task, and failed to offer cueing statements.

Although aligned strategies can help groups minimise the costs and maximise the benefits of collaboration, it is less clear if being explicitly aware of group level strategies is beneficial or detrimental to group recall performance. Many of the communication strategies seen in Meade et al. (2009) and Harris et al. (2011) did not require (but also did not rule out) explicit awareness of the group's processes and strategies. That is, members of the groups did not always explicitly agree to use these strategies; they often just used them without discussion. It is possible that these strategies are emergent; that is, they appear only after the group has shared a sufficient number of experiences with similar content and structure (as in the case of Meade et al.'s expert pilots) or with the same people (as in the case of Harris's older couples). Further, there is some evidence that explicit discussion of how to approach a task does not benefit all groups equally. As discussed in Chapter 1, Hollingshead (1998) reported that strangers benefited from explicitly getting on the same page during encoding. In the case of couples, however, explicit strategy discussion made them depart from the (implicit) strategies they would have used (and which perhaps developed across time) to instead try new, less efficient strategies. Given the benefit strangers appear to gain from the opportunity to explicitly discuss strategies, I wanted to explore if an instruction to agree on a retrieval strategy (without an opportunity to engage in shared encoding) offers an additional benefit over and above previous joint exposure to the memory task.

Thus, in this study I extended the canonical collaborative recall paradigm to test the influence of explicitly agreeing on a retrieval strategy on the costs and benefits of collaborative recall. Rather that studying and recalling just one word list, I asked stranger

dyads to study and then recall a first word list, then study and recall a second word list, and then study and recall a third word list. In other words, there were three study-recall occasions. Participants either recalled each of the three lists alone (to form nominal dyads) or together (as collaborative dyads). Just prior to recalling the second word list, I asked half the dyads to nominate a strategy for recalling these words. I expected that if explicit agreement on a retrieval strategy is necessary for strangers to coordinate their retrieval, then collaborative dyads in the strategy condition should demonstrate less collaborative inhibition at the second and third recall points than collaborative dyads in the no strategy condition.

Method

Participants and Design

Participants included 64 pairs of strangers (n = 128) recruited from the Macquarie University community in Sydney, Australia tested in a (3) x 2 x 2 (Time (Recall 1, Recall 2, Recall 3) x Strategy (no strategy, strategy) x Dyad Type (nominal, collaborative)) mixed design experiment. Participants received course credit or payment of AU$15 per hour. The age of participants ranged from 17 to 55 years (M = 21.12, SD = 6.37). Dyads were comprised of 28 female-male, and 36 female-female pairs.

Materials

Materials used in the experiment included: (1) three word lists, and (2) a post-experiment questionnaire.

Word lists. Each of the three word lists consisted of 40 words presented in black Arial 24 point font sequentially on a white screen using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Every participant saw the list in the same fixed pseudo-random order, such that no two exemplars from the same category were presented consecutively. I counterbalanced the study order of the lists. As in the word list used in Experiment 1 and Experiment 2, the three lists in the present study were created from the 225

words previously selected by Harris et al. (2012) from the Affective Norms for English Words list (Bradley & Lang, 1999) and the Edinburgh Word Association Thesaurus (Kiss et al., 1973) (see Appendix E). As in Experiment 1 and Experiment 2, each word list in the present study contained neutral concrete nouns (e.g., elbow), affective concrete nouns (e.g., leprosy), and affective abstract nouns (e.g., merry), with 4 semantically related categories and 10 words per category. I did not tell participants about the categories.

Post-experiment questionnaire. At the end of the experiment, participants completed a short questionnaire (presented using Qualtrics (Qualtrics, Provo, UT)) that asked for four kinds of information. First, participants reported their basic demographic information (age, gender). Second, those in the collaborative condition indicated whether they used a group level strategy for each time point ("Did you and your partner use any strategies to help you recall the first/second/third word list?") as a self-report measure of group coordination. In Experiments 1 and 2, I used an open-ended question to measure self-reported group coordination, but this resulted in incomplete information (e.g., some participants responded "yes" but then did not provide a description of the strategy). Thus, in the present experiment I asked a "yes/no" question first, and if the participant selected "yes" they were then asked to describe the strategy they and their partner had used. Third, participants described how helpful collaboration is in their everyday life as a measure of beliefs about the effectiveness of collaboration during everyday remembering (as in Experiments 1 and 2). Those in the collaborative condition also described the helpfulness of recalling with the other participant in their dyad (as in Experiments 1 and 2) at each Recall time point as a measure of beliefs about the effectiveness of collaboration during each memory task. Finally, all participants described the difficulty of recalling each word list by selecting from five options: 1 (very difficult), 2 (difficult), 3 (neither easy nor difficult), 4 (easy), or 5 (very easy) as a self-report measure of recall difficulty.

Procedure

The experiment consisted of four phases: (1) study and recall word list 1, (2) study and recall word list 2, (3) study and recall word list 3, and (4) post-experiment questionnaire. I allocated dyads to conditions using blocked randomisation. I tested all participants. Where possible, dyad partners completed the experiment at the same time, resulting in 26 true nominal dyads and 6 post-hoc dyads.

Study and recall word list 1. Participants sat at individual tables, each with a computer. I told participants they would see a list of words presented sequentially on the computer monitor and their task was to try to remember these words. Each word appeared for 5 seconds with an inter-stimulus interval of 1 second. The verbatim instructions were the same as in Experiments 1 and 2. After viewing the word list, I asked participants to individually complete a 3-minute distractor task which involved solving as many multiplication problems as possible. Immediately following the distractor task, participants recalled the word list either alone (nominal condition) or together (collaborative condition). In the nominal condition, participants worked independently at their own tables, where they could not see the other participant's recall sheet, to recall as many words as possible in 4 minutes from the list they had just seen. In the collaborative condition, participants worked together at a table to recall as many words from the list as possible in 4 minutes. The verbatim instructions for the nominal and collaborative dyads were the same as in Experiment 1. As in Experiment 2, the role of scribe was randomly allocated to one of the two partners in the collaborative condition.

Study and recall word list 2. Following Recall 1, I asked collaborative participants to return to their individual tables, and asked nominal participants to remain at their individual tables. I told all participants I would present them with another list of words and that their task was to once again try to remember these words. After viewing the word list, I asked

participants to complete another distractor task that involved solving another set of multiplication problems for 3 minutes. After the distractor task, participants completed Recall 2 in the same recall condition (nominal or collaborative) as Recall 1. However, the instructions given at the beginning of Recall 2 varied according to strategy condition. Participants in the no strategy condition were not given any instructions relating to strategy or any time to think about strategy. Instead, they moved straight to the recall task itself. Participants in the strategy condition, however, were asked to think of a strategy to help them recall the word list. This was the case for both collaborative and nominal groups, with the only difference being that collaborative groups determined a strategy together whereas participants in the nominal condition determined a strategy independently (thus, it is possible that each dyad member within a nominal pair might each have nominated a different strategy). In each case, collaborative or nominal, participants were asked to write their nominated strategy at the top of their recall sheet. The verbatim strategy instructions for participants in the nominal condition were:

> Before you start the memory task, I would like you to decide on a strategy for recalling the words. When deciding on a strategy it may help you to think about any strategies or methods you planned to use to recall the words. Try to think of these or any other strategies that might help you to bring other words to mind. When you have decided on a strategy to help you recall the words, write it down on the space provided on the piece of paper.

The verbatim strategy instructions for participants in the collaborative condition were:

> Before you start the memory task, I would like you to decide together on a strategy for recalling the words. When deciding on a strategy it may help you to think about any strategies or methods you planned to use to recall the words. Try to think of these or any other strategies that might help you to bring other words to mind. When you have

> decided on a strategy to help you recall the words, write it down on the space provided on the piece of paper.

Once the participants in the nominal and collaborative strategy conditions had written down their strategy, I asked them if they had any questions. Nominating a strategy took on average 33 seconds, and no more than 2 minutes.

For all participants, irrespective of whether they were in a strategy condition (and had thus received prior strategy instruction) or not, I gave the same verbatim recall instructions as in Recall 1.

Study and recall word list 3. Following Recall 2, I asked collaborative participants to return to their individual tables, and asked nominal participants to remain at their individual tables. I told participants I would present them with another list of words on the computer monitor and their task was to once again try to remember these words. After viewing the word list, I asked participants to complete another distractor task that involved solving another set of multiplication problems for 3 minutes. After the distractor task, participants completed Recall 3 in the same recall condition (nominal or collaborative) as Recall 1. No participants were asked to nominate a strategy at this time. The verbatim instructions were the same as Recall 1.

Post-experiment questionnaire. Following Recall 3, participants completed a short questionnaire as described above. The verbatim instructions were:

> This questionnaire is about you and the tasks you have done today. Please answer every question, even if it doesn't apply to you that well. Answer as honestly as you can what is true for you. Please do not select something because it seems the right thing to say. Please do not discuss your answers with your partner.

At the end of the experimental session, participants were debriefed, given an opportunity to ask questions about the experiment, and thanked for their time.

Scoring and Coding

Recall performance. In this experiment, my unit of analysis was dyad performance at all recall points. Unlike in Experiments 1 and 2, where only one word list was presented followed by two free recall tests (Recall 1 completed alone or collaboratively, and Recall 2 completed alone), this study included the presentation of three word lists, with each list followed by one free recall test (completed either alone or collaboratively).

To calculate the proportion of correctly recalled words for nominal dyads at each recall point, I pooled the non-redundant recall on the word list for each dyad member and then divided this total pooled recall by 40 (the total number of words on the list). To calculate the proportion of correctly recalled words for collaborative groups I simply counted the number of words each dyad correctly recalled together and divided this total by 40.

As in Experiments 1 and 2, to create raw intrusion scores for nominal groups at each recall point I counted the number of non-redundant incorrectly recalled words by each dyad member. To create raw intrusion scores for collaborative groups at each recall point I simply counted the number of incorrectly recalled words by each dyad. In addition to these raw intrusion scores, for each dyad I also calculated the proportion of intrusions in recall by dividing the raw intrusion score by the sum of the number of correctly recalled words and the raw intrusion score using the same formula as in Experiment 1 and Experiment 2.

Self-reported group strategies. The way I scored self-reported retrieval strategies differed from Experiments 1 and 2. Since some participants in Experiments 1 and 2 responded to the open-ended question “did you and the other participant adopt any strategies to help you recall the word list?” with “no” or “not really” but then went on to describe a process that could be considered an effective collaborative strategy, in this experiment I made the answer to this question a forced “yes” or “no” response. To explore perceptions of group level

strategy use for each recall point I simply calculated the number of participants in the collaborative condition who positively responded to this question.

Collaborative processes. As in Experiments 1 and 2, the large number of collaborative dyads I tested, and my lack of success coding the transcripts of top performers in Experiment 1 made me reluctant to invest the huge time and resources needed to conduct detailed process coding of all the collaborative recall sessions. However, to examine if an explicit instruction to agree on a retrieval strategy changed how groups started their recall, I transcribed the first and second conversational turns for each partner in the collaborative dyads at Recall 1 (prior to the strategy instruction), and Recall 2 (immediately following the strategy instruction). I then developed a coding scheme for these conversational turns to score for instances of either partner trying to orientate or coordinate retrieval with explicit strategy references. A conversational turn was deemed to be "starting on the same page" if some attempt was made by either partner: (1) to explicitly state a particular category to start recall with (e.g., "Do you want to start with body parts?"), (2) to identify one or more of the categories (e.g., "Um, there was architect. Like this is jobs, occupations"), (3) to explicitly state they could remember the list in the presentation order (e.g., "Ok so start from the top? Architect"), (4) to identify word order (e.g., "Um the first word was alley, I remember"), or (5) to offer some other strategy (e.g., "Ok, so do you want me to say the questions, the um words that I remember first and then if you agree we'll write them down?"). A research assistant was trained on the coding scheme and also coded the conversational turns to allow interrater reliability to be analysed.

Results

I present a series of five analyses: (1) costs and benefits during collaboration, (2) nominated strategies and self-reported group strategy use, (3) collaborative processes in the first conversational turns, (4) difficulty of recalling, and (5) helpfulness of collaboration.

Costs and Benefits During Collaboration

Proportion correctly recalled. The proportion of the word list correctly recalled by dyads at Recall 1 ranged from 0.28 to 0.93, at Recall 2 from 0.38 to 0.87, and at Recall 3 from 0.18 to 0.90 (see Table 4.1 for means). I conducted a (3) x 2 x 2 mixed ANOVA. Time (Recall 1, Recall 2, Recall 3) was entered as a within-subject variable, Strategy (no strategy, strategy instruction), and Dyad Type (nominal, collaborative) were each entered as independent between-subjects variables and the proportion of correct recall was entered as the dependent variable. This ANOVA revealed a significant main effect of Dyad Type, $F(1, 60) = 15.00$, $p < .001$, $\eta_p^2 = .20$. This main effect reflects a collaborative inhibition effect: dyads in the collaborative condition recalled a smaller proportion of the three word lists than dyads in the nominal condition. I also found a significant main effect of Time, $F(2, 120) = 21.14$, $p < .001$, $\eta_p^2 = .26$. Follow up pairwise contrasts found that Recall 1 performance was lower ($M = 0.52$, $SD = 0.12$) than both Recall 2 ($M = 0.59$, $SD = 0.12$) and Recall 3 ($M = 0.59$, $SD = 0.14$), $p < .001$, and $p < .001$ respectively. There was no significant difference between Recall 2 and Recall 3 performance, which suggests that dyad performance increased from Recall 1 to Recall 2 and then plateaued at Recall 3, $p = .949$. I found no significant main effect of strategy, $F(1, 60) = 0.60$, $p = 0.442$, $\eta_p^2 = .01$, and no significant interactions, all Fs < 1.56, all ps > 0.214. These findings suggest that although dyads improved their recall performance with practice, collaborative inhibition persisted (see Figure 4.1).

Table 4.1
Mean Proportion of Word List Correctly Recalled by Strategy Instruction, Collaborative Condition, and Time

	Recall 1		Recall 2		Recall 3	
Condition	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
No strategy						
Nominal[a]	0.58 (0.10)	[0.41, 0.52]	0.67 (0.10)	[0.49, 0.62]	0.67 (0.12)	[0.45, 0.58]
Collaborative[a]	0.46 (0.10)	[0.52, 0.63]	0.56 (0.12)	[0.62, 0.73]	0.52 (0.12)	[0.61, 0.74]
Strategy						
Nominal[a]	0.56 (0.15)	[0.42, 0.52]	0.58 (0.13)	[0.50, 0.61]	0.63 (0.15)	[0.50, 0.61]
Collaborative[a]	0.47 (0.10)	[0.48, 0.64]	0.55 (0.10)	[0.52, 0.65]	0.55 (0.10)	[0.55, 0.71]

Note. CI = confidence interval.
[a]*n* = 16 dyads

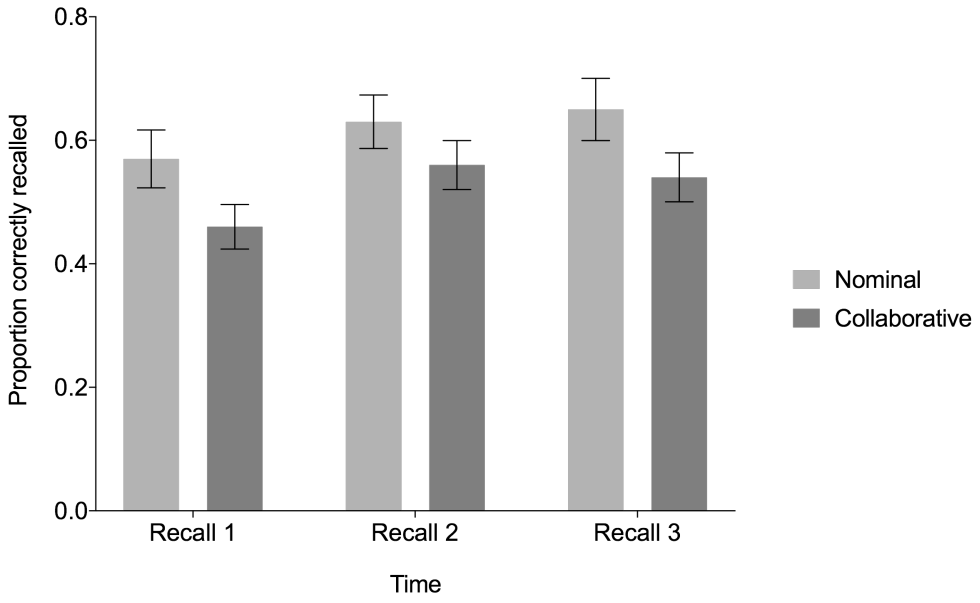

Figure 4.1. Mean proportion of correctly recalled words at each recall time point by Dyad Type. Error bars indicate 95% CI.

Intrusions. Dyad intrusion scores ranged from 0 to 5 at Recall 1, 0 to 8 at Recall 2, and 0 to 6 at Recall 3 (see Table 4.2 for means). A (3) x 2 x 2 mixed ANOVA on raw intrusion scores revealed only a significant main effect of Dyad Type, $F(1, 60) = 22.15$, p

< .001, η_p^2 = .27. This main effect reflects a collaborative benefit: collaborative dyads recalled fewer intrusions than nominal dyads. I found no other significant main effects, all *F*s < 1.59, all *p*s > .212, and no significant interactions, all *F*s < 1.43, all *p*s >.244. Since the lower number of intrusions produced by collaborative dyads could be a result of collaborative dyads simply producing fewer words (correct and incorrect) in total than nominal dyads, I conducted another (3) x 2 x 2 mixed ANOVA on the proportion of recall containing intrusions. As above, I found only a significant main effect of Dyad Type, $F(1, 60) = 17.37$, $p < .001$, $\eta_p^2 = .23$. These results suggest that while collaborative groups were more accurate than nominal groups, the magnitude of this benefit was not influenced by a strategy instruction or practice.

Table 4.2
Mean Number of Intrusions Recalled by Strategy Instruction, Collaborative Condition, and Time

	Recall 1		Recall 2		Recall 3	
Condition	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
No strategy						
Nominal[a]	1.69 (1.85)	[0.70, 2.67]	1.19 (0.98)	[0.66, 1.71]	1.38 (1.71)	[0.46, 2.29]
Collaborative[a]	0.38 (0.50)	[0.11, 0.64]	0.50 (0.82)	[0.06, 0.94]	0.38 (0.62)	[0.05, 0.70]
Strategy						
Nominal[a]	1.56 (1.59)	[0.72, 2.41]	2.25 (2.24)	[1.06, 3.44]	1.88 (1.36)	[1.15. 2.60]
Collaborative[a]	0.44 (0.62)	[0.62, 0.21]	0.75 (1.48)	[-0.04, 1.54]	0.44 (0.89)	[-0.04, 0.91]

Note. CI = confidence interval.
[a]*n* = 16 dyads

Self-Reported Strategy Use

Nominated retrieval strategies. In both the nominal strategy and collaborative strategy conditions all participants successfully nominated a strategy prior to Recall 2. The most common strategy nominated prior to beginning Recall 2 was to use the categorical

nature of the word list to bring more words to mind, with 21 (65.6%) nominal individuals, and all 16 (100%) collaborative groups nominating this strategy. The remaining nominal participants nominated strategies such as using a story they had created at encoding, or using associations they made outside of the word list at encoding.

Self-reported group strategies. At Recall 1, about half the participants in the collaborative condition self-reported that they and their recall partner had used a retrieval strategy, and there was no difference in the proportion of self-report in the strategy and no strategy conditions; 15 (46.88%) participants in the collaborative strategy condition compared to 14 (43.80%) participants in the collaborative no strategy condition, $\chi^2 = 0.63$, $p = .802$. At Recall 2, the study manipulation influenced the self-reporting of a group strategy: all 32 (100%) participants in the collaborative strategy condition reported using a strategy compared to 22 (68.75%) participants in the collaborative no strategy condition, $\chi^2 = 11.85$, $p < .001$. By Recall 3, almost all collaborative groups self-reported a group strategy, although again self-report was greater in the strategy condition than in the no strategy condition: 31 (96.88%) participants in the collaborative strategy condition, compared to 23 (71.88%) participants in the collaborative no strategy condition, $\chi^2 = 7.59$, $p = .006$. These results suggest that, even without an explicit strategy instruction, collaborative groups reported using group level strategies and that self-report increased after one exposure to the type of memory task. Since the majority of our collaborative participants reported that both they and their partner were using a strategy by the second recall point, analysing the association between reporting a group strategy and group recall performance could provide no further insight. But given the persistence of collaborative inhibition despite most groups believing they were using a group strategy, I next examine how well groups implemented their group level strategies.

Collaborative Processes

At Recall 1, both raters agreed 100% on the presence or absence of an attempt to coordinate retrieval; the interrater reliability for the specific type of coordination attempt was extremely high, Kappa = 0.945 ($p < .001$). At Recall 2, raters agreed on the presence or absence of an attempt to coordinate retrieval in all but one case (this case was discussed and a consensus was reached); the interrater reliability for the specific type of coordination attempt was again extremely high, Kappa = 0.908 ($p < .001$). At Recall 1, four (25.00%) of the pairs in the collaborative strategy condition and eight (50.00%) of the pairs in the collaborative no strategy condition saw one partner make an attempt to "start on the same page" as their recall partner on their first conversational turn. In contrast, at Recall 2, twelve (75.00%) collaborative strategy condition pairs and seven (43.80%) collaborative no strategy pairs saw one partner make an attempt to start on the same page as their recall partner. Importantly, and perhaps disappointingly, these coordinating attempts were unrelated to both Recall 1 and Recall 2 performance. Collaborative dyads that started on the same page in Recall 1 (M = 0.45, SD = 0.09) recalled no more than collaborative dyads that did not start on the same page (M = 0.47, SD = 0.10), $F(1, 30) = 0.23$, $p = .637$. Likewise, collaborative dyads that started on the same page in Recall 2 (M = .56, SD = 0.11) recalled no more than dyads that did not start on the same page (M = 0.56, SD = 0.13) (with Recall 1 entered as a covariate), $F(1, 29) = 0.08$, $p = .930$. Looking at the transcripts, this seems to be because few groups that started on the same page then continued to systematically exhaust their recall using the first strategy offered. Starting on the same page did not guarantee remaining on the same page.

Difficulty of Recalling

Nearly two thirds of participants described recalling at Recall 1 as "very difficult" or "difficult", compared to just under half at Recall 2, and just over half at Recall 3 (see Table 4.3 for frequency of responses). Given the ordinal nature of the data, I used non-parametric

tests to examine differences in the proportion of responses across conditions. I found no difference in the proportion of responses between those in the nominal condition or those in the collaborative condition at Recall 1, Recall 2, or Recall 3, Mann-Whitney U = 1944.50, p = .583, Mann-Whitney U = 1736.00, p = .119, and Mann-Whitney U = 1998.50, p = .801 respectively. When I split the sample and compared those in the no strategy condition and those in the strategy condition separately, I still found no difference in the proportion of difficulty responses between those in the nominal condition and those in the collaborative condition at any recall time point. These findings suggest that participants experienced a similar level of difficulty across conditions.

Helpfulness of Collaboration

During collaboration. The majority of participants who collaborated described collaborating with their recall partner as "helpful" or "very helpful" at each recall time point (see Table 4.4 for frequency of responses). Given the ordinal nature of the data, I used non-parametric tests to examine differences in the proportion of responses across conditions. At Recall 1, I found no difference in the proportion of responses between those in the strategy condition and those in the no strategy condition, Mann-Whitney U = 432.00, p = .212. At Recall 2 and Recall 3, however, I found a difference in the proportion of responses between those in the strategy condition, and those in the no strategy condition Mann-Whitney U = 340.00, p = .015, and Mann-Whitney U = 366.50, p = .031 respectively. This finding reflects that at these later recall points, a greater proportion of participants in the strategy condition described recalling with their partner as "very helpful" compared to participants in the no strategy condition. This suggests that a strategy instruction made participants more likely to endorse the helpfulness of recalling with the other dyad member.

Table 4.3
Frequency of Difficulty of Recall Responses by Strategy and Dyad Type

Condition	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy
			Recall 1		
No strategy					
Nominal[a]	2 (6.25%)	16 (50.00%)	9 (28.13%)	3 (9.38%)	2 (6.25%)
Collaborative[a]	1 (3.13%)	19 (59.38%)	9 (28.13%)	2 (6.25%)	1 (3.13%)
Strategy					
Nominal[a]	4 (12.50%)	14 (43.75%)	10 (31.25%)	3 (9.38%)	1 (3.13%)
Collaborative[a]	0 (0.00%)	22 (68.75%)	7 (21.88%)	3 (9.38%)	0 (0.00%)
			Recall 2		
No strategy					
Nominal[a]	2 (6.25%)	11 (34.38%)	14 (43.75%)	5 (15.63%)	0 (0.00%)
Collaborative[a]	2 (6.25%)	11 (34.38%)	10 (31.25%)	9 (28.13%)	0 (0.00%)
Strategy					
Nominal[a]	5 (15.63%)	14 (43.75%)	7 (21.88%)	5 (15.63%)	1 (3.13%)
Collaborative[a]	2 (6.25%)	10 (31.25%)	11 34.38%)	9 (28.13%)	0 (0.00%)
			Recall 3		
No strategy					
Nominal[a]	1 (3.13%)	16 (50.00%)	10 (31.25%)	3 (9.38%)	2 (6.25%)
Collaborative[a]	5 (15.63%)	16 (50.00%)	8 (25.00%)	3 (9.38%)	0 (0.00%)
Strategy					
Nominal[a]	4 (12.50%)	16 (50.00%)	9 (28.13%)	2 (6.25%)	1 (3.13%)
Collaborative[a]	5 (15.63%)	9 (28.13%)	13 (40.65%)	4 (12.50%)	1 (3.13%)

[a] n = 32 individuals

In everyday life. The majority of participants (85.94%) described collaboration of every day memory tasks as "helpful" or "very helpful" (see Table 4.5 for frequency of responses). Given the ordinal nature of the data, I used non-parametric tests to examine differences in the proportion of responses across conditions. I found no difference in the proportions of responses between those in the nominal condition and those in the collaborative condition, Mann-Whitney U = 1698.50, $p = .056$. When I split the sample and compared those in the no strategy condition and those in the strategy condition separately, I still found no difference in the proportion of helpfulness responses between those in the nominal no strategy condition and those in the collaborative no strategy condition, Mann-Whitney U = 486.00, $p = .670$. In the strategy condition, however, I did find a difference in responses between the nominal and collaborative conditions, Mann-Whitney U = 367.50, $p = .031$. Those in the collaborative strategy condition had more "very helpful" responses than those in the nominal no strategy condition. This suggests that, even though there was no difference in performance, collaborative participants' belief in the helpfulness of collaboration in everyday life was greater when given a strategy instruction than when not given a strategy instruction.

Table 4.4
Frequency of Helpfulness During Collaboration Responses by Strategy Condition

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
			Recall 1		
No strategy[a]	0 (0.00%)	0 (0.00%)	4 (12.5%)	23 (71.88%)	5 (15.63%)
Strategy[a]	0 (0.00%)	2 (6.25%)	2 (6.25%)	17 (53.13%)	11 (34.38%)
			Recall 2		
No strategy[a]	0 (0.00%)	0 (0.00%)	2 (6.25%)	23 (71.88%)	7 (21.88%)
Strategy[a]	0 (0.00%)	1 (3.13%)	1 (3.13%)	12 (37.50%)	18 (56.25%)
			Recall 3		
No strategy[a]	0 (0.00%)	0 (0.00%)	5 (15.63%)	19 (59.38%)	8 (25.00%)
Strategy[a]	0 (0.00%)	0 (0.00%)	3 (9.38%)	12 (37.50%)	17 (53.13%)

[a]*n* = 32 individuals

Table 4.5
Frequency of Helpfulness of Collaborating in Everyday Life Responses by Strategy Condition and Dyad Type

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
No strategy					
Nominal	0 (0.00%)	2 (6.25%)	4 (12.50%)	20 (62.50%)	6 (18.75%)
Collaborative	0 (0.00%)	1 (3.13%)	2 (6.25%)	24 (75.00%)	5 (15.63%)
Strategy					
Nominal	1 (3.13%)	0 (0.00%)	7 (21.88%)	16 (50.00%)	8 (25.00%)
Collaborative	0 (0.00%)	0 (0.00%)	1 (3.13%)	18 (56.25%)	13 (40.63%)

[a]*n* = 32 individuals

Discussion

In this experiment, I found a persistent pattern of collaborative inhibition at all recall time points. This suggests that, at least on a word list recall task, minimal previous experience retrieving a similar list with another person increased recall but was not sufficient to reduce the magnitude of collaborative inhibition. Notably, the explicit strategy instruction also did not reduce the magnitude of collaborative inhibition. Despite this lack of effect on recall performance, participants who were told to agree on a strategy before collaborating described recalling with their recall partner as more helpful at the second and third recall points than those who were not given a strategy instruction before collaboration. Those in the collaborative strategy condition also rated recalling with others in everyday life as more helpful than those in the nominal strategy condition. For people who collaborated, the strategy instruction was associated with a more positive belief in the helpfulness of remembering with others (both during the experiment and in everyday life) even though there was no evidence that they performed any better than collaborative dyads in the no strategy condition. I also found that collaborative dyads recalled fewer intrusions than nominal dyads. This benefit is consistent with my findings in Experiments 1 and 2, and consistent with findings of previous research (Congleton & Rajaram, 2011; Harris et al., 2012, 2013; Hyman et al., 2013; Ross et al., 2008). Intrusion rates were stable across recall time points, and the strategy instruction had no influence on the magnitude of the collaborative accuracy benefit.

Contrary to my expectation, the strategy instruction offered no benefit to collaborative dyads. This is somewhat surprising since all of the collaborative dyads who were asked to agree on a strategy agreed to use the categories to help their recall, which should be an effective strategy for group coordination in this task. However, the post-experiment questionnaire results revealed that grouping recall by categories was a commonly reported strategy at Recall 2, even for those who did not receive the explicit strategy instruction. The

word lists had a clear categorical structure that, with or without an explicit strategy instruction, collaborative dyads identified and tried to use. Thus, far from concluding that strategy use is ineffective, these results show that all collaborative dyads tried to implement the categorisation strategy to assist recall. This suggests that recalling together may, over time, result in emergent retrieval strategies that increase group performance, albeit not enough to reduce collaborative inhibition. An opportunity to explicitly discuss retrieval strategies may only offer an additional benefit over practicing the recall task when a strategy that helps coordinate group retrieval is less likely to be identified without discussion. A possible future direction would be to use stimuli that either are more abstract and less concrete, or perhaps are able to be categorised in more than one way (e.g., Barber & Rajaram, 2011b).

Given both the no strategy and strategy collaborative dyads had high rates of self-reported group retrieval strategies, the persistence of collaborative inhibition at Recall 2 and Recall 3 requires further investigation. The transcripts of the recall phases provide a hint that intention to use a strategy did not necessarily mean effective implementation and maintenance of that strategy. While close to half of the collaborative groups started out on the same page by beginning their recall with an attempt to coordinate retrieval, few dyads were able to stay on the same page by maintaining their strategy systematically throughout the recall phase. There was a tendency to revert back to idiosyncratic individual retrieval strategies even after an attempt to agree on a group level strategy. One partner, for example, may begin recalling from a new category without first checking if their partner has exhausted all their recall from the current category. This can lead to exchanges, as illustrated below, from a dyad in the collaborative strategy condition at Recall 2. The dyad members had just recalled words from the nature category. Although one partner appears to still be considering words from this category, their recall deviates into a different category:

Partner B: Um… sunrise, um… there were more-

Partner A: Merry?

Partner B: Merry, yep.

Partner A: Uh, I'm trying to remember-

Partner B: Merry, joyful, elated.

Partner A: Elated.

Partner B: Excited.

Partner A: Excited. Um…

Partner B: Ocean, there were more of those. Snow.

This exchange is interesting because while Partner B is still pondering the nature category, Partner A offers a word from a different category and then Partner B takes that offer up and recalls a few emotions, before returning to the prior nature category. Partner A has no other unique contributions to the recall of emotions except the initial word that prompted the category change.

Dyads may also lack a shared representation of the categories. A word may cue one dyad member to recall another word that is not part of the current category due to a temporal association (e.g., the words were presented near each other at study), or an individual association distinct to that participant. Alternatively, the dyad members may have defined their categories differently. For example, in the following collaborative strategy dyad, after working well together to systematically recall two categories, as they approach the third category they become somewhat discordant:

Partner A: And then there was like snow and all them.

Partner B: Yes. Happy was one.

Partner A: Yeah. There was like blossom.

Partner B: Yeah, blossom.

Partner A: Ocean.

Partner B: Yeah, ocean.

Partner A: Stars.

Partner B: Stars. And there was untroubled.

Partner A: Yeah. And there was relaxed.

In this exchange, Partner A recalls from the nature category, whereas Partner B recalls positive emotions. It is unclear if Partner B has created a category that groups words relating to nature and positive emotions together, or if Partner B simply cannot retrieve any words relating to nature. Regardless, even though they are acknowledging each other's contributions, they appear to no longer be on the same page. Even though Partner A, at the end of the above extract, joins Partner B in recalling emotions, following this exchange Partner A reverts to recalling from the nature category within a few more conversational turns.

Another consideration regarding the use of categories to aid recall, is that even if the dyad members are on the same page as to which category they are trying to recall, it does not necessarily mean that the category will effectively and efficiently cue more information. In the present experiment, it was not uncommon for group members to agree that a category was present in the word list, yet be unable to recall many words from the category. For example, in another collaborative strategy dyad, after recalling two categories together the following exchange occurs:

Partner A: What was another category?

Partner B: Um, like negative feelings. So like distressed, insecure…

Partner A: Yes, there was. Was angry there?

Partner B: I don't remember seeing angry.

Partner A: Ok. So we won't write that down. Insecure was there.

Partner B: Yeah. Misery?

Partner A: Yes, that was definitely there.

Partner B: Um, was depressed? Or depression? Or something like that? Nah?

Partner A: I don't remember that one.

Partner B: Alright. Um. There [were] other negative feelings. Much more. Heaps. Oh! Um, there was also- this one I made a story about. Uh, a king who lived in a palace, who was very affluent…

After identifying the category they are going to focus on next, they only agree on three items from that category (from a possible ten). While acknowledging there are more words yet to recall in that category, Partner B abandons recalling from it to describe an encoding story that lists items from a different category. Negative emotions are fleetingly returned to towards the end of the recall phase, but no more items from that category are recalled.

The above examples of discordant retrieval, disruption, unsuccessful cueing attempts, and the use of individual strategies from study suggest that maintaining group level coordination might be easier if participants have encoded the stimuli in a similar way. That is, retrieval may be too late to optimise group coordination, and instead, instructions to encourage group coordination may need to be given at encoding, allowing participants an early opportunity to get on the same page, making staying on the same page easier at retrieval. So in Experiment 4, I used the same design as Experiment 3, but I moved the strategy instruction so that it was given just prior to study of the second word list.

Chapter 5

Experiment 4

Starting on the Same Page:

A Laboratory Examination of Explicit Strategy Agreement at Encoding on Strangers' Collaborative Recall

In the previous chapter I discussed the difficulty that collaborating strangers encountered in maintaining a coordinated approach to recall, even when encouraged to use an explicit strategy to structure group retrieval. Although all groups in my strategy instruction condition in Experiment 3 were able to agree on strategies to use during recall, they were not always successful in maintaining their group level strategy as they tried to recall each word list. One possible explanation for this difficulty is that group level coordination at retrieval is too late. Members of dyads in Experiment 3 were never given the opportunity to explicitly coordinate their encoding, since I only allowed those in the strategy condition to discuss their approach once just prior to recalling the second word list. Although participants went on to study and recall a third word list, they were not able to discuss with their partner how they planned to encode or retrieve this final list of words. As such, their individual retrieval strategies were likely diverse at all three recall points. Thus, I wanted to test whether an explicit instruction to coordinate strategies at encoding would help groups better coordinate their retrieval and reduce or eliminate collaborative inhibition.

There is some evidence to suggest that decreasing the diversity of the encoding experience can reduce collaborative inhibition. For example, simply presenting a word list in the same order for all group members can reduce collaborative inhibition (e.g., Finlay et al., 2000; Exp 3). Finlay et al. (2000) argued that studying the stimuli in the same order places a constraint on idiosyncratic individual retrieval strategies, making them more likely to be similar to other group members and less prone to disruption from others' recall. However, the role of the encoding experience on collaborative memory performance is not well understood.

Shared encoding (where group members study the stimuli together) has been offered as one possible method for groups to better coordinate their encoding experience, but findings have been mixed. Previous studies examining the effect of shared encoding on collaborative recall have found mixed results. Finlay et al. (2000; Exp 1) had participants view a series of

10 puzzle pictures with hidden animals and asked them to find four target animals per picture. Participants either completed the study phase by themselves (individual encoding) or with another participant (shared encoding). When asked to later recall the names of the 40 target animals, collaborative groups who shared encoding did not demonstrate collaborative inhibition. Similarly, Harris et al. (2013) also found that shared encoding eliminated collaborative inhibition. In Harris et al.'s design, three person collaborative groups were shown a personality trait during the incidental encoding phase and asked to agree on a famous person (Experiment 1) or mutual friend (Experiment 2) who they thought represented this trait, and then later participants were asked to recall the personality traits they had seen. Harris et al. reported that this form of (implicit) shared encoding eliminated collaborative inhibition in both stranger triads and friend triads. Further, when encoding was shared, more strangers (but not friends) self-reported the use of a group level strategy than when encoding was unshared. In contrast, Barber et al. (2010; Exp 1) found evidence of collaboration inhibition even amongst participants who shared an incidental encoding experience. To manipulate encoding, Barber et al. (2010) asked participants to create sentences from displayed word pairs either on their own (unshared encoding condition) or jointly with another participant (shared encoding condition). Participants then completed a surprise cued recall memory test individually, or with the same partner they had encoded with, or with a partner they had not encoded with. Barber et al. (2010) reported that, relative to encoding individually, sharing the encoding phase impaired recall performance across all groups. These findings suggest that not all shared encoding experiences serve to reduce costs of collaboration.

While Finlay et al. (2000) did not provide much detail about how participants undertook the shared encoding phase together, the tasks used by Barber et al. (2010) and Harris et al. (2013) differed in the degree to which participants needed to develop a shared understanding of the stimuli. Barber et al. (2010) did not allow participants in the shared

encoding phase to discuss their sentences, and the task was not conducive to creating joint meaning. In comparison, the task used by Harris et al. (2013) required participants to come to some shared understanding. It is perhaps this opportunity to meaningfully coordinate at encoding that determined later benefits to recall.

In the present study I wanted to give participants an opportunity to coordinate their encoding before the encoding activity itself. Agreeing on a strategy before encoding a word list may be one way for groups to coordinate the way they learn the words in a meaningful and explicit manner. To keep the present experiment as similar as possible to Experiment 3, I modified the timing of the strategy agreement instruction so that it occurred just prior to studying the second word list (and not just before recall, as in Experiment 3). I kept all other aspects of the study the same. I expected that if an opportunity to discuss and agree on a method for studying the words later helps groups maintain coordination during retrieval (over and above just practicing the memory task) then those in the strategy instruction condition should show a reduction in collaborative inhibition relative to those in the no strategy condition. In addition, I expected that if agreeing on a strategy prior to encoding helps to constrain idiosyncratic strategies of individual group members, then those in the strategy condition should show a greater ability to start Recall 2 in a coordinated manner and maintain their group coordination during the task.

Method

Participants and Design

Participants included 64 pairs of strangers (n = 128) recruited from the Macquarie University community in Sydney, Australia in a (3) x 2 x 2 (Time (Recall 1, Recall 2, Recall 3) x Strategy (no strategy, strategy) x Dyad Type (nominal, collaborative)) mixed design experiment. Participants received course credit or payment of AU$15 per hour. The age of

participants ranged from 17 to 51 years (M = 21.15, SD = 6.01). Dyads were comprised of 2 male-male, 25 female-male, and 37 female-female pairs.

Materials

Materials used in the experiment included: (1) three word lists, and (2) a post-experiment questionnaire.

Word lists. Each of the three word lists were the same as in Experiment 3, presented in black Arial 24 point font sequentially on a white screen using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Every participant saw the list in the same fixed pseudo-random order, such that no two exemplars from the same category were presented consecutively. I counterbalanced the study order of the lists. I did not tell participants about the categories.

Post-experiment questionnaire. At the end of the experiment, I asked participants to complete the same post-experiment questionnaire as in Experiment 3 (presented using the Qualtrics online survey platform (Qualtrics, Provo, UT)) that asked for four types of information. First, participants reported their basic demographic information (age, gender). Second, those in the collaborative condition indicated whether they used a group level strategy for each time point as a self-report measure of group coordination (as in Experiment 3). Third, participants described how helpful collaboration is in their everyday life as a measure of beliefs about the effectiveness of collaboration during everyday remembering (as in Experiments 1, 2, and 3). Those in the collaborative condition also described the helpfulness of recalling with the other participant in their dyad as a measure of beliefs about the effectiveness of collaboration during each memory task (as in Experiments 1, 2 and 3) at each Recall time point. Finally, all participants described the difficulty of recalling each word list as a self-report measure of recall difficulty (as in Experiment 3).

Procedure

The experiment consisted of the same four phases as Experiment 3: (1) study and recall of word list 1, (2) study and recall of word list 2, (3) study and recall of word list 3, and (4) post-experiment questionnaire. I allocated dyads to conditions using blocked randomisation. I tested all participants. Where possible, dyad partners completed the experiment at the same time, resulting in 27 true nominal dyads and 5 post-hoc nominal dyads.

Study and recall word list 1. Participants sat at individual tables, each with a computer. I told participants they would see a list of words presented sequentially on the computer monitor and their task was to try to remember these words. Each word appeared for 5 seconds with an interstimulus interval of 1 second. The verbatim instructions were the same as in Experiments 1, 2, and 3. After viewing the word list, I asked participants to individually complete a 3-minute distractor task which involved solving as many multiplication problems as possible. Immediately following the distractor task participants recalled the word list either alone (nominal condition) or together (collaborative condition). In the nominal condition, participants worked independently at their own tables, where they could not see the other participant's recall sheet, to recall as many words as possible from the list they had just seen in 4 minutes. In the collaborative condition, participants worked together at a table to recall as many words from the list as possible in 4 minutes. The verbatim instructions for the nominal and collaborative dyads were the same as in Experiments 1, 2, and 3. As in Experiments 2 and 3, in the collaborative condition I randomly assigned the role of scribe to one partner.

Study and recall word list 2. Following Recall 1, I told all participants I would present them with another list of words and their task was to try to once again remember these words. The instructions given at the beginning of study 2, however, varied according to strategy condition. In the nominal no strategy condition, participants remained at their individual tables and received the same instructions as they had at study 1. In the

collaborative no strategy condition, I asked participants to return to their individual tables, and then read them the same instructions as in study 1. In the nominal strategy condition, participants remained at their individual tables, independently decided on a strategy to use and then wrote it down on separate pieces of paper. The verbatim instructions were:

> Before you start viewing the word list I would like you to decide on a strategy for studying the words. When deciding on a strategy it may help you to think about any strategies or methods you plan to use during study to help you later recall the words. Try to think of these or any other strategies that might help you to remember the words. When you have decided on a strategy to help you study the words, write it down on the space provided on this piece of paper.

I then collected the piece of paper and presented the word list.

In the collaborative strategy condition I asked participants to agree on a strategy, then asked Partner A to write it down on a piece of paper. The verbatim instructions were:

> Before you start viewing the word list I would like you to decide together on a strategy for studying the words. When deciding on a strategy it may help you to think about any strategies or methods you plan to use during study to help you later recall the words. Try to think of these or any other strategies that might help you to remember the words. When you have decided on a strategy to help you study the words, write it down on the space provided on this piece of paper.

I then collected the piece of paper, asked participants to return to their computers, and presented the word list. Nominating a strategy took on average 2.5 minutes and no more than 5 minutes. After viewing the word list I asked participants to complete another distractor task that involved solving another set of multiplication problems for 3 minutes. After the distractor task participants completed Recall 2 in the same recall condition (nominal or collaborative) as

Recall 1. I gave all participants the same verbatim recall instructions as they received in Recall 1.

Study and recall word list 3. Following Recall 2, I asked collaborative participants to return to their individual tables and asked nominal participants to remain at their individual tables. I told all participants I would present them with another list of words and their task was to once again try to remember these words. No participants were asked to nominate a strategy. After viewing the word list I asked participants to complete another distractor task that involved solving another set of multiplication problems for 3 minutes. After the distractor task, participants completed Recall 3 in the same recall condition (nominal or collaborative) as Recall 1. The verbatim instructions were the same as Recall 1.

Post-experiment questionnaire. Following Recall 3, participants completed the post-experiment questionnaire, as described above. The verbatim instructions were the same as in Experiment 3. At the end of the experimental session, participants were debriefed, given an opportunity to ask questions about the experiment, and thanked for their time.

Scoring and Coding

Recall performance. In this experiment my unit of analysis was dyad performance at all recall points. As in Experiment 3, this study included the presentation of three word lists, with each list followed by one free recall test (completed either alone or collaboratively). I calculated the proportion of correctly recalled words, number of intrusions, and proportion of intrusions at each recall point as in Experiment 3

Self-reported group strategies. As in Experiment 3, I explored perceptions of group level strategy use at each recall point by calculating the number of participants in the collaborative condition who positively responded to this yes or no question.

Collaborative processes. As in Experiments 1, 2, and 3, the large number of collaborative dyads I tested, and my lack of success coding the transcripts of top performers in Experiment 1 made me reluctant to invest the huge time and resources needed to conduct detailed process coding of all the collaborative recall sessions. However, to explore if an explicit instruction to agree on an encoding strategy changed how groups started their recall, I transcribed and coded the first and second conversational turns for each partner in the collaborative dyads at Recall 1 (prior to the strategy instruction), and Recall 2 (following the strategy instruction) (as in Experiment 3). The opening utterances were deemed to be "starting on the same page" if some attempt was made by either partner: (1) to explicitly state a particular category to start recall with (e.g., "Do you want to go through careers first?"), (2) to identify one or more of the categories (e.g., "I remember a few of the body parts like arm."), (3) to explicitly state the group could remember the list in the presentation order (e.g., "Start with the first ones?"), (4) to identify word order (e.g., "Alley, cancer, skyscraper I think were the first three"), or (5) to offer some other strategy that aimed to coordinate or direct the group recall (e.g., "Let's go one each."). A research assistant was trained on the coding scheme and also coded the conversational turns to allow for interrater reliability to be analysed.

Results

I present a series of five analyses: (1) costs and benefits during collaboration, (2) nominated strategies and self-reported group strategy use, (3) collaborative processes in the first conversational turns, (4) difficulty of recalling, and (5) helpfulness of collaboration.

During one nominal testing session, a fire alarm sounded during the post-experiment questionnaire phase, and the session was ended. There was only one participant run during this session. Since recall data had been collected without interruption, this participant was included in the recall performance analyses, but has missing data for some of the questions from the post-experiment questionnaire analysed below.

Costs and Benefits During Collaboration

Proportion correctly recalled. The proportion of the word list correctly recalled by dyads ranged from 0.28 to 0.75 at Recall 1, from 0.18 to 0.78 at Recall 2, and from 0.20 to 0.83 at Recall 3 (see Table 5.1 for means). I conducted a (3) x 2 x 2 mixed ANOVA. Time (Recall 1, Recall 2, Recall 3) was entered as a within-subject variable, Strategy (no strategy, strategy instruction), and Dyad Type (nominal, collaborative) were each entered as independent between-subjects variables and the proportion of correct recall was entered as the dependent variable. This ANOVA revealed a significant main effect of Dyad Type, $F(1, 60) = 20.79$, $p < .001$, $\eta_p^2 = .26$. This main effect reflects a collaborative inhibition effect: dyads in the collaborative condition recalled a smaller proportion of the three word lists than dyads in the nominal. I also found a significant effect of Time, $F(2, 120) = 17.97$, $p < .001$, $\eta_p^2 = .23$. Follow up pairwise contrasts found that Recall 1 performance was lower ($M = 0.51$, $SD = 0.13$) than both Recall 2 ($M = 0.58$, $SD = 0.13$) and Recall 3 ($M = 0.59$, $SD = 0.13$), $p < .001$, and $p < .001$ respectively. There was no significant difference between Recall 2 and Recall 3 performance, which suggests that dyad performance increased from Recall 1 to Recall 2 and then plateaued at Recall 3, $p = .299$. I found no significant main effect of Strategy, $F(1, 60) = 0.25$, $p = .618$, $\eta_p^2 < .01$, and no significant interactions, all Fs < 821, all ps > .06. These findings suggest that although dyads improved their recall performance with practice, the magnitude of the collaborative inhibition effect did not reduce over time (see Figure 5.1).

Table 5.1
Mean Proportion of Word List Correctly Recalled by Strategy Instruction, Dyad Type, and Time

	Recall 1		Recall 2		Recall 3	
Condition	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
No strategy						
Nominal[a]	.54 (.06)	[0.51, 0.57]	.62 (.10)	[0.57, 0.67]	.66 (.08)	[0.62, 0.70]
Collaborative[a]	.46 (.13)	[0.40, 0.53]	.53 (.11)	[0.47, 0.59]	.50 (.13)	[0.44, 0.57]
Strategy						
Nominal[a]	.58 (.12)	[0.52, 0.64]	.64 (.11)	[0.58, 0.70]	.64 (.10)	[0.59, 0.70]
Collaborative[a]	.45 (.16)	[0.36, 0.53]	.52 (.16)	[0.43, 0.60]	.56 (.15)	[0.48, 0.64]

Note. CI = confidence interval.
[a]*n* = 16 dyads

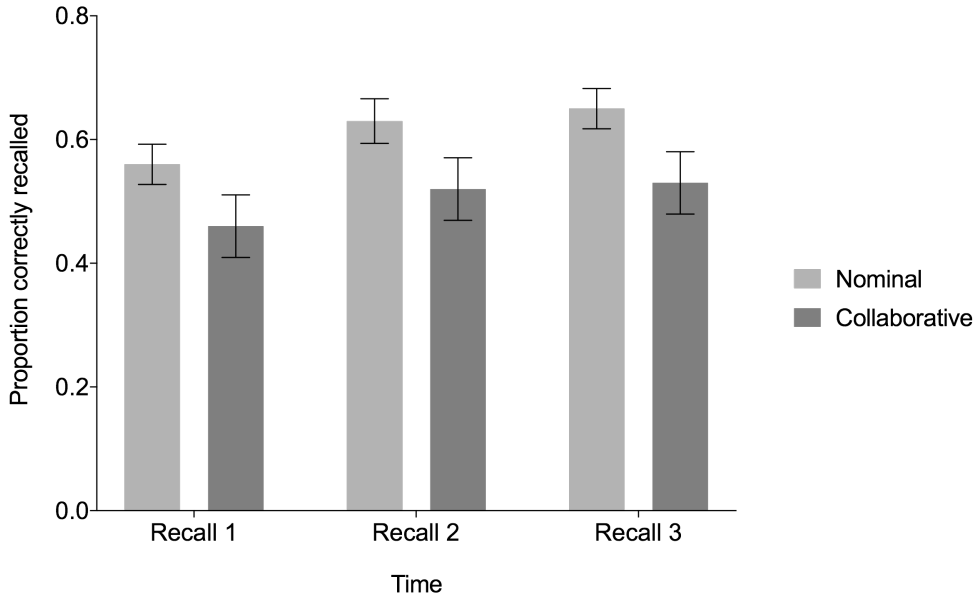

Figure 5.1. Mean proportion of correctly recalled words at each recall point by Dyad Type. Error bars indicate 95% CI.

Intrusions. Dyad intrusion scores ranged from 0 to 9 at Recall 1, from 0 to 6 at Recall 2, and from 0 to 12 at Recall 3 (see Table 5.2 for means). A (3) x 2 x 2 mixed ANOVA on raw intrusion scores revealed only a significant main effect of Dyad Type, $F(1, 60) = 18.53$, $p < .001$, $\eta_p^2 = .24$. This main effect reflects a collaborative benefit: collaborative dyads recalled fewer intrusions than nominal dyads. I found no other significant main effects, all Fs < 0.349, all ps > .706, and no significant interactions, all Fs < 0.841, all ps >.434. Since the lower number of intrusions produced by collaborative dyads could be a result of collaborative dyads simply producing fewer words (correct and incorrect) in total than nominal dyads I conducted another (3) x 2 x 2 mixed ANOVA on the proportion of recall containing intrusions. As above, I found only a significant main effect of Dyad Type, $F(1, 60) = 16.49$, $p < .001$, $\eta_p^2 = .22$. These results suggest that while collaborative groups were more accurate than nominal groups, this benefit did not increase with practice.

Table 5.2
Mean Number of Intrusions Recalled by Strategy Instruction, Dyad Type, and Time

	Recall 1		Recall 2		Recall 3	
Condition	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
No strategy						
Nominal[a]	1.50 (2.66)	[0.08, 2.92]	1.75 (1.84)	[0.77, 2.73]	1.88 (2.90)	[0.33, 3.42]
Collaborative[a]	0.38 (0.62)	[0.05, 0.70]	0.50 (0.97)	[-0.01, 1.01]	0.56 (0.89)	[0.09, 1.04]
Strategy						
Nominal[a]	1.81 (1.33)	[1.11, 2.52]	2.44 (1.79)	[1.48, 3.39]	1.81 (1.94)	[0.78. 2.85]
Collaborative[a]	0.63 (0.96)	[0.11, 1.14]	0.31 (0.60)	[-0.01, 0.63]	0.38 (0.62)	[-0.05, 0.70]

Note. CI = confidence interval.
[a]n = 16 dyads

Self-Reported Strategy Use

Nominated encoding strategies. In both the nominal strategy and collaborative strategy condition all participants successfully nominated a strategy prior to Study 2. In the nominal strategy condition 16 (50.0%) participants wrote down that they would use the categories in the word list, 10 (31.3%) participants wrote they would create a story, 5 (15.6%) wrote that they would create acronyms with the first letter of the words, 5 (15.6%) wrote that they would associate the words with something external to the list, 5 (15.6%) wrote that they would rehearse the list, and 3 participants (9.4%) wrote that they would create images or visualise the words. Collaborative groups also nominated diverse strategies prior to encoding, and 10 dyads (62.50%) nominated more than one strategy. Overall, 7 dyads wrote down they would use the categorical nature of the list, 4 dyads wrote down they would use chunking, and 6 dyads wrote down that they would simply rehearse the words. Interestingly, 8 dyads wrote down a strategy explicitly involving dividing the encoding load (e.g., "taking turns remembering words in groups of two"). Only 2 dyads wrote down a strategy that explicitly mentioned sharing the encoding process. Of these two dyads, one wrote that they would use shared rehearsal ("our strategy is to say the words out loud") and the other dyad wrote down that they would each remember certain categories, to be agreed upon during the study phase ("we will each try and remember words associated with certain groups which will be decided during the task").

Self-reported group strategies. At Recall 1, about half the participants self-reported that they and their recall partner had used a retrieval strategy; 17 (53.13%) participants in the collaborative strategy condition compared to 16 (50.00%) participants in the collaborative no strategy condition, $\chi^2 = 0.06$, $p = .802$. At Recall 2, the majority of participants self-reported a group retrieval strategy; 31 (96.88%) participants in the collaborative strategy condition and 28 (87.50%) participants in the collaborative no strategy condition. By Recall 3, once again

the majority of participants self-reported a group retrieval strategy; 23 (71.88%) participants in the collaborative strategy condition, and 29 (90.63%) participants in the collaborative no strategy condition. Unlike in Experiment 3, I found no difference in the proportion of participants who self-reported a group strategy in the strategy and no strategy conditions at any time point, $\chi^2 = 0.06$, $p = .802$, $\chi^2 = 1.95$, $p = .162$, and $\chi^2 = 3.69$, $p = .055$ respectively. These results suggest that even those in collaborative no strategy condition had high rates of self-reported group strategies and that self-report increased after one exposure to the type of memory task. Since the majority of our collaborative participants indicated that they thought they and their partner were using a strategy by the second recall, there was no point in analysing the association between reporting a group strategy and group recall performance. However, as in Experiment 3, given the persistence of collaborative inhibition despite most groups believing they were using a group strategy, next I examine how well groups implemented their group level strategies during recall.

Collaborative Processes

At Recall 1, both raters agreed 100% on the presence or absence of an attempt to coordinate retrieval; the interrater reliability for the specific type of coordination attempt was extremely high, Kappa = 0.955, $p < .001$. At Recall 2, raters agreed on the presence of absence of an attempt to coordinate retrieval in all but one case (this case was discussed and a consensus was reached); interrater reliability for the specific type of coordination attempt was again extremely high, Kappa = 0.907, $p < .001$. At Recall 1, nine (56.25%) of the pairs in the strategy condition and nine (56.25%) of the pairs in the no strategy condition saw one partner make an attempt to "start on the same page" as their recall partner on their first conversational turn. In contrast, at Recall 2 twelve (75.00%) strategy condition pairs compared to only four (43.80%) no strategy pairs saw one partner start the session with an explicit attempt to coordinate group recall, $\chi^2 = 8.00$, $p = .005$.

Importantly, as in Experiment 3, these coordinating attempts were unrelated to both Recall 1 and Recall 2 performance. Collaborative dyads that started on the same page in Recall 1 ($M = 0.44$, $SD = 0.16$) recalled no more than collaborative dyads that did not start on the same page ($M = 0.47$, $SD = 0.12$), $F(1, 30) = 0.32$, $p = .579$. Likewise, collaborative dyads that started on the same page in Recall 2 ($M = 0.50$, $SD = 0.14$) recalled no more than dyads that did not start on the same page ($M = 0.54$, $SD = 0.13$) (with Recall 1 entered as a covariate), $F(1, 29) = 0.01$, $p = .908$. Looking at the transcripts, this seems to be because, as in Experiment 3, few groups that started on the same page continued to systematically exhaust their recall using the first strategy offered. Starting on the same page again did not guarantee remaining on the same page, even when strategies were agreed before encoding. This may be in part due to the differentiated strategies the groups in the strategy used during encoding of the second word list, compared to the more consistent categorisation strategy used in Experiment 3. This sometimes resulted in pairs not being able to reach consensus on the presence of words because during encoding they used a "divide and conquer" approach. For example, one dyad agreed to alternate studying every three words, making a story for themselves with each set of three words. As they started their recall the following exchange occurred, as they identified a challenge with their earlier encoding strategy:

Partner A: Ok... Um... first one was mouth?

Partner B: Yes.

Partner A: And then... arm. No?

Partner B: No. Sorry.

Partner A: Insecure? No!

Partner B: Sorry.

Partner A: I think there was a flaw!

Throughout the rest of their recall they faced similar challenges of not remembering the words their partner had encoded.

Difficulty of Recalling

About two thirds of participants described recalling at Recall 1 as "very difficult" or "difficult", compared to half at Recall 2 and Recall 3 (see Table 5.3 for frequency of responses). Given the ordinal nature of the data, I used non-parametric tests to examine differences in the proportion of responses across conditions. I found no difference in the proportion of responses between those in the nominal condition or those in the collaborative condition at Recall 1, Recall 2, or Recall 3, Mann-Whitney U = 1832.00, p = .251, Mann-Whitney U = 1930.50, p = .657, and Mann-Whitney U = 1987.00, p = .883 respectively. When I split the sample and compared those in the no strategy condition and those in the strategy condition separately, I still found no difference in the proportion of difficulty responses between those in the nominal condition and those in the collaborative condition at any recall time point.

Table 5.3
Frequency of Difficulty of Recall Responses by Strategy and Dyad Type

Condition	Very difficult	Difficult	Neither easy nor difficult	Easy	Very easy
			Recall 1		
No strategy					
Nominal[a]	3 (9.38%)	19 (59.38%)	8 (25.00%)	1 (3.13%)	1 (3.13%)
Collaborative[a]	3 (9.38%)	18 (56.25%)	5 (15.63%)	6 (18.75%)	0 (0.00%)
Strategy					
Nominal[a]	5 (15.63%)	18 (56.25%)	4 (12.50%)	5 (15.63%)	0 (0.00%)
Collaborative[a]	2 (6.25%)	18 (56.25%)	5 (15.63%)	7 (21.88%)	0 (0.00%)
			Recall 2		
No strategy					
Nominal[b]	1 (3.23%)	10 (32.26%)	13 (41.94%)	7 (22.58%)	0 (0.00%)
Collaborative[a]	0 (0.00%)	14 (43.75%)	12 (37.50%)	5 (15.63%)	1 (3.13%)
Strategy					
Nominal[a]	1 (3.13%)	17 (53.13%)	10 (31.25%)	4 (12.50%)	0 (0.00%)
Collaborative[a]	2 (6.25%)	17 (53.13%)	8 (25.00%)	5 (15.63%)	0 (0.00%)
			Recall 3		
No strategy					
Nominal[b]	4 (12.90%)	9 (29.03%)	6 (19.35%)	12 (38.71%)	0 (0.00%)
Collaborative[a]	3 (9.38%)	13 (40.65%)	10 (31.25%)	6 (18.75%)	0 (0.00%)
Strategy					
Nominal[a]	4 (12.50%)	16 (50.00%)	6 (18.75%)	6 (18.75%)	0 (0.00%)
Collaborative[a]	3 (9.38%)	13 (40.65%)	6 (18.75%)	10 (31.25%)	0 (0.00%)

[a]*n* = 32 individuals
[b]*n* = 31 individuals

Helpfulness of Collaboration

During collaboration. The majority of those in the collaborative condition described collaboration as "helpful" or "very helpful" at Recall 1 (79.69%), Recall 2 (84.38%), and Recall 3 (85.94%) (see Table 5.3 for frequency of responses). Given the ordinal nature of the data, I used non-parametric tests to examine differences in the proportion of responses across conditions. At Recall 1, Recall 2, and Recall 3, I found no difference in the proportion of responses between those in the no strategy condition and those in the strategy condition, Mann-Whitney U = 426.00, p = .186, Mann-Whitney U = 467.50, p = .513, and Mann-Whitney U = 495.00, p = .794 respectively. This suggests that a strategy instruction given prior to encoding did not make participants more likely to endorse the helpfulness of collaboration. This is contrary to my findings in Experiment 3, where participants in the strategy condition felt collaboration more helpful than those in no strategy condition at Recall 2 and Recall 3. The lack of an effect in the present study may reflect the less effective strategies that collaborative dyads in the strategy condition nominated before encoding.

In everyday life. The majority of participants (90.55%) rated collaboration in everyday life as "helpful" or "very helpful" (see Table 5.5 for frequency of responses). Given the ordinal nature of the data, I used non-parametric tests to examine differences in the proportion of responses across conditions. I found no difference in the proportions of responses between those in the nominal condition and those in the collaborative condition, Mann-Whitney U =1812.50, p = .257. When I split the sample and compared those in the no strategy condition and those in the strategy condition separately, I still found no difference in the proportion of helpfulness responses between those in the nominal condition and those in the collaborative condition, Mann-Whitney U = 436.00, p = .355, and Mann-Whitney U = 471.00, p = .515 respectively. This suggests that, unlike in Experiment 3, everyone thought collaboration was helpful regardless of whether they were asked to agree on a strategy.

Table 5.4
Frequency of Helpfulness During Collaboration Responses by Strategy

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
			Recall 1		
No strategy[a]	0 (0.00%)	1 (3.13%)	5 (15.63%)	17 (53.13%)	9 (28.13%)
Strategy[a]	0 (0.00%)	0 (0.00%)	7 (21.88%)	22 (68.75%)	3 (9.75%)
			Recall 2		
No strategy[a]	1 (3.13%)	0 (0.00%)	5 (15.63%)	16 (50.00%)	10 (31.25%)
Strategy[a]	1 (3.13%)	1 (3.13%)	2 (6.25%)	16 (50.00%)	12 (37.50%)
			Recall 3		
No strategy[a]	1 (3.13%)	0 (0.00%)	4 (12.50%)	17 (53.13%)	10 (31.25%)
Strategy[a]	0 (0.00%)	0 (0.00%)	4 (12.50%)	23 (71.88%)	5 (15.63%)

[a]*n* = 32 individuals

Table 5.5
Frequency of Helpfulness of Collaboration in Everyday Life Responses by Strategy and Dyad Type

Condition	Very unhelpful	Unhelpful	Neither helpful nor unhelpful	Helpful	Very helpful
No strategy					
Nominal[a]	0 (0.00%)	0 (0.00%)	4 (12.90%)	19 (61.29%)	8 (25.80%)
Collaborative[b]	1 (3.13%)	1 (3.13%)	1 (3.13%)	17 (53.13%)	12 (37.50%)
Strategy					
Nominal[b]	0 (0.00%)	0 (0.00%)	3 (9.75%)	21 (65.63%)	8 (25.00%)
Collaborative[b]	0 (0.00%)	0 (0.00%)	2 (6.25%)	20 (62.50%)	10 (31.25%)

[a]*n* = 31 individuals
[b]*n* = 32 individuals

Discussion

Consistent with Experiment 3, but contrary to my expectations, I found the typical collaborative inhibition effect at all three recall time points. In addition, I found that providing collaborative dyads with an instruction to agree on a way to remember the words prior to encoding the second word list offered no additional benefit or cost to subsequent collaborative recall. I also found a high rate of self-reported use of group retrieval strategies at Recall 2 in both the collaborative no strategy and strategy conditions, suggesting that practice without an explicit strategy agreement was sufficient in this experiment to encourage the perception of group strategy use. I did find that those in the collaborative strategy condition were more likely than those in the collaborative no strategy condition to start Recall 2 with some attempt to orientate or coordinate group recall. Starting recall in this manner, however, was not associated with better group performance. As in Experiment 3, this may be due to a lack of maintenance of the group strategy.

In Experiment 3, I noted the difficulties collaborative groups experienced in maintaining group level strategies during recall. I expected that offering the strategy instruction at encoding might help groups to coordinate their retrieval by making encoding strategies more similar, and thus reduce variation in their idiosyncratic retrieval strategies. However, in the current experiment I found that half the groups in the collaborative strategy instruction condition chose encoding strategies that encouraged each partner to encode different words. Thus, rather than encouraging encoding overlap, my instructions seemingly encouraged many groups to use a divide and conquer approach. The tendency to want to divide the encoding load may have been detrimental to later recall in two ways. First, often the encoding strategy added additional cognitive load to the encoding phase. For example, participants in one group opted for one participant to remember the first five words, and then the other participant to remember the next five words, and so on, meaning that they each had

to track the number of words that had been displayed so far and whether this was one of "their" words. This no doubt made encoding more difficult. Second, if the differentiated encoding strategy was strictly adhered to, groups may have had problems reaching consensus at recall about the presence of words (as required by my recall instructions) because there was little overlap in the words they encoded during study. These potentially less effective encoding strategies may explain why those in the collaborative strategy condition and those in the collaborative no strategy condition found collaboration equally helpful (at Recall 2). This finding differs from Experiment 3, where even though there was no difference in collaborative performance, those in the collaborative strategy condition felt collaboration more helpful at this second recall point than those in the collaborative no strategy condition. Future studies exploring explicit strategy agreement at encoding should consider using an instruction that emphasises group coordination and discourages dividing the task.

As in Experiment 3, groups that began Recall 2 with an explicit statement that either orientated their partner to how they were going to try to recall, or suggested a way to coordinate group recall did not outperform groups in which neither partner attempted to explicitly direct recall. Once again, this is likely because few groups that started "on the same page" were able to maintain their coordination for the duration of the recall period. In both Experiments 3 and 4 my instructions did not include any direction to try to maintain their nominated strategy. It is possible that without such an instruction to increase metacognitive awareness of their processes, staying on the same page is challenging for stranger dyads to achieve. In addition, for better maintenance of group level strategies, perhaps groups need to encode stimuli in a context that encourages mutual understanding of the stimuli. Perhaps this sort of collaborative encoding would be similar to the use of elaborative encoding strategies by individuals. To test this possibility, future studies exploring the use of explicit strategy agreement on collaborative inhibition should use stimuli that collaborative encoding groups

are more likely to encode in a meaningful way together, and make the importance of strategy maintenance explicit in the instructions.

Chapter 6

General Discussion

In this thesis I took my first steps towards bridging the gap between cases of collaborative remembering in the world and cases of collaborative remembering in the laboratory. Drawing on socio-cultural learning theories, mother-child memory scaffolding studies, and transactive memory studies, I replicated in a controlled setting three conditions that may be associated with collaborative success: (1) closeness, (2) asymmetrical cognitive need, and (3) the use of explicit group level memory strategies. I experimentally tested the influence of each of these three factors on the costs and benefits of collaboration.

I chose to examine the effects of closeness on collaborative recall since, according to socio-cultural theory, sensitive and responsive interactions are important for successful scaffolding (Bliss et al., 1996; Cleveland & Reese, 2005; Rogoff & Gardner, 1984). In turn, closeness may underlie the ability of group members to respond sensitively to each other. Further, closeness in intimate groups, such as romantic couples, is thought to support the development of transactive memory systems (Wegner et al., 1985).

I chose to examine the influence of asymmetrical need on collaborative recall since the importance of scaffolding has frequently been demonstrated in groups with asymmetrical cognitive abilities, such as teachers and children (e.g., Bliss et al., 1996), parents and children (e.g., Cleveland & Reese, 2005; Fivush et al., 2006; Habermas et al., 2010; Haden, 1998; McGuigan & Salmon, 2004; K. Nelson & Fivush, 2004; Van Bergen et al., 2009; Wareham & Salmon, 2006), and carers and people with dementia (e.g., Hydén, 2011, 2014; Majlesi & Ekström, 2016). In addition, it may only be in combination with a sense of closeness that group members are willing to seek and accept help in a sensitive and responsive manner.

Finally, I chose to examine the impact of explicit strategies on collaborative recall since there is converging evidence from mother-child memory scaffolding studies, transactive memory research, and collaborative recall research that getting on the same page (aligning and coordinating through sensitive and responsive interactions) is positively associated with

memory performance (e.g., Cleveland & Reese, 2005; Fivush, 2011; Harris et al., 2013; Harris et al., 2011; Meade et al., 2009; Vredeveldt, Groen, et al., 2016; Vredeveldt, Hildebrandt, et al., 2016; Wegner et al., 1991).

To test the influence of closeness, cognitive need, and explicit strategy use on collaborative recall, I extended the collaborative recall paradigm in a series of four experiments. Specifically, I manipulated the sense of closeness between two strangers and the cognitive need of participants during recall (Experiment 1), recruited romantic partners and close friends to recall a variety of stimuli and also manipulated their cognitive need during recall (Experiment 2), and I gave stranger dyads an opportunity to agree on group level strategies either prior to recalling (Experiment 3) or prior to encoding (Experiment 4).

Main Findings

In all four experiments I found a robust cost of remembering together, with collaborative groups consistently recalling fewer items than nominal groups. This finding of collaborative inhibition is consistent with the large majority of collaborative recall experiments in the last two decades (e.g., Barber & Rajaram, 2011a, 2011b; Barber et al., 2010; Barber, Rajaram, & Fox, 2012; Basden et al., 1997; Blumen & Rajaram, 2008, 2009; Blumen & Stern, 2011; Blumen et al., 2014; Congleton & Rajaram, 2011, 2014; Dahlström, Danielsson, Emilsson, & Andersson, 2011; Finlay et al., 2000; Harris et al., 2012, 2013; Henkel & Rajaram, 2011; Hyman et al., 2013; Meade & Roediger, 2009; Pereira-Pasarin & Rajaram, 2011; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004; Weldon & Bellinger, 1997; Weldon et al., 2000; Wright & Klumpp, 2004). Importantly, however, I also found evidence of multiple benefits of remembering together.

First, in the two experiments in which I tested for post-collaborative effects (Experiments 1 and 2), I found that individuals who previously collaborated recalled more than individuals who previously recalled alone. This post-collaborative benefit is consistent

with previous studies that have explored individual recall following collaboration (Barber & Rajaram, 2011b; Blumen & Rajaram, 2008, 2009; Blumen et al., 2014; Congleton & Rajaram, 2011, 2014; Harris et al., 2012; Henkel & Rajaram, 2011; Wissman & Rawson, 2015), and highlights the potential value of collaboration even given inhibition at the time of collaboration itself.

Second, in all four experiments I found greater accuracy during collaboration, with collaborative groups producing fewer intrusions (both in total number and relative to the total amount recalled) than nominal groups. These findings are consistent with experiments in which collaboration instructions encourage group members to monitor for and correct errors (via a focus on consensus; e.g., Congleton & Rajaram, 2011; Harris et al., 2012; Hyman et al., 2013; Ross et al., 2008). Contrary to some previous studies (e.g., Harris et al., 2012; 2013, Exp 1), I did not find any evidence for increased accuracy post collaboration. This finding may be due to a floor effect since intrusion scores were generally low (as also suggested by Harris et al., 2013, Exp 2).

Finally, participants themselves typically reported that collaboration helped them during the experimental tasks. Thus, while collaboration may inhibit scorable performance during the recall task itself, there may be subjective benefits. Those who previously collaborated with another participant also perceived that remembering with others in everyday life was more helpful than those who recalled alone. Although this perceived helpfulness was influenced by the strategy manipulations (Experiments 3 and 4)—whereby those who nominated a strategy and collaborated (at retrieval but not at encoding) described collaboration in everyday life as more helpful than those who nominated a strategy and recalled alone—these findings are nonetheless consistent with a previous study that explored beliefs about the helpfulness of collaboration (Henkel & Rajaram, 2011).

Given my focus in this thesis on the conditions that may reduce the costs and enhance the benefits of collaboration, I summarise below the main findings relating to closeness, cognitive need, and explicit strategy agreement. I discuss each condition in turn, noting both reasons for the persistence of collaborative inhibition and implications of my findings of collaborative benefits.

Closeness and Cognitive Need

In Experiment 1, I successfully increased the sense of closeness in dyads of previously unacquainted participants using a modified version of Aron et al.'s (1997) intimacy task. In addition, I also attempted to create asymmetrical cognitive need within dyads by assigning a divided attention task to one dyad member during recall. I expected that these manipulations, either alone or in combination, might encourage scaffolding, and reduce the costs and increase the benefits of remembering with another. However, neither my closeness nor my cognitive need manipulation influenced the magnitude of collaborative inhibition, individual post-collaborative benefit, or accuracy during collaboration. It may be that experimentally induced closeness is simply not sufficient to influence collaborative performance or processes in unfamiliar pairs. This transient closeness lacks the richness of a deeper sense of intimacy, and the absence of shared knowledge and experiences with other group members may result in groups lacking the metacognitive knowledge required to sensitively respond to and support each other.

I did find, however, one hint that asymmetrical cognitive need may reduce the magnitude of collaborative inhibition when the divided attention task made recall challenging. I did not find the typical pattern of collaborative inhibition when participants who were under divided attention described the recall task as "very difficult" or "difficult", thus indicating that they were experiencing significant cognitive load. But I found the typical pattern of collaborative inhibition when participants who were under divided attention described the

recall task as “neither easy nor difficult”, “easy”, or “very easy”, suggesting they were not experiencing significant cognitive load. Since half the sample who were placed under divided attention did not find recall challenging in the first place, it is possible that a stronger cognitive need manipulation would eliminate collaborative inhibition in stranger dyads. Further supporting the possibility that my closeness and cognitive need manipulations were not strong enough, I found that participants who collaborated described collaboration as helpful, regardless of condition. This suggests that neither the closeness nor the cognitive need manipulations were able to alter the experiential quality of collaboration.

In Experiment 2, a follow up to Experiment 1, I made two changes based on my Experiment 1 results. First, since the rapid intimacy task used to induce closeness in Experiment 1 does not match in richness the deeper intimacy and shared past experiences of some close and familiar groups (e.g. family members and friends), I recruited romantic couples and close friends to participate. To test whether closeness is helpful during collaboration for personally relevant material, I also added two additional memory tasks: one in which participants were asked to recall their shared friends and acquaintances—drawing on personally relevant semantic information—and one in which they were asked to recall the countries in Europe—drawing on non-personally relevant semantic information. Second, since the divided attention task in Experiment 1 may not have added sufficient cognitive load, I increased the difficulty of the task. Despite the increased difficulty of the divided attention task and the closer participant groups, I again found the typical pattern of collaborative inhibition. I also found post-collaborative benefits on all memory tasks, and greater accuracy during recall of the word list during collaboration (with a hint of increased accuracy on individual recall post collaboration). As in Experiment 1, participants in the no divided attention and divided attention conditions who collaborated found collaboration equally

helpful. This finding suggests that my manipulations were not able to alter the experiential quality of collaboration.

While my findings in Experiment 2 were broadly consistent with collaborative inhibition, there was some suggestion that couples might have experienced less collaborative inhibition than close friends. Thus, the kind of closeness shared between partners and the kind of task might both be important. This possibility emerged specifically in the shared friends task when I considered the 31 romantic couple dyads separately from the 32 close friend dyads. While I found that close friends collaborating on this task showed the standard collaborative inhibition pattern, couples collaborating on this task performed the same as nominal pairs (a finding that is consistent with Harris et al.'s (2011) study with older couples). Given this, the overarching finding of collaborative inhibition on this task may have been driven predominantly by inhibition amongst the close friend dyads.

One possible explanation for the difference between couples and friends on the shared friends task is that couples may have been closer. However, this possibility was not supported by my closeness measurements, as both samples reported similar levels of closeness, except close friends reported a higher level of Social intimacy than couples. I therefore speculate that the elimination of collaborative inhibition amongst couples but not friends may be due to the strategies couples were able to employ during the task: couples were able to structure their recall using a your/my friend distinction, whereas friends more commonly had one super-category of "our friends". Supporting this possibility, as noted above, friends rated their Social intimacy higher than couples, suggesting that they spent more time together socialising with mutual friends. Further, there were no indications of a difference in performance between couples and close friends on either of the other two memory tasks (the word list or the countries of Europe task). This finding highlights the importance of considering both the type of group and the type of task when assessing collaborative performance. Overall, my

findings suggest that even a strong sense of closeness with a shared past, combined with asymmetrical cognitive need, was not sufficient to abolish the standard collaborative inhibition effect, nor was it able to boost the standard benefits of collaboration.

Strategy Use

In both Experiments 1 and 2, I captured participants' self-reported group memory strategies by coding responses to an open-ended question and used this as a measure of group coordination. In Experiment 1, participants in all collaborative conditions reported similar rates of strategy use. However, I did find that dyads in which at least one person reported they and their recall partner used a strategy during recall outperformed collaborative dyads in which neither dyad member self-reported a group memory strategy. This is consistent with previous findings by Harris et al. (2013), who reported that self-report of a group strategy was positively associated with collaborative memory performance. In Experiment 2, it was more difficult to compare those who did and did not report using a group memory strategy due to high rates of reported strategy use. Indeed, *most* participants believed that they and their partner or friend used a group strategy, irrespective of whether they were in a group with additional cognitive need or not. This meant that there was an insufficient number of participants reporting no group memory strategy to directly compare performance of strategy users and non-users. Interestingly, despite the high rate of group strategy reporting in Experiment 2, collaborative inhibition was not eliminated. It may be that there is a disconnect between the strategies these close and familiar dyads reported and the effectiveness of these strategies for overcoming the costs of collaboration. Alternatively, while the strategies may not have been effective in reducing the magnitude of collaborative inhibition, they may have benefited the group in other ways, such as helping group accuracy, or reflect the sense of ease couples and friends felt when completing the tasks together (see Strategy Use and Maintenance section).

To expand on the group strategy findings from Experiments 1 and 2, in Experiment 3 I introduced an explicit instruction in which half the participating dyads were asked to agree on a recall strategy prior to retrieval. Given the benefit of group strategy I observed for stranger dyads in Experiment 1, I recruited strangers for Experiment 3. Also, given the high rate of self-reported group memory strategies in the couple and close friend dyads in Experiment 2 (who have past experiences of shared remembering), I was interested in how practice recalling together may change group performance and perception of group coordination in stranger dyads over multiple recall points. Contrary to my expectations, the explicit retrieval strategy instruction did not reduce collaborative inhibition, nor did it increase accuracy during collaboration. Similarly, while recall performance improved between the first and second recall tasks, this also did not reduce collaborative inhibition. Those in the collaborative and nominal groups improved at a similar rate, suggesting that task practice enhances performance but with no additional benefit of practicing together vs. alone, with or without an explicit instruction to use a strategy.

The lack of effect for the strategy instruction was interesting given that all dyads in this condition agreed to use the categories to help them recall (which is potentially an effective strategy given the categorical nature of the word list). One possible explanation is that many participants who were not given the strategy instruction also reported (in the post-experiment questionnaire) that their group used the categories to help them recall the words. In other words, groups used an effective strategy regardless of whether they had been instructed to agree on a strategy or not. Alternatively, it is possible that participants were poor at maintaining their strategy use. An analysis of first conversational turns of each group revealed that, although the majority of collaborative strategy dyads started their recall following the strategy instruction with an attempt to coordinate group retrieval, less than half of those dyads were able to maintain the strategy through the recall session. Thus, my results

suggest that the strategy agreement instruction may have helped dyads *start* on the same the page, but did not help them *stay* on the same page.

Interestingly, despite the strategy instruction not improving collaborative performance, participants in this condition found collaboration (after the introduction of the strategy instruction) more subjectively helpful than participants who were not given the strategy instruction. This suggests that explicitly discussing and agreeing on a retrieval strategy changed the experiential quality of the collaborative experience – not just immediately following the agreement, but on a subsequent recall task as well.

Since the instruction just prior to retrieval in Experiment 3 may have been too late to optimally facilitate dyads *staying* on the same page, in Experiment 4 I aimed to explore if giving a strategy agreement just prior to encoding could help groups approach encoding with a shared understanding of the task and thus facilitate staying on the same page during retrieval. As in Experiment 3, I found no evidence that the strategy agreement instruction either reduced collaborative inhibition, or increased accuracy during collaboration. However, the reasons for this could be different to Experiment 3.

Whereas in Experiment 3 all the collaborative strategy groups nominated a potentially effective retrieval strategy (using the categorical nature of the list), in Experiment 4 the nominated encoding strategies varied greatly in potential effectiveness. For example, many groups used a divide and conquer approach, such as alternating words to remember or each participant using a different type of individual encoding strategy (e.g., one member created a story from the words, and the other visualised the words). These strategies likely added cognitive load during encoding. In addition, previous findings suggest that facilitating a shared representation during encoding can eliminate collaborative inhibition (Harris et al., 2013), but it seems likely that these differentiated encoding strategies would be less effective in facilitating this shared understanding, and thus less effective in abolishing collaborative

inhibition. Instead of participants getting on the same page during encoding, the strategy instruction did not encourage many groups to come to a shared understanding of the stimuli, or the task. Participants who used different encoding strategies would face standard retrieval disruption at recall. Further, participants who divided the word list up may have struggled to reach consensus at recall as each dyad member had encoded different items. While differentiation of knowledge can be beneficial to collaboration (as perhaps in the couples completing the shared friends task discussed above), under the conditions of this task—in which both dyad members needed to agree an item was present on the list or not—these strategies were less effective.

The less effective strategies in Experiment 4 may explain why, contrary to Experiment 3, those given the strategy instruction found collaboration no more useful than those not given the strategy instruction. Interestingly, an analysis of the first conversational turns during collaboration following the strategy instruction found that the majority of groups started on the same page, but as in Experiment 3, most were unable to maintain coordination of their strategy throughout the entire recall session. The conversational turns analyses from both Experiments 3 and 4 highlight how challenging stranger dyads find staying on the same page. Maintenance perhaps requires sensitivity and reflexivity from at least one member of the group, or the introduction of a metacognitive instruction to monitor the implementation of the strategy.

Nuances of Collaborative Recall

The results of my four experiments show how remarkably robust collaborative inhibition is. Moreover, they also show how robust the findings are of commensurate benefits for accuracy during collaboration and for post-collaborative recall. While my manipulations of closeness, cognitive need, and strategy use were not successful in influencing the amount or accuracy of recall, it is important to remember that each is only a first step towards

considering the influence of these conditions on recall, within a laboratory setting. There is potential for future research to strengthen the manipulation of each of the three factors under consideration: perhaps to generate or isolate cases that are more extreme, for example, by using a stronger cognitive need manipulation, or by using different stimuli or tasks.

Despite the remarkably robust effects of collaborative inhibition and post-collaborative benefits, a number of interesting nuances also emerged. I now turn to discuss three aspects that emerged from my findings that are important for collaborative performance: the type of group, the types of recall tasks, and strategy type and strategy maintenance.

Relationship Type

Although both Experiments 1 and 2 explored the influence of closeness on collaboration, the key difference between participants was relationship type. At face value it is easy to conclude that the results from Experiment 1 are due to a weak sense of closeness since intimacy was manipulated in strangers though a simple activity. Although closeness has not been manipulated this way in memory research before, there is related evidence from organisational research that group closeness developed from self-disclosure activities may not improve group performance in the absence of the development of group cohesion (i.e., a sense of group identity; Rosh et al., 2012). Thus, close strangers may not have shared joint goals, but rather maintained a focus on meeting individual goals.

Given the suggestion that the close strangers in Experiment 1 may simply not have been close enough to share joint goals with one another, it is particularly interesting that the couples and close friends in Experiment 2—despite their richer sense of closeness and their shared pasts—also did not demonstrate a reduction in typical collaborative costs nor an increase in typical collaborative benefits on tasks that could utilise their shared knowledge. The only exception to this pattern was for collaborative performance on the personal semantic memory task. Couples appeared to show no collaborative inhibition when recalling the names

of shared friends, whereas close friends showed the standard pattern of collaborative inhibition. As I suggest above, however, this difference may have more to do with task type than a difference in the qualitative closeness in couples and friends: a possibility I discuss below (see Types of Memory Tasks section).

Since my participants in Experiment 2 were all "real world" dyads with shared lives, one possibility that arises when comparing my findings to others is that differences may exist according to age, life stage, or other socio-cultural and ecological factors. My findings of standard collaborative inhibition may reflect that the couples and close friends I recruited were younger and had less enmeshed lives than, for example, Harris et al.'s (2011) long-time married couples (many of whom did not show the typical pattern of collaborative inhibition on similar types of tasks). Participants in my study did not necessarily live together, and had by definition been together for a shorter period of time: in some cases, just one year. In addition, as young adults, many were perhaps more independent as a function of their current life stage. This means that their everyday experiences of recalling together may more frequently serve social goals such as intimacy maintenance (e.g., reminiscing about the first time they met) rather than more practical or instrumental goals (e.g., reminding each other of upcoming appoitnments, or groceries they need to buy; Alea & Bluck, 2003, 2007; Harris, Rasmussen, et al., 2014). Remembering together to meet these social goals may not require all details of an event to be recalled; indeed, some memory discussions may quickly morph into discussions about other events. Therefore, despite their opportunity to previously recall together (unlike the strangers in Experiment 1), couples and close friends may not be well practiced in helping each other to recall *more* information (Dixon & Gould, 1998). Thus, even for close and intimate groups, learning how best to scaffold and support the recall of one another may take a long time to develop (Barnier et al., 2014).

It is also possible that there is great diversity in scaffolding skills across different romantic couples and close friends. These individual differences may make it difficult to see "success" when focusing on the average output of groups that is typically measured. This possibility is supported by a rich body of work from sociocultural and developmental psychology (see Introduction, pp. 7-9). In research examining mothers' and children's discussions about shared past events, for example, findings across two decades have revealed that not all mothers optimally scaffold their children's recall (e.g., Cleveland & Reese, 2005; Fivush, 2011; Fivush & Fromhoff, 1988; Reese & Fivush, 2008; Reese et al., 1993). Likewise, not all of the older adult couples in Harris et al.'s (2011) study used the most effective communication strategies during collaboration. Thus, looking past the average performance amongst collaborating groups and exploring individual differences in how those groups carried out that collaboration may provide further insight into the scaffolding abilities of younger familiar adults. Although beyond the scope of the current project, the transcripts of the couples and close friends could be coded and scored using a similar coding scheme to Meade et al. (2009), Harris et al. (2011), Vredeveldt, Hildebrandt, et al. (2016), or Vredeveldt, Groen, et al. (2016). This would reveal if any of the close dyads in Experiment 2 used communication strategies (e.g., acknowledgment, repetition, and elaboration) that have been found to increase collaborative recall in some groups.

Further, while the overarching finding of collaborative inhibition in Experiment 2 is consistent with previous collaborative recall research with younger adult romantic couples (Ross et al., 2008) and friends (Andersson & Rönnberg, 1995; Harris et al., 2013), I predicted that the inclusion of a cognitive need manipulation would make participants more likely to reach beyond their individual memory systems and offer or accept help from their partner or close friend. Yet, not even the cognitive need manipulation was able to shift the standard finding of collaborative costs and post-collaborative benefits. A challenge in this thesis was

creating a laboratory analogue of asymmetrical cognitive need that generated sufficient difficulty when recalling. I was restricted in my choice of cognitive load task because participants needed to still be capable of engaging in typical social interaction with verbal discussion and eye contact. With an even more difficult divided attention task I may have been able to impair individual performance more consistently. However, it is possible that young, healthy adults simply have enough cognitive capacity to cope with added demands when recalling relatively simple types of stimuli. Alternatively, it could be that a temporary asymmetrical cognitive load was not salient enough to change group recall processes: these young adults may not have recognised that their partner or friend required assistance.

Young adults are competent independent remembers and may not yet be skilled at noticing and responding to memory difficulties in their recall partners, especially when the need has been artificially created. Consistent with Wegner's (1987) Transactive Memory theory, supporting a recall partner with a genuine cognitive need may be a skill that is developed over time as it requires the development of deep metacognitive knowledge about other group members' capabilities. A sudden, temporary, manufactured need may not reflect how groups respond to genuine need in everyday life. While little research has yet considered the difference between temporary and permanent cognitive need amongst couples, anecdotal support for this possibility is evident in Harris et al.'s (2011) study of older couples. In one couple, the husband had a brain injury that affected his short-term memory. The wife described how she had to "retrain" herself to interact with her husband to reduce interfering with his retrieval (e.g., letting him finish what he is saying before adding her own contribution to the conversation; as cited in Harris, Barnier, et al., 2014, p. 294). To test the possibility that similar metacognitive judgements about a partner's need might influence the recall of younger adults too, future studies could directly measure participants' beliefs about the need for memory assistance when one recall partner has a temporary or permanent

cognitive impairment. In addition, future research might also consider longitudinal studies capturing the influence of emerging group strategy development. Although I found little evidence to suggest that close groups were able to overcome the costs of collaboration irrespective of cognitive need, the investment in successful remembering strategies in younger adult couples and close friends might nonetheless be beneficial in later life when cognitive impairment becomes more common (Barnier et al., 2014).

Types of Memory Tasks

In addition to possible nuances in my findings according to the nature of the relationships, there may also be nuances according to the tasks themselves. Some tasks might be interpreted differently by different groups. In Experiment 2, I used a range of tasks (i.e., a word list, recalling the countries in Europe, and recalling the names of shared friends), and examined if the type of recall task (episodic recall of the word list vs. semantic recall of European countries and shared friends, and personally relevant recall of shared friends vs. not personally relevant recall of the word list and European countries) influenced group performance. As I note in several places above, the personal semantic task—in which participants were asked to recall their shared friends—was the only task for which romantic couples did not show the standard pattern of collaborative inhibition. The different pattern of performance in the shared friends task for couples and close friends highlights one challenge in administering tasks that try to tap into personally relevant content across more than one type of group. On the surface, both couples and friends remembered a similar number of people that they both knew. Examining the data more closely, however, couples tended to have two categories apparent in their recall (your/my friends), whereas friends tended to have one category (our friends). The former may have provided couples with a way to structure their recall, thus reducing retrieval disruption in a similar way as when groups are asked to exhaust their recall for each category of a word list before moving on to the next (Basden et

al., 1997, Exp 4). Thus, care must be taken when designing tasks to consider whether the structure of the stimuli may differ for different groups, even if on the surface the task appears to be tapping into the same information.

Different tasks might also promote different kinds of retrieval strategies that are more or less susceptible to the costs of collaboration. For example, my finding of collaborative inhibition on the European countries task in Experiment 2 is contrary to Andersson and Rönnberg's (1996; Exp 1) findings of no collaborative inhibition on a history quiz task, but similar to Hinds and Payne's (2016; Exp 1) findings of collaborative inhibition on a stem completion task. Given that I tested friends and romantic couples, Andersson and Rönnberg (1996) tested strangers and friends, and Hinds and Payne (2016) tested strangers, it is possible that these discrepancies relate not to the nature of the relationships but to the task itself. While all are semantic in nature, they are nonetheless distinct. First, the history quiz offers external cues for recall, whereas the European task and the stem completion require free recall. Second, the opportunity for elaboration to successfully cue recall is minimal in stem completion, and variable when listing European countries. Depending on geographical knowledge or past experiences travelling, couples and close friends may or may not have had ways to cue one another during this task. In contrast, a series of cued history questions allows more opportunity for group members, even if they do not know the correct answer at first, to elaborate on information that they might know that is related to each question and thus increase the chances of cross-cueing.

An alternative explanation to the persistence of collaborative inhibition on the semantic European task is that repeated recall of the same stimuli changes the episodicity of the task. Specifically, while the stimuli itself did not change, each recall instance may have added episodic cues from the previous generation of the stimuli. Despite the instructions to give each task a "fresh go", participants at the later recall points might have tried to recall the

countries they had previously recalled alone at Elicitation. This highlights one complexity in designing tasks that measure different types of memory that require some initial elicitation to gather baseline performance.

Finally, in all my experiments I used simple stimuli such as word lists. Although word lists have the benefit of being easy to score, they perhaps lack the complexity needed for group members to gain the most benefit from pooled cognitive resources (Kirschner et al., 2009; Kirschner, Paas, & Kirschner, 2011), or to scaffold each other's recall through communication strategies such as elaboration, restatements, or open-ended questions (Fivush & Fromhoff, 1988; Harris et al., 2011; Meade et al., 2009; Vredeveldt, Groen, et al., 2016; Vredeveldt, Hildebrandt, et al., 2016). More generally, considerations of the complexity vs. simplicity of stimuli raise questions about the generalisability of explanations for the costs and benefits of collaboration. Collaborative inhibition has been found using more complex stimuli, including stories (Weldon & Bellinger, 1997), images (Ross et al., 2008), and personal shopping lists (Ross et al., 2004). But complexity does not necessarily mean the tasks are ecologically valid, and some stimuli may be more difficult to process than their real-life counterpart. For example, the story used by Weldon and Bellinger (1997), "War of the Ghosts", is a mythological tale used by Bartlett in the 1930s when considering the impact of cultural knowledge on schema development (Bartlett, 1932). As such, it may not reflect the types of stories typically retold in a contemporary setting. Ross et al. (2008) used images designed for social contagion studies (Roediger et al., 2001). Although the images contained objects in "everyday" scenes (e.g., a tool box, a bedroom, or a desk), they were only displayed for 25 seconds. Thus, while the task content was familiar to participants, the task itself was novel—in day-to-day life we rarely have reason to recall items from static scenes presented so briefly. In contrast, Vredeveldt, Groen, et al. (2016) and Vredeveldt, Hildebrandt, et al. (2016) found no collaborative inhibition when recalling complex narrative based stimuli (a film

scene and a scene from a theatre production respectively) and when interviewed using a technique based on Dutch police interviewing procedure. The interview procedure may not only have encouraged similar retrieval strategies (e.g., to recall events in chronological order), but the cued recall phases during the interview may have helped collaborative dyads stay on the same page; it is possible the interviewer provided scaffolding that helped collaborative dyads perform as well as nominal dyads.

The personal shopping list task used by Ross et al. (2004) is interesting as it is more ecologically valid than the large majority of tasks used in collaborative memory experiments. In this study, older couples were asked to work together to select 25 items (from a possible 70 items) they would buy if they went shopping that day or in the near future. The list was then removed and the couple distracted for about an hour. Finally, they were driven to their local supermarket where, working alone or together, they proceeded to fill a shopping cart with items they recalled from their personal list. Yet despite stimuli with some personal relevance to the participants, and despite the test occurring in a familiar environment, it is uncommon to go shopping for 25 items without an external aid of a written shopping list. Thus, while collaborative inhibition was still observed, an easier task of the same general design may not show this same effect.

Strategy Use and Maintenance

While there is plentiful research highlighting effective recall strategies for individual recall, such as elaboration and organisation (Gronlund & Shiffrin, 1986; Hertzog et al., 1998; T. O. Nelson & Narens, 1990), we currently do not have a clear picture of what (if any) group level strategies are effective for recall. Studies by Meade et al. (2009), Harris et al. (2011), Vredeveldt, Hildebrandt, et al. (2016) and Vredeveldt, Groen, et al. (2016) have found examples of communication strategies that are associated with adults recalling more (e.g., acknowledgements, repetitions, or elaborations) or less (e.g., disagreements) together.

Although developmental research highlights the very robust findings that elaborative parental scaffolding supports stronger memory outcomes in children (Fivush, 2011; Reese, 2002; Wareham & Salmon, 2006), in adults the effectiveness of these strategies may still vary by group type. For example, contrary to Harris et al.'s (2011) finding that disagreements reduced collaborative performance in older adults, Selwood (2015) found that disagreements had no effect on the amount that younger adult siblings were able to recall together. It is important that future research consider what each collaborative group is doing to fully capture the range of individual differences in strategy use and memory outcomes.

Despite our limited understanding of *what* strategies are effective for groups, as in previous research (Harris et al., 2013), I found some evidence that groups who simply reported using a group strategy during collaborative recall recalled more together. These self-reported group memory strategies may differ from the communication strategies discussed above. Nevertheless, subjective perceptions of group level coordination may reflect important aspects of group performance. I also found that previous experience recalling together influenced the proportion of groups reporting a group memory strategy. For example, the couples and close friends in Experiment 2 had very high self-report of group memory strategies, suggesting familiarity may increase the perception of being on the same page. Further, even the strangers in Experiments 3 and 4 had very high self-reported group strategy use at the second recall point. This finding suggests that the perception of being on the same page is a rapidly emerging aspect of collaborative recall. However, despite the high rates of self-report I found a persistent pattern of collaborative inhibition. Perhaps in some instances, a sense of group coordination may not reflect the use of effective group strategies for increased recall, but instead reflect feelings of ease or enjoyment during collaboration, or perhaps an entirely different goal such as striving for greater accuracy (rather than productivity).

In terms of explicit strategy agreement, my findings highlight the challenge some strangers face when asked to nominate a strategy. Collaborative participants in Experiment 4 took longer to generate an encoding strategy, and chose strategies that were likely less effective than collaborative participants in Experiment 3 who were asked to nominate a retrieval strategy. It should be noted that the encoding strategies nominated by collaborative participants in Experiment 4 may have been more effective if the recall task had not required a consensus approach. When it was time to nominate a strategy, groups already had experienced one recall time point together: however, it is possible that the consensus instruction was not salient enough to influence their strategy discussion. Given that participants were not told whether or not they would be tested in the same way as previously, it is also possible that the ambiguous nature of the instructions or lack of clarity of the stimuli made selecting a strategy challenging. In order to successfully agree on a strategy that has the greatest chance of being effective, groups may need: more information about what they are going to be asked to recall and how they are going to be asked to recall it, more exposure to the type of task and more time to discuss and practise their strategies.

Another key finding from my last two experiments was the challenge that collaborative strangers had in maintaining a group level strategy, even when they explicitly agreed on a strategy together. This highlights the importance of not only having an effective group memory strategy, but the capacity to maintain that strategy. Maintaining a strategy in the context of a word list task is similar to maintaining a shared understanding of more complex tasks. As discussed in my Introduction, shared understanding of a task is one factor that influences the success of scaffolding, and this shared understanding requires a dynamic sensitivity and responsiveness in group members (e.g., Bliss et al., 1996; Cleveland & Reese, 2005). Thus, it is possible that strangers working together might find strategy maintenance more challenging than groups that have some degree of familiarity or closeness. Future

studies could identify the sorts of conditions that help groups to maintain group strategies. For example, perhaps if I had recruited couples and close friends in Experiments 3 and 4, their sense of closeness might have helped them to remain on the same page (assuming that practicing the task together before nominating a strategy could prevent intimate dyads from nominating ineffective as found by Hollingshead (1998)). Alternatively, perhaps stranger groups could better maintain group strategies if the importance of strategy maintenance is emphasised; for example, perhaps if I had provided explicit instructions to participants in Experiment 3 and Experiment 4 to try to maintain their nominated strategies.

Implications

This thesis has implications for theory, for collaborative recall methodology, and for practical applications in educational, organisational, and everyday collaborative memory settings. I discuss each of these implications in turn.

Implications for Theory

Although theories of socio-cultural learning and extended cognition, in particular Wegner's (1987) theory of Transactive Memory Systems, informed my research, I found little evidence that my participants used the external support of other people to scaffold their individual memory recall. This highlights the importance of considering how and when others may look to external memory support potentially provided by other people. As I noted above when discussing my cognitive need manipulation (pp. 169-171), it is possible that external support is only sought and accepted when a certain threshold of cognitive need is perceived and met. There is no easy way to reconcile these theories with my robust findings of collaborative inhibition, but perhaps the inclusion of pre-existing group history, the kind of task, and group communication processes in models of collaborative remembering will allow researchers to map more closely to theories of extended cognition.

As noted in my Introduction, current cognitive models of the costs and benefits of collaboration focus predominantly on internal cognitive processes common to all adults. For example, in Rajaram and Pereira-Pasarin's (2010) theoretical framework processes such as social contagion, blocking and retrieval disruption are thought to underlie the costs typically seen in collaborative memory tasks, and re-exposure, relearning via-retrieval, and error pruning are thought to underlie the benefits typically seen in collaborative memory tasks. Although generally I was unable to induce conditions that shifted the standard costs and benefits of collaboration, I did find hints that the shared history of the group (depending on *what* you ask them to remember), individual differences in the abilities of group members (if they found a recall task sufficiently difficult), and emergent group processes (*how* the group reported approaching recalling together) influenced how much groups recalled together. While it is too early to draw firm conclusions, these hints suggest that collaborative memory may depend not only on internal cognitive processes within the individual, but also on individual factors specific to the particular group and task. As I suggested above, models of collaborative memory should consider more explicitly the influence pre-existing group history, the kind of task, and group-level communication strategies and task strategy type to increase ecological validity (Coman, Brown, Koppel, & Hirst, 2009).

My work combined with others' work with the collaborative recall paradigm, raises important questions about the ecological validity of our comparisons and findings. At what level of complexity, and with what content, do tasks have enough "likeness" to real world remembering for us to feel confident that what we see in the laboratory helps to explain how groups experience remembering in different settings "in the wild" (Barnier, 2012)? For instance, as technology becomes ubiquitous in our lives, perhaps now more than ever we should start to consider if testing any individual in the absence of external aids (e.g., a smart

phone) reflects how they remember outside of the laboratory—together or alone (Barnier, 2010).

Implications for Methodologies

Since I opted to use the collaborative recall paradigm, this thesis focused predominantly on the amount and accuracy of recall during collaboration and individually following collaboration. In this paradigm, collaborative performance is considered relative to nominal group performance. This is a high benchmark for collaborative success (Larson, 2010). Depending on the goals that need to be met by collaboration, success could be conceptualised as collaborative groups outperforming the average of individual performance, or outperforming the best individual. There may be few situations in day-to-day life in which it is important for groups to reach the high standard of outperforming the pooled output of the same number of individuals recalling alone. Collaborative groups reliably recall more than the average of those who recalled alone, and this was true in the current studies too. Thus, although seen in the collaborative recall literature as a weak form of success, the finding that collaborative groups outperform individuals may be sufficient in many applied contexts (Dixon, 2013).

Also consistent with previous collaborative inhibition research (e.g., Barber & Rajaram, 2011b; Blumen & Rajaram, 2008, 2009; Blumen, Young, & Rajaram, 2014; Congleton & Rajaram, 2011, 2014; Henkel & Rajaram, 2011; Harris et al., 2012; for meta-analysis see Marion & Thorley, 2016; Wissman & Rawson, 2015), I analysed only individual performance following collaboration. Considering individual performance at Recall 2, however, does not explore potential costs and benefits to the dyadic unit following collaboration. The observed post-collaborative benefit for individuals may not reflect an overall gain for the unit because the two members of the dyad may recall many of the same words. Thus, if their recall is pooled at Recall 2 (as in Recall 1 scoring) there may be no

benefit to observe. The overall gains and losses of groups are core to considerations of collective memory and shared rendering (Hirst & Echterhoff, 2012).

When considering collaborative "success", different outcomes should also be considered relative to the goals of remembering across different domains. For example, I found a reliable benefit for accuracy during collaboration, which may be critically important in forensic, educational and other settings. As previously noted (see Introduction, p.15), the accuracy benefit during collaboration (at least for young adults) is not due to a criterion shift that makes individuals less likely to offer an incorrect item, but rather due to error checking and pruning (Harris et al., 2012, 2013; Ross et al., 2008). Although accuracy during subsequent individual recall was not similarly enhanced, it could nonetheless be that error correction is an important function of remembering with others (Hyman et al., 2013). In everyday life, being able to recall more accurately may give a greater functional benefit than being able to recall more. I also found that people subjectively described collaboration as helpful. Believing that working with others helps may be important for enjoyment and task persistence. Other outcomes that could also be measured systematically as alternate measures of "success" include wellbeing (does remembering with others improve life quality, especially as we age?) and longer-term memory function (does remembering with other people serve a protective function for our individual cognitive processes?).

Consistent with previous collaborative recall experiments, I used instructions that encouraged groups to interact in free-flowing recall together and did not measure individual cognitive ability prior to group formation. Social psychologists, however, have explored group performance using a methodological approach that could be informative to future collaborative recall research. For example, one possible extension of my experiments would be to consider the influence of cognitive need on collaborative performance by measuring the cognitive ability of each participant (e.g., measure Verbal Intelligence Quotient if a word list

task is being used). Average group cognitive ability, the "weakest" group member's cognitive ability, and the "strongest" group member's cognitive ability have all been found to be positively correlated with group performance (see meta-analysis by Devine & Philips, 2001). Further, one contributing factor to the presence or absence of a positive correlation between cognitive ability and group performance is the type of collaborative processes used by groups. For example, O'Brien and Owens (1969) found a positive correlation between summed group cognitive ability and the "weakest" group member's cognitive ability on a task that required parallel turn taking (e.g., three group members each work on a different story, then passing each story on to be worked on by another group members), but not on a task that required high levels of collaboration (e.g., three group members work together to co-write three stories). Although collaborative inhibition is also found in turn taking groups (Wright & Klumpp, 2004) my consensus instruction might have increased the likelihood that group performance was limited by the ability of the "weakest" dyad partner. Similarly, in Experiment 4 many collaborative dyads in the strategy condition took a "divide and conquer" approach to their encoding strategies, potentially reducing the "collaborativeness" of their group processes. Future studies exploring cognitive need and collaborative performance could be inspired by social psychology's interesting literature on "coordination" and include a measure of individual cognitive ability as well as vary group membership based on ability.

Implications for Practice

My findings have implications for group remembering in a number of different domains including educational and occupational settings, as well as when we remember with our friends and family.

In the classroom. In an educational context, my results from Experiments 1 and 2 are in line with previous laboratory studies that have shown that despite collaborative inhibition, individuals recall more after collaborating (Barber & Rajaram, 2011b; Blumen & Rajaram,

2008, 2009; Blumen et al., 2014; Congleton & Rajaram, 2011, 2014; Harris et al., 2012; Henkel & Rajaram, 2011; Wissman & Rawson, 2015). As such, testing or studying in pairs may be beneficial to students' subsequent retention of information. In the case of errors, however, there is likely no advantage or disadvantage: although I found increased accuracy during collaboration, this benefit typically did not persist for individuals post collaboration. Interestingly, across all my studies I found high levels of endorsement of the helpfulness of collaboration in everyday life. Thus, as noted above, it is possible that remembering together is more enjoyable that working alone, and group work could be used as a way to motivate students to engage in activities that are known to benefit learning but that some individuals may not spontaneously engage in alone.

My results from Experiment 1 suggest that classroom activities aimed at increasing group closeness offer limited value for increasing group output on memory tasks. And although students in the same school class may already be closer or more familiar with each other, my highly intimate pairs in Experiment 2—couples and close friends—demonstrated collaborative inhibition. This finding is consistent with the notion that closeness, even when group members share past experiences and knowledge, does not help groups overcome the costs of collaboration, at least against nominal group comparison. In terms of both group performance and individual performance following collaboration, there may be limited benefit from activities that aim to generate a sense of closeness between group members in school or university settings.

There may be some benefit, however, in letting classmates practice recalling together. In both Experiments 3 and 4, participants benefitted from practicing the task and recalled more at Recall 2 on average than at Recall 1. This observed practice effect differs from the testing effect studied in individual recall (e.g., Roediger & Butler, 2011; Roediger & Karpicke, 2006) since in the present experiments the stimuli changed at each testing point. The testing

effect is thought to be due to retrieval not encoding processes, but in Experiments 3 and 4 it is likely that the previous recall point helped to better organise encoding of the second word list. One way to further test this practice effect could be to conduct a similar experiment with multiple study and recall phases, but to add in individual recall phases too. When groups repeatedly recall the same material collaboratively, they recall more on subsequent individual recall tests (Blumen & Rajaram, 2008). Repeatedly undertaking similar (but not the same) collaborative recall tasks across time might also increase subsequent individual recall of what has been studied collaboratively.

In the workplace. Effective teamwork enhances workplace productivity (Cohen & Bailey, 1997). Whereas in educational settings the unit of interest tends to be the individual, in workplaces the productivity of both individuals and the group is of interest. My results reinforce the view that teambuilding activities that focus only on self-disclosure to create a sense of closeness will not improve collaborative performance (Rosh et al., 2012). However, as noted above, my participants overwhelmingly found collaboration helpful, which suggests that working with another person may engender a sense of sharing the load of a task despite no clear benefits for output. In other words, working with others may be one way to increase morale within an organisation even if it does not enhance productivity on the particular task.

While group output may be lower than nominal group output on average, at least for memory tasks, my findings re strategy use also have implications for occupational settings. When I told groups to agree on a strategy, with no hint as to what might be an effective strategy, it did not help them. Potentially this is because even when a strategy that should be successful is adopted, unfamiliar groups find it difficult to maintain the strategy in a systematic way. Thus, managers of teams may want to highlight to their team members the importance not only of deciding on a way to approach a task, but ways in which groups can monitor their metacognitive processes. It also may mean that if employers can create

collaborative systems that help groups adhere to best practice for a given task, they may be able to eliminate or even reverse the costs of collaboration. Future research could explore the role of metacognitive processes during collaboration including how to provide effective strategy training and support, how much exposure to a task and to other group members is required to generate effective strategies, and the development of guidelines to help groups monitor their activity so they stay on the same page.

Friends and family. My thesis project emphasised the amount recalled and accuracy of recall during collaboration and post collaboration. While this emphasis has clear implications for educational and occupational settings, implications for the everyday social realm are less clear. When we remember with a romantic partner or with friends, our goal may not always be to recall as much as possible. When remembering with people we know, our shared remembering can serve many goals including entertainment, teaching or sharing our knowledge and experiences, and relationship maintenance (Alea & Bluck, 2003, 2007; Harris, Rasmussen, et al., 2014). How much and how accurately we are able to remember together may not aid, and could hinder, some of these goals. For example, to tell an entertaining story it may be necessary to not include everything that is remembered about an experience. The accuracy of what is recalled may also be irrelevant and there may be little need for yourself or others in the group to recount the story later. But there are times when how much we are able to recall with a close friend or partner is a critical function of remembering together. For example, the capacity of a parent to scaffold a child's recall is positively associated with how much the child is able to later recall independently about discussed events (e.g., Leichtman, Pillemer, Wang, Koreishi, & Han, 2000; Reese et al., 1993). Also, from a long-term, cumulative perspective, this parental memory scaffolding is positively associated with the development of the child's memory system (Fivush, 2011). At the other end of the developmental spectrum, a healthy spouse may help compensate for

memory difficulties in a person with dementia (Majlesi & Ekström, 2016). Thus, how much we are able to remember with close others may be an important aspect of collaborative remembering in certain situations. Further, the benefits of recalling more together may only become apparent after cumulative experiences have allowed collaborative strategies to be developed (Barnier et al., 2014).

Limitations and Future Directions

Thought this thesis and in this Discussion I have acknowledged limitations and suggested future directions. For instance, I have discussed the difficulty I experienced in generating enough cognitive load from a divided attention task at retrieval, and the challenge of using personally relevant semantic tasks. I also have mentioned the potential for future studies to explore how couples or close friends might implement a strategy instruction, or the possibility for future studies to consider a metacognitive strategy instruction as well as a memory instruction to encourage groups to try and maintain their strategies. Testing these types of manipulations using the collaborative recall paradigm would continue to build our understanding of collaborative recall performance and processes.

More generally, although using a series of laboratory experiments increased my ability to control for some of the interacting (and potentially confounding) conditions that exist in real world cases of group remembering, it also potentially limited the ecological validity of my results. The physical space of the laboratory, the simplistic stimuli being recalled, and the artificial manipulation of closeness and cognitive need are removed from the environments we recall in, what we recall, and the types of people we recall with in everyday life. A related criticism is my use of convenience sampling of university students. These participants may not be representative of the general population. However, using simpler tasks and an educated young adult sample had the benefit of offering a starting point for stepping the collaborative

recall paradigm towards remembering in more naturalistic settings, and is consistent with where the collaborative recall literature is now (Barnier et al., 2013).

More specifically, the word lists, European countries, and shared friends and acquaintances tasks I used in my project have the benefit of being relatively easy tasks to score, enabling me to quantify the amount recalled. The relative simplicity of such materials, however, also limits potential strategies that can be used by collaborative groups. For example, when recalling a categorical word list together, groups may only be able to use features such as the categorical nature or the order of presentation of the list to find common ground on how to approach the task. With more complex stimuli, such as the aviation scenarios used with pilots by Meade at al. (2009) or the violent scenes from a television program used by Vredeveldt, Groen, et al. (2016), there are more distinct features that may be co-opted by groups to structure their joint recall. Future studies could use similar closeness, cognitive need, and strategy agreement manipulations to tease out if, and to what degree, these conditions contribute to the cost and benefits of memory collaboration for more complex stimuli.

I opted to use relatively simplistic measures of how groups carried out the collaborative tasks (self-report of group strategies, and coding only the first two conversation turns) since it was outside the scope of my thesis to examine collaborative dialogue on an utterance-by-utterance basis for all collaborative dyads. Pilot testing of detailed process coding for only the top five collaborative groups in each condition in Experiment 1 was not informative, in part due to the simplistic nature of the stimuli. However, a possible future direction is to fully transcribe the collaborative recall sessions from each experiment and code for the presence or absence of micro-strategies or communication strategies (this would require the transcription and double coding of 64 x 4 minute word list recall in Experiment 1; 32 x 4 minute word list recall, 32 x 3 minute European countries recall, and 32 x 3 minute shared friends recall in Experiment 2; and 32 x 4 minute x 3 word lists for both Experiment 3

and Experiment 4). It could be that group strategies on a gross level are not generalisable to collaborative success, but the sorts of communication features identified in previous research (e.g., Harris et al., 2011; Meade et al., 2009; Vredeveldt, Groen, et al., 2016; Vredeveldt, Hildebrandt, et al., 2016) may be the key to understanding the *how* of collaborative memory success and individual differences across groups.

These limitations and suggestions for future directions highlight the tension between trying to understand the rich contexts of shared remembering in small groups in day-to-day life and not making the testing environment so complex that the individual contribution of factors cannot be isolated. If we are not able to distinguish what is important for which outcomes, for whom, and when, then we will face great challenges in implementing successful collaborative memory advice in real world contexts such as schools and universities, workplaces, and in aging interventions.

Concluding Comment

This thesis aimed to take first steps to bridge the gap between laboratory explorations of collaborative memory and the conditions of naturalistic collaborative memory that determine group memory success. It offers a starting point for future research: to strengthen and extend analyses of closeness, cognitive need, explicit strategy agreement, and other factors that may influence collaboration, and to better map cases of successful remembering in the world.

In this thesis I found that the costs and benefits of collaboration are robust, even when closeness, cognitive need, and explicit strategy agreement were manipulated. Perhaps the most surprising findings, aside from the challenge of shifting the magnitude of the collaborative inhibition effect, was the difficulty strangers experienced in generating effective group encoding strategies. Moreover, even when strangers were able to generate effective strategies, they often had trouble staying on the same page. These findings highlight the

importance of individual metacognitive skills in group memory performance. Collaborative memory interventions need to consider implementation strategies to ensure groups are able to optimally use suggested memory interventions. Notwithstanding these difficulties, however, several robust benefits of collaboration also emerged. First, collaborative recall was more accurate. Second, those who collaborated subsequently recalled more individually than those who previously recalled alone. Finally, participants consistently experienced collaboration as helpful. These findings have critical importance in applied settings.

Although I did not overturn collaboration inhibition with my manipulations of closeness, cognitive need, or strategy use, I discovered the importance and value of trying to isolate and test parameters of individual and group memory using robust experimental methods.

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Appendices

Appendix A

Word List (Experiments 1 and 2)

cozy	beast	contaminate
excited	farm	disgusting
happy	hawk	messy
inspired	lion	repulsive
merry	python	smelly
blossom	arm	ashamed
ocean	elbow	distressed
snow	hair	helpless
sunrise	leg	misery
waterfall	skull	troubled
cash	architect	cancer
extravagant	doctor	leprosy
king	lawyer	paralysis
profit	professor	smallpox
treasure	teacher	tumour

Appendix B

Questions from Non-Close Condition

Partner A	Partner B
What was the best gift you ever received and why?	If you had to move from Sydney, where could you go, and what would you miss most about Sydney?
What is a good number of people to have in a household and why?	If you could invent a new flavour of ice cream, what would it be?
What is the best restaurant or cafe you've been to recently that your partner hasn't been to? Tell your partner about it.	Describe the last pet you owned.
Tell your partner the funniest thing that ever happened to you when you were with a small child.	What gifts did you receive on your last birthday?
Tell your partner the name and ages of your family members, include grandparents, aunts and uncles, and where they were born (to the extent you know this information).	One of you say a word, the next say a word that starts with the last letter of the word just said. Do this until you have said 50 words. Any words will do – you aren't making a sentence.
Do you like to get up early or stay up late? Is there anything funny that has resulted from this?	Where are you from? Name all of the places you've lived.
What is/was your favourite class at University/high school? Why?	What did you do last summer?
Who is your favourite actor of your own gender? Describe a favourite scene/TV show/film in which this person has acted.	What was your impression of X University the first time you ever came here?
What is the best TV show you've seen recently that your partner hasn't seen? Tell your partner about it.	What is the best book you've read recently that your partner hasn't read? Tell your partner about it.
What foreign country would you most like to visit? What attracts you to this place?	Do you prefer digital watches and clocks or the kind with hands? Why?
Do you think left-handed people are more creative than right-handed people?	What is the last concert you saw? How many of that band's albums do you own? Had you seen them before? Where?
How often do you get your hair cut? Where do you go? Have you ever had a really bad haircut experience?	What is your favourite public holiday? Why?

Appendix C

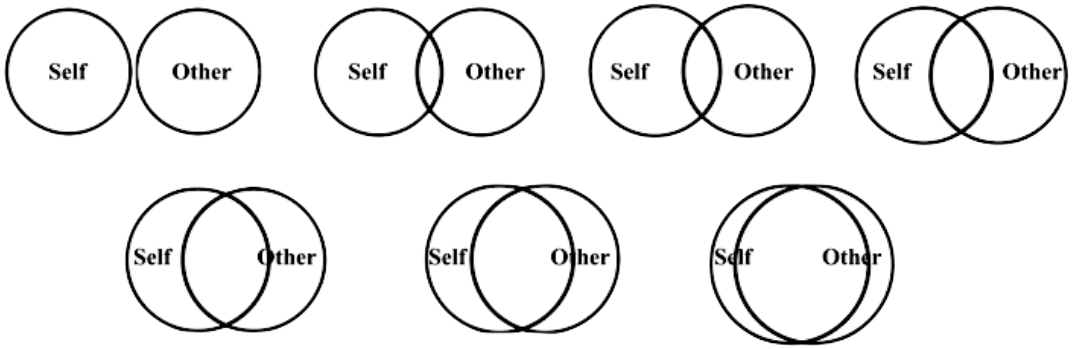
Questions from Close Condition

Partner A	Partner B
Given the choice of anyone in the world, whom would you want as a dinner guest?	Would you like to be famous? In what way?
Before making a telephone call, do you ever rehearse what you are going to say? Why?	What would constitute a "perfect" day for you?
When did you last sing to yourself? To someone else?	If you were able to live to the age of 90 and retain either the mind or body of a 30-year-old for the last 60 years of your life, which would you want?
For what in your life do you feel most grateful?	If you could wake up tomorrow having gained any one quality or ability, what would it be? Why would you want this new quality or ability?
Take 3 minutes and tell your partner your life story in as much detail as possible.	Alternate sharing something you consider a positive characteristic of your partner. Share 3 items each.
If a crystal ball could show you something about the future, or anything else, what would you want to know?	Is there something that you've dreamed of doing for a long time? Why haven't you done it?
What is the greatest accomplishment of your life?	What do you value most in a friendship?
If you knew you only had a year to live, would you change anything about the way you are now living? Why?	What does friendship mean to you?
How close and warm is your family? Do you feel your childhood was happier than most other people's?	Make one true "we" statement each. For instance "We are both in this room feeling…"
If you were going to become a close friend with your partner, please share what would be important for him or her to know.	Tell your partner something that you like about them already.
What, if anything, is too serious to be joked about?	Your house, containing everything you own, catches fire. After saving your loved ones and pets, you have time to safely make a final dash to save any one item. What would it be? Why?

Appendix D

Inclusion of Other in Self Scale

Please circle the picture below which best describes your relationship with the other participant:



Appendix E

Word Lists (Experiments 3 and 4)

List A	List B	List C
affluence	ambition	blossom
dollar	fame	ocean
jewel	outstanding	snow
palace	talent	sunrise
riches	victory	waterfall
cash	applause	beach
extravagant	glory	life
king	prestige	sky
profit	triumphant	star
treasure	win	rainbow
body	alley	architect
eye	skyscraper	doctor
hand	corridor	lawyer
mouth	hospital	professor
stomach	museum	teacher
arm	statue	cook
elbow	building	engineer
hair	avenue	manager
leg	elevator	psychologist
skull	hotel	writer
chaos	cancer	cemetery
damage	leprosy	death
disaster	paralysis	funeral
injury	smallpox	slaughter
tragedy	tumour	tomb
catastrophe	gangrene	coffin
crisis	malaria	drown
destroy	pus	massacre
emergency	surgery	suffocate
tornado	ulcer	victim
depressed	desire	elated
frustrated	hug	hopeful
insecure	passion	joyful
rejected	spouse	relaxed
unhappy	couple	untroubled
ashamed	flirt	merry
distressed	caress	cozy
helpless	lust	happy
misery	sexy	excited
troubled	valentine	inspired

Appendix F

Final Ethics Approval Letter

MACQUARIE University

VANA WEBSTER <vana.webster@students.mq.edu.au>

Request for Ethics Amendment to Project REF 5201300512

Ethics Secretariat <ethics.secretariat@mq.edu.au>
To: Amanda Barnier <amanda.barnier@mq.edu.au>
Cc: Vana Webster <vana.webster@students.mq.edu.au>

11 October 2016 at 10:35

Dear Amanda

The Executive considered and approved your amendment request at its meeting today. A copy of the approved documents is attached for your records.

Kind regards

Fran

Ethics Secretariat
Research Office | Level 3, C5C Building
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T: +61 2 9850 4194 (HREC: Medical Sciences)

Request for Ethics Amendment to Project REF 5201300512

APPROVED
By Fran Thorp at 10:32 am, Oct 11, 2016

Fran Thorp

Amanda Barnier

Tue 27/09/2016 9:40 AM

To:Ethics Secretariat <ethics.secretariat@mq.edu.au>;

Cc:Vana Webster <vana.webster@students.mq.edu.au>;

Dear colleagues

Please find attached a zipped folder with a request for ethics amendment for Project REF 5201300512 and all necessary attachments.

Thanks and best wishes

Amanda

Amanda Barnier

Professor and Australian Research Council Future Fellow

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Appendix G

Exemption Letter from Montana State University Institutional Review Board

MONTANA
STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
c/o Immunology & Infectious Diseases
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
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Chair: Mark Quinn
406-994-5721
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Administrator:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Michelle Meade

FROM: Mark Quinn, Chair Mark Quinn CMJ

DATE: March 29, 2013

RE: *"Memory and Collaboration"* [MM032913-EX]

The above research, described in your submission of March 28, 2013, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

___ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

_____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.