Dyadic cognition in old age: paradigms, findings, and directions

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Dyadic cognition in old adults

In the next decades, the number of couples who have been married for a long time or couples who have been living together for a long time will rise. In fact, in Switzerland at the time of retirement 75% of women and 80% of men still live together with their spouses, and one third of the 80-year-olds are still married. In addition, women aged 65 on average still live 15 more years with their partner (Swiss Federal Statistical Office, 2005). In Germany from 1996 to 2005 the proportion of old couples rose from 8% to 27% for husbands and from 6% to 21% for wives (German Federal Statistical Office, 2000). As an increasing number of couples grow older and may be able to tackle tasks, responsibilities and problems jointly, the examination of dyadic cognition in old age requires a fresh view on existing paradigms and studies. In this respect, one key question is to which degree interdyadic differences in dyadic cognitive skills or the “interactive social context” (see chapter by Blanchard-Fields et al., this volume) predict how they manage to overcome everyday problems such as financial, social, health related, and cognitive problems (Meegan & Berg, 2002).

The present chapter reviews findings from studies examining paradigms that have been used to study cognition in old dyads, i.e., pairs of persons both 60 years or older. We focus on (a) paradigms that have been used to examine dyadic cognition in old age, (b) performance differences in dyadic cognition, and (c) explanatory concepts for performance differences such as dyadic versus individual performance, age, gender, training, relationship characteristics, and communication patterns. Studies included have examined dyadic memory, dyadic planning, dyadic decision-making, dyadic reasoning, and dyadic comprehension. It is shown that relatively few paradigms have been used to study the developmental changes in dyadic cognition performance and we point to future directions in terms of needs for further paradigm development and empirical research.

To capture the dyadic ability to solve cognitive tasks, a number of different constructs have been proposed in the literature. The most influential ones in recent years have been
“interactive minds” (Baltes & Staudinger, 1996), “transactive memory” (Wegner, Giuliano, & Hertel, 1985), “socially shared cognition“, and “collaborative cognition“ (Dixon, 1992). All of these constructs see cognition mainly as a social process and, therefore, examine cognitive performances of social entities such as dyads (see Strough & Margrett, 2002). “Interactive minds” refers to the phenomenon that the acquisition of individual knowledge may be influenced by other’s cognition-related behaviors. This reciprocal influence can lead to a level of performance that may be higher than each individual’s level of independent individual performance. In the tradition of the “interactive minds” approach, social interactions during learning, problem solving, collaborative memory at old age as well as the cooperative acquisition of expert knowledge have been studied. It is interesting to note that the authors in this area have pointed out that social interactions can enhance cognitive performance and cognitive development, but that social interaction can also have negative consequences on cognitive performance (Baltes & Staudinger, 1996).

The notion of “transactive memory” refers to two or more people encoding, storing, and retrieving information. Transactive memory theory is based on the idea that individuals can serve as external memory aids for others (Wegner, 1986). Partners in close relationships such as spouses should typically be relatively well informed about their partner’s knowledge (Wegner, Erber, & Raymond, 1991). That way both partners can profit from the couple’s memory and only have to encode things that belong to their own knowledge areas. It needs time to develop such knowledge about the partner’s knowledge, but it eventually has the advantage that couples develop an implicit structure to jointly solve memory tasks. With this implicit structure, couples may have a transactive memory that is better than both partners’ individual memories.

Compared to the interactive minds and the transactive memory approaches, “collaborative cognition” and “socially shared cognition” are more specifically describing cognitive activities with more than one person present. This cognitive activity is directed
towards one or more cognitive tasks, involves collaboration, and is characterized by common
goals of the interacting persons (Dixon, 1992). Collaborators are often used as external
memory aids, which is why collaboration is often seen as a possibility for enhanced
performance and as a compensation for age-related memory decline. People with injury- or
age correlated declines of fundamental memory mechanisms (e.g., processing speed, neuronal
integrity) might be able to compensate for these losses through collaboration (Dixon & Gould,
1998).

For the purpose of this review, we will consider dyadic cognition to be the general
term to indicate whenever two persons work together on the same cognitive task at the same
time. When considering specific cognitive abilities, we may also use the more specific terms
dyadic memory, dyadic planning, dyadic decision making, dyadic reasoning, or dyadic
comprehension. We consider dyadic cognition paradigms when, at least in principle, they
allow to obtain information about the product and the process of particular dyadic cognitive
abilities and performances. Although a number of studies with younger dyads have used
cognitive tests to manipulate the amount of stress (e.g., Bodenmann, 2000) and examine
dyadic responses to stress (e.g., Bodenmann, 1995; Bodenmann & Cina, 1999; Bodenmann &
Widmer, 2000; Bodenmann, Pihe, Cina, Widmer, & Shantinath, 2006) or the relation
between cognitive abilities and ratings of emotional well-being (e.g., Kolanowski, Hoffman,
& Hofer, 2007), we focus on papers that have been examining dyadic cognition in old age and
where the dependent variable of interest was cognitive performance. This means that at least
one outcome measure in the included studies had to be cognitive performance of an older
dyad.

Overall, this review has three goals. First, to examine which paradigms have been used
to study dyadic cognition in old age. Second, to determine if there is evidence for
performance differences in dyadic cognition. Third, to review to which degree performance
differences can be explained by age, individual versus dyadic cognition, sex, prior training
with the materials used, relationship characteristics, and communication patterns of the dyads examined. Finally, we will make recommendations for future paradigm development and research directions.

**Paradigms to examine dyadic cognition**

To examine age differences in dyadic cognition, experimental paradigms need to fulfil some essential requirements: Paradigms should be appropriate to use with individuals and dyads covering a wide age range, gender differences and hierarchy differences. Paradigms should also allow repeated measurement. This way, paradigms can be used in age comparisons, comparisons between individual versus dyadic performance, longitudinal studies, and in married couples versus professional dyads of different ages. From an experimental point of view, paradigms should allow to manipulate the causal mechanisms suspected to influence dyadic performance. When examining existing paradigms, we will therefore determine to which degree existing paradigms fulfil these criteria and which areas might need additional paradigm development.

**Dyadic memory**

*Dyadic memory paradigms.* In the literature on old peoples’ dyadic cognition, dyadic memory has been studied most often. This is probably due to the idea that collaborating on a memory task may compensate for age-related individual losses in memory performance. In fact, several memory studies with young adults show that young individuals can gain by collaborating on memory tasks (Dixon, 2000; Dixon & Bäckman, 1995; Dixon, Fox, Threithick, & Brundin, 1997; Dixon, Gagnon, & Crow, 1998; Finley, Hitch, & Meudell, 2000; Stephenson, Kniveton, & Wagner, 1991). However, relatively little is known about old adults’ performance in dyadic cognition. Generally, the paradigms that have been used to examine old dyads memory performance are similar to paradigms examining individual memory performance (for an overview, see Table 1). They reach from recognition for verbal material over recall for verbal and spatial material, to prospective memory, and include
typical laboratory tasks as well as tasks using materials familiar from or similar to everyday life.

Dyadic memory paradigms: Performance or process differences. Summarizing the results of the few studies on dyadic memory tasks is difficult, because the studies focus on different aspects of old dyads’ collaborative memory performance. However, three aspects of dyadic memory in old age have received particular attention. First, with respect to dyadic performance most studies with old adults report that dyadic performance is superior to individual memory performance (Dixon & Gould, 1998; Johansson et al., 2000; Johansson et al., 2005; Ross et al., 2004). That is, one individual trying to recall items or a story will perform worse than two people working jointly on the same task. This result is the same for naturalistic tasks such as remembering items from a shopping list and typical laboratory tasks, such as word or story recall. When comparing dyadic memory performance to nominal group performance, i.e., the pooled, non-redundant performance of two individuals, real dyads typically perform worse than nominal dyads (Andersson & Rönnerberg, 1995; Basden, Basden, Bryner, & Thomas, 1997; Johansson et al., 2000; Johansson et al., 2005; Ross et al., 2004). However, this is only true for episodic memory, but not semantic memory. This means that semantic tasks are not negatively affected by collaboration. A difference in the process of achieving memory performance seems that real dyads generate fewer correct answers, but they also make fewer mistakes than nominal pairs (Johansson et al., 2000).

Second, one may wonder if old familiar dyads such as married couples perform better on memory tasks than unacquainted pairs. Here, the findings are inconclusive. Whereas Dixon and Gould (1998) report such a familiarity effect on story recall tasks, other studies (Gould et al., 2002; Johansson et al., 2000) found no or only small advantages of familiarity on
retrospective verbal tasks, spatial memory tasks, and prospective memory tasks (Johansson et al., 2000). When married couples indicate that they use a transactive memory system, performance levels can be as high as nominal pair performance (Johansson et al., 2005).

Third, studies of dyadic cognition in old age typically compare old adults’ collaborative memory performance to young adults’ collaborative performance. For this comparison, different results have been reported. Some studies find no story recall performance differences between young and old married couples (Dixon and Gould, 1998), and other studies do report performance differences between old and young married couples (Gould et al., 2002). However, differences in the structure, the content, and the interaction when recalling an experienced event have been observed (Dixon & Gould, 1998; Gould et al., 1994). Important age differences were found in the referential naming task (Gould et al., 2002), with old dyads communicating less efficiently than young dyads. A reason for this result could be that old adults focus on reducing errors instead of increasing efficiency, i.e., they verify and re-verify their viewpoints more often to accomplish the task with as few errors as possible. In addition, Gould and Dixon (1993) found that story structure, content, and interaction style differ between old and young married couples when recalling a jointly experienced event. Old adults’ strategy of using more words and speaking more slowly could possibly be explained by old adults’ word-finding difficulties (Gould & Dixon, 1993). Fewer supportive words from old adults as well as more monologues might be explained by old adults’ strategy to decrease the memory demands of the task and the cognitive demands of collaboration (Gould & Dixon, 1993).

**Interdyadic differences in memory: Explanatory concepts.** In most tasks mentioned in Table 1, causal mechanisms suspected to influence performance are collaboration, age, and familiarity. What has been examined as potential causes underlying the interdyadic differences in memory performance are familiarity of the dyadic partners (married versus unacquainted, length of relationship, general dyadic collaboration expertise), closeness of task
to everyday experience, communication style (number of words used, number of turns taken), strategy differences (use of transactive memory, division of responsibility, readiness to risk errors, reduction of memory load through monologues), dyadic agreement, intradyadic responsibility distribution, metacognitive skills, memory self-efficacy, age- and gender-typical communication styles (willingness to interrupt, formal versus informal communication), individual memory skills of partners, interference of individual encoding with partner’s explicit encoding, and need for contextual support. Again, the emerging picture is inconclusive. Whereas familiarity, operationalized through comparing married with non-married couples, did play a role for some areas such as story recall (Dixon & Gould, 1998), it did not affect performance in a referential naming task (Gould et al., 2002). The effect of familiarity may be explained by old couples being experts at working together, meaning that they have excellent knowledge of each other’s cognitive skills and knowledge as well as having practice in all kinds of collaborative situations (Dixon & Gould, 1998). Also, old couples might have experienced individual cognitive decline and might be more motivated to compensate for those losses by collaboration than young couples (see also the chapter by Blanchard-Fields et al., this volume). Yet another explanation might be the considerable collaborative metacognitive skills (pre- and postdictions) old couples show (Dixon & Gould, 1998). Their accuracies follow a pattern similar to patterns of young individuals or young couples, suggesting that old couples are dyadic collaboration experts. When more specifically the intradyadic agreement and distribution of responsibilities were examined, there are indications that these factors can contribute to best possible performance of old dyads, probably because the division of responsibility reduces the required amount of inhibition and enhances the effort the individual puts into the task (Johansson et al., 2005). Responsibility and agreement did not influence dyadic performance on the semantic task, because no new information needs to be encoded and, therefore, information overload for the individual is not a problem.
Ross et al.’s (2004) result that collaborating dyads make fewer mistakes than nominal dyads can be explained by false positives being unique to each person and therefore make it unlikely that one’s partner has the exact same wrong memories. This suggests that collaboration can counteract the effects of aging on source monitoring. The reduction of false positives (chose item that was on original list, but not on personal shopping list or chose item that is on no list, but is in the supermarket) in collaborative remembering can be very important, because old people tend to have wrong memories more often than young adults. Empirical findings do support the importance of the readiness to risk errors and the age- and sex differences in communication styles, even when no performance differences could be observed.

A limitation of the existing approaches is the difficulty to compare individual and dyadic performance in a within-subjects design, the lack of individual ability measurements, and the lack of experimental manipulation of the explanatory variables. In fact, most studies use between-dyads designs, age is often taken as a proxy for a general decline in memory performance, and explanatory variables are mostly examined through questionnaires. Therefore, the power to detect effects is smaller than in typical experimental paradigms. This suggests that ideally experimental paradigms applied within a within-dyad design may help to disentangle the factors contributing to age- and interdyadic differences in dyadic cognition. Although it may be argued that most of the existing paradigms might be used for this purpose, more empirical evidence from experimental within-dyad designs, demonstrating feasibility and adequate measurement properties, is clearly needed. The measurements of relationship characteristics also need more attention in future old dyads’ memory research. Transactive memory, degree of responsibility and agreement, and couples’ expertise, i.e., how well the partners know each other, have been analyzed with a few tasks, but deeper understanding of these and other characteristics are needed to better understand dyadic memory in old age.

**Dyadic planning**
Dyadic planning paradigms. Old dyads’ planning has not received much attention in the literature. Only three studies consider old dyads planning abilities, and planning typically appears under the heading of everyday problem solving. In these studies, dyadic planning focuses on errand planning and trip planning.

Dyadic planning paradigms: Performance or process differences. The few studies looking at old adults’ dyadic planning abilities have focused on dyadic versus individual performance and on the comparison of old and young dyads. Familiarity aspects have not received much attention on planning tasks, but instead some studies have looked at sex differences (Cheng & Strough, 2004; Margrett & Marsiske, 2002) and relationship characteristics (Berg et al., 2003). Unlike for the memory tasks, for planning tasks differences between individual performance and dyadic performance and differences between old and younger dyads are not very clear. Cheng and Strough (2004) found that young adults planned faster and more accurately than older adults, but no age differences were found on most of the primary performance measures. When old adults were instructed to pay attention to important aspects of the planning task, they were able to perform as well as young adults. Berg et al. (2003) expected that old couples would show less low affiliation interactions than younger couples, because of the less conflictual nature of long-term marriages (Carstensen, Isaacowitz, & Charles, 1999). Surprisingly, however, there was no difference between young and old couples in how they interacted. However, Berg et al. (2003) found that independent of the dyads’ age, collaboration characterized by high affiliation was associated with shorter routes on the errand-running task. Thus, interaction characteristics seem to be important when we look at collaboration outside of the laboratory in everyday life.
Comparing collaborators and individuals, Cheng and Strough (2004) did not find differences on most of the performance measures, even though collaborators make fewer planning mistakes than individuals (cf. dyadic memory research). Differences between the planning task in this study and the memory tasks used in other studies might explain the different results when it comes to collaborative performance. The studies that found collaborative performance to be superior to individual performance used memory tasks such as story recall (Dixon & Gould, 1998) and remembering digits (Dixon, 1992).

If sex differences in dyadic planning exist remains unclear, because one study (Cheng & Strough, 2004) has found women to perform worse on planning tasks than men and one study has not found sex differences (Margrett & Marsiske, 2002). It is interesting to note that even though Margrett and Marsiske (2002) do not find sex differences on planning performance, they do find that men are more influential, i.e., more likely to use their own judgement to influence their own collaborative outcome on the planning task in the collaborative situation.

Interdyadic differences in planning: Explanatory concepts. The fact that collaborating dyads did not outperform individuals on most performance measures (Cheng & Strough, 2004) of trip-planning may be explained by the relatively low memory demands of the task. Participants were allowed to use external memory aids such as maps, instructions, and daily itineraries. In the dyadic memory tasks that found an advantage of collaboration, memory demands were higher and therefore collaboration is more likely to enhance performance (Cheng & Strough, 2004).

Married couples interaction styles were related to cognitive planning performance (Berg et al., 2003). Constructive elaborations, explorations of the situation, and initiation of joint action instead of commanding, rejecting, and resisting others led to better planning. Berg et al. (2003) state that this finding is consistent with findings reported in the child development literature (Rogoff, 1998; quoted in Berg et al., 2003). One explanation for the
worse performance of low-affiliation couples is that they often made two individual plans for the errands. Berg et al. (2003) suggest that these couples find collaboration aversive and try to avoid it in daily life.

Overall, planning seems to be of enormous importance to cope with the changing demands of everyday life of old dyads. The studies reviewed are inconclusive with respect to the factors contributing to optimal planning performance in the laboratory and in everyday life. Clearly, more studies on elderly dyads planning abilities are needed. Within-dyad designs as well as larger sample sizes would help to better understand which mechanisms influence dyadic planning performance in old age.

**Dyadic decision making**

*Dyadic decision making paradigms.* Margrett and Marsiske (2002) as well as Berg et al. (2003) also used decision making tasks in the studies mentioned above. Another approach to examine decision making in old dyads stems from the wisdom tasks used by Staudinger and Baltes (1996). Again, only very few studies about dyadic decision-making in old age exist, and they have used very different types of tasks. While wisdom and social dilemma tasks require social competence, the vacation decision making is a decision-making task in the traditional sense (see Table 3).

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Until now only three studies on old adults’ dyadic decision-making exist. Most of the paradigms do not fulfil the criteria that would allow a wider use in empirical research or comparisons of results between studies. Small sample sizes (Berg et al., 2003) and the lack of within-subject studies make comparisons between old and young dyads as well as between collaborative and individual performance difficult. Margrett and Marsiske (2002) and Staudinger and Baltes (1996) allow with their tasks a comparison between individual and
dyadic performance, but not between familiar and unfamiliar and old and young dyads.

Comparable to the dyadic planning tasks, Berg et al. (2003) were interested in how relationship characteristics influenced dyadic performance and coded speech acts into low and high affiliation interactions. Margrett & Marsiske (2002) asked about couples’ daily collaboration. Staudinger and Baltes (1996) varied five causal mechanisms to find out how collaboration can be most effective. Individual and dyadic measurements are possible in all three decision-making tasks and relationship indicators are measured by all three paradigms.

**Dyadic decision making paradigms: performance or process differences.** In sum, three studies have looked at old adults’ dyadic decision-making (Berg et al., 2003; Margrett & Marsiske, 2002; Staudinger & Baltes, 1996). The focus of the three studies is on differences between individual and dyadic decision-making, on age differences when it comes to making decisions, and on sex differences as well as relationship characteristics. Important relationship or communication characteristics for making optimal decisions are high- or low-affiliation interactions. High-affiliation interactions were associated with better decision-making strategies. This pattern of high-affiliation interactions being related to searching more information on the particular features of the potential solutions instead of information allowing a fast exclusion of particular alternatives is congruent with the idea that for feature-based decision strategies couples need to agree on which features are most important instead of just agreeing on the final choice. Again, affiliation did play a role for dyadic performance, but no age effects were found. The expectation that because of more high-affiliation interactions old dyads would be better at collaborative decision-making was not supported (Berg et al., 2003).

Margrett and Marsiske (2002) examined sex differences in decision-making. Men were more likely to influence their own collaborative performance and their partners’. In the planning task, men were more likely to use their own judgement to influence their own collaborative outcome, and when it came to making decisions about social situations, men
were more likely to influence their own collaborative performance and their partners’. This was an unexpected finding, because women performed better on this task than men. This result, together with the interpersonal nature of the task that is traditionally seen as a more feminine domain, makes it surprising that men were more influential during collaboration on this decision-making task.

Another type of decision-making tasks are wisdom tasks. Young and old people perform the best on wisdom tasks when they can discuss the problem with somebody they know, when they have sufficient time for individually pondering the decision, or when they internally think about what a person they know would say to the problem (Staudinger & Baltes, 1996). This means that external and internal dyadic decision-making leads to higher quality wisdom decisions than individual decision-making. The usual focus on the individual when analyzing wisdom might lack ecological relevance, because wisdom can be considered as a prototype of an interactive-minds construct. Two important factors for optimal wisdom-related performance are the interaction with other peoples’ minds and individual thinking to review other peoples’ ideas (Staudinger & Baltes, 1996). The wisdom task showed significant age differences, i.e., old dyads profited more from the “external dialogue plus individual thinking time”- condition than young dyads.

Interdyadic differences in decision-making: Explanatory concepts. The findings reviewed show that men have more influence on collaborative outcome when the task is not very structured and allows more than one correct answer (Margrett and Marsiske, 2002). This finding clearly suggests that collaborative performance in decision-making tasks depends more on interpersonal and social factors than on individual cognitive abilities or task familiarity.

One important factor can be individual and dyadic beliefs and knowledge about how an optimal performance can be achieved. To examine this aspect of dyadic cognition, metacognitive questionnaires have been used in several studies on decision-making as well as
other domains of dyadic cognition (Strough, Cheng, & Swenson, 2002). For example, Berg et al. (2003) found that couples report that when collaborating in everyday life, they often divide and delegate labour. Division of labour occurred because of special interests of couple’s members, because of different abilities (Margrett & Marsiske, 2002), or based on a traditional distribution of responsibilities within the older couple that is not reported by younger couples (Berg et al., 2003). Some couples described collaboration as a form of problem solving, where one person takes the lead and the other person refines the plan. Most of the individuals said that their partner’s and their own problem solving styles were complementary (Berg et al., 2003), and that they were convinced that working together with a spouse leads to the best outcome in a dyadic cognition task (Feltmate, Gagnon, Kang, and Dixon, 2006), followed by collaborating with a friend, and working alone. That is despite the fact that typical for old adults is their general preference to solve everyday problems alone (Berg, Meegan, & Deviney, 1998; Blanchard Fields, Jahnke, Camp, 1995). Only old adults, who think that their own cognitive performance is weak, prefer to work with others (Strough et al., 2002). What is more, Margrett and Marsiske (2002) could demonstrate that people working with their spouse rated their expectations of satisfaction with collaborative teamwork more positively than the participants who were assigned to work with a stranger. In fact, self and partner-rated expectations of competitiveness were predictive of collaborative performance on tasks of planning, decision-making, and comprehension (Strough, Patrick, Swenson, Cheng, & Barnes, 2003).

One social factor shown to affect performance independent of the age of the dyads examined is the affiliation of the partners. The fact that there were more high-affiliation interactions on the decision-making task than on the planning task may be explained by the task being presented via computer, which led to more interaction between the couples in general (Berg et al., 2003). Another possible explanation is that vacation decisions are seen as very important, regularly occurring in everyday life, and, therefore, have to be discussed and
negotiated intensively. This is different for the wisdom-related decision-making that may be optimized through the interaction with other minds of persons (external or in our own head) and individual thinking time to filter and review the different aspects. The age effects in favor of old dyads may depend on the familiarity with the problem domain and the existing knowledge interacting with good performance conditions providing an external dialogue and the time needed for an individual appraisal of the important aspects of the decision to be made.

Overall, the literature on dyadic decision-making in old age suggests a differentiation of paradigms to capture different decision-making domains of everyday relevance, and to integrate measures of dyadic interaction to analyze to which degree performance of process differences depend on the age, the sex, the cognitive abilities, or the task characteristics of the particular decision-making paradigm used.

**Dyadic reasoning**

_Dyadic reasoning paradigms._ Only two studies have looked at dyadic reasoning in old age. It is interesting to note that both studies analyze reasoning performance in old age and focus on the consequences of a reasoning-training program and the differences between individual and dyadic training on reasoning performance.

Margrett and Willis (2006) and Saczynski, Margrett and Willis (2004) used a letter series test (Blieszner et al., 1981, quoted in Margrett & Willis, 2006), a word series test (Schaie, 1985, quoted in Margrett & Willis, 2006) and a letter set test (Ekstrom et al., 1976, quoted in Margrett & Willis, 2006) to train and test reasoning abilities in older couples. The main difference between both studies is that Saczynski et al. (2004) included a post test three month after the training. In the study of Margrett and Willis (2006) the sample size was 49 older couples (M age= 71.43 years; M marriage= 46.53 years) and in the study by Saczynski et al. (2004) the sample size was 47 couples (M age= 71.6 years and M marriage= 47 years). Couples in both studies were randomly assigned to questionnaire only (n=31 individuals), individual training (n=32 individuals), and collaborative training (n=32 individuals). Within-
subjects-designs have not been used in either of the studies. Possible influences like individual and dyadic training were manipulated and individual and dyadic measurements were possible in both studies. Both studies did not include measurements of relationship characteristics.

_Dyadic reasoning paradigms: Performance or process differences._ The two studies reviewed have analysed inductive reasoning in older dyads. Both studies primarily focus on training this ability through a self-guided strategy training (individual and collaborative) and the question if dyadic training is better than individual training. The study by Saczynski et al. (2004) found that inductive reasoning training is related to gains in strategic behaviour for individual and collaborative training groups on assessments completed alone and with the spouse. The performance level was maintained until three months after the end of the training program. There was no difference in strategy use at immediate post-test between the individual and the dyadic training group (see also Margrett & Willis, 2006). However, collaboratively trained people demonstrated a better maintenance of strategy use than individually trained people at the three months follow-up when assessed in a collaborative problem solving context. This means that collaborative learning alleviates dissipation of training effects observed once intervention is complete, but only in the collaborative context in which they were learned.

_Interdyadic differences in reasoning: Explanatory concepts._ A reason for the benefit of collaboratively trained people at the three months follow-up (Saczynski et al., 2004) could be that collaboratively trained dyads were more likely to apply their training to everyday life or engaged more in practice and reinforcement with their spouse than individually trained people. Margrett and Willis (2006) also mention the possibility that benefits of dyadic collaboration in their study could have become evident after more time had passed. It is also possible that the benefits of dyadic inductive reasoning training can be found in other aspects of the training such as the subjective experience, the transfer of training effects, or at other
time points during the training. Clearly more research is needed to determine which factors may lead to improved dyadic reasoning skills in old adults, and more paradigms are needed to relate reasoning performance in laboratory tasks to reasoning in everyday tasks.

**Dyadic comprehension**

*Dyadic comprehension paradigms.* Just one study with a task to assess old dyads dyadic comprehension of everyday material exists. Margrett and Marsiske (2002) included a task in their study of old adults’ everyday cognitive collaboration to assess old married couples ability to solve problems concerning everyday printed materials, e.g., health and medication use, financial management, or housekeeping. The sample size was 98 old married couples (M age = 72.90 years; M marriage = 45.81 years). Two parallel 14-item forms from the 28-item short form version of the everyday problems test (Willis & Marsiske, 1993; quoted in Margrett & Marsiske, 2002) were created. The questions were open-ended to provide enough possibilities for dyadic interaction. The task was unambiguous and highly structured, requiring one solution. Performance on the task was assessed by the total number of correctly answered items. The same task was done individually and in dyads, but because half the people worked with their spouse and the other half worked with a stranger, the study did not use a real within-subjects design. Manipulated possible influences were collaboration, gender, familiarity (actor –partner method), collaborative and task specific expectations and evaluations, and competitiveness. In order to find out about relationship characteristics that might influence collaboration, the authors used an open-ended interview about couples’ daily collaboration.

*Dyadic comprehension paradigms: Performance or process differences.* Results indicate that men and women equally influenced each other on this task. Most important for collaborative performance was the actor’s performance in the work-alone condition, i.e., the better the performance when working alone, the better the collaborative performance. There was also a significant influence of the actor’s partner, meaning that the better the actor’s
partner performed when alone, the better the actor’s own performance in the collaborative condition.

_Dyadic comprehension differences: Explanatory concepts._ The authors explain this finding by saying that in highly structured tasks both partners are equally influential. However, it remains an open question how the dyadic interaction and the dyadic performance might change when task demands are increasingly more complex. Thus, more paradigms and more research are needed to better understand old dyads’ comprehension performance.

**Discussion**

Clearly, dyadic cognition requires different abilities as well as different skills in dyadic ability management depending on the particular cognitive task examined. In addition, task requirements may interact differentially with relationship characteristics before and while working on the cognitive task at hand. Therefore, to summarize the results from studies on dyadic cognition in old age it is necessary to differentiate between dyadic memory, dyadic planning, dyadic decision making, dyadic reasoning, and dyadic comprehension. With respect to dyadic memory performance, empirical findings show that older adults’ dyadic performance is superior to their individual memory performances. Compared to the pooled, non-redundant episodic memory performance of two individuals (nominal pairs), real dyads usually generate fewer correct recalls, but also make fewer mistakes (e.g. Ross et al., 2004). When the partners know each other (spouses, friends) and use a transactive memory system they are able to perform better than stranger dyads on memory tasks and sometimes even as well as nominal pairs (e.g., Johansson et al., 2000). It remains unclear if older dyads perform worse (Gould et al., 2002) or the same (Dixon & Gould, 1998) as younger dyads on memory tasks, although most studies show differences in interaction styles between young and old dyads. Results suggest that older adults communicate less efficiently, i.e., they tend to use more words, speak more slowly, and use fewer supportive words for their partners (Gould & Dixon, 1993; Gould et al., 1994; Gould et al., 2002).
For dyadic planning and dyadic decision making, Berg et al. (2003) did not find interaction differences between younger and older dyads. The hypothesis of the authors that older adults would show more high-affiliation interactions than younger adults was not confirmed. High-affiliation interactions were associated with better planning and decision making in young and old couples though. On general planning and decision making performance measures old dyads performed as well as young dyads. It is interesting to note that contrary to the results on dyadic memory, older adults dyadic planning does not lead to more efficient plans than individual planning, probably because of the relatively low memory demands of the task. However, dyads make fewer planning errors than individuals (Cheng & Strough, 2004). If sex differences in planning exist, remains unclear, but Margrett and Marsiske (2002) found that in dyadic planning old men influence their own collaborative outcome more than women. A similar result was found for dyadic decision making: When it came to making decisions about social situations men aged 70 and older were more likely to use their own judgement to influence their own and their partners’ collaborative outcome (Margrett & Marsiske, 2002). This finding is interesting, because old men and women performed equally well on the planning task and women performed better than men on the decision making task. On the everyday problems test (comprehension task), Margrett and Marsiske (2002) did not find such gender effects. Men and women were equally influential on this task. What was important for good dyadic performance on this task was the actor’s performance in the individual condition and the actor’s partner’s performance in the individual condition.

With respect to dyadic decision making on wisdom tasks, young and old people perform better when they can collaborate with a familiar partner in a dyad than when they have to make decisions individually. For optimal decisions people need individual thinking time after the external or internal dyadic discussion (Staudinger & Baltes, 1996). Dyadic reasoning studies suggest that dyadic and individual inductive reasoning training is associated
with better strategic behaviour on assessments completed alone or with the spouse. Interestingly, dyadic training leads to better strategy maintenance than individual training on the three months follow-up when assessed collaboratively. Finally, studies on dyadic comprehension suggest the importance of the individual performance for the collaborative performance.

**Future directions**

We have started out by defining the requirements of optimal paradigms to examine dyadic cognition and its development in old age. According to these requirements, paradigms should be appropriate to use with individuals and dyads covering a wide age range, gender differences and hierarchy differences. Paradigms should also allow repeated measurement to be used in age comparisons, comparisons between individual versus dyadic performance, longitudinal studies, and in married couples versus professional dyads of different ages. From an experimental point of view, paradigms should allow to manipulate the causal mechanisms suspected to influence dyadic performance.

Despite the relatively large number of studies on dyadic memory in old adults, it is not clear if the paradigms used do fulfil the criteria that would allow a wider use in empirical research or comparisons of results between studies. For example, with respect to the possible comparison between individual and dyadic performance, only Johansson et al. (2005) use a within-subjects design in their episodic and semantic memory tasks. Because of the use of repeated measurements, the study by Gould et al. (2002) allows comparisons between familiar and unfamiliar dyads (story recall, word recall, referential naming task). All other studies do not use within-subjects designs to compare performances of different groups. Comparisons between young and old couples have not been done with a within-subjects design in the studies reviewed. However, it appears that except for the referential naming task (Gould et al., 2002) all tasks examined may allow to compare individual and dyadic performance as well as
interdyadic differences in performance. Thus, empirical testing is needed to demonstrate if the comparison between dyads is possible with all other paradigms.

The three studies on dyadic planning in old age have used tasks for which it stays unclear if they fulfil our criteria for experimental paradigms. A within-subjects design has partly been used by Margrett and Marsiske (2002), but the other studies do not use such a design. Causal mechanisms suspected to influence dyadic performance are age, gender, collaboration, but also relationship characteristics as well as collaborative expectations. Individual and dyadic measurements are potentially possible in all three planning tasks, but not done in Berg et al. (2003). Again, like with the dyadic memory tasks, there is not too much information on relationship characteristics. Berg et al. (2003) coded interactions into low and high affiliation interactions and Margrett and Marsiske (2002) asked about couples’ daily collaboration. Thus, more empirical testing is needed to examine the influence of relationship characteristics on dyadic planning.

The inductive reasoning and the comprehension studies allow individual and dyadic measurements and therefore the manipulation of the suspected causal mechanism (dyadic vs. individual training). The authors examined old adults’ learning abilities and, therefore, did not include young dyads or same-sex dyads. A within-subjects design has not been used and relationship indicators have not been measured. Thus, more data are required to establish potential age effects and effects of dyadic collaboration in reasoning and comprehension tasks and to clarify the influence of relationship characteristics on the quality of reasoning and comprehension performance.

Overall, a number of paradigms have been or may be used to examine dyadic cognition in old age. Most paradigms may potentially be used to establish age and dyadic collaboration effects in dyadic cognition and to examine the role of particular explanatory mechanisms, but have not been used for this purpose. Therefore, more empirical research is needed to establish and understand the phenomena of dyadic cognition in old age, the
potentials and adaptive capacities old dyads may possess and to improve our understanding in which types of tasks and in which dyadic constellations it is preferable to collaborate and which individual efforts are leading to better task performance. With respect to paradigm development, there seems to be a need for standard paradigms to be used to for individual, dyadic and repeated individual and dyadic testing for each of the domains of cognition reviewed here. In addition, paradigms that clearly dissociate the required abilities would allow to better understand how dyads manage the abilities and responsibilities to optimize dyadic task performance.

Overall, we strongly believe that the developmental and longitudinal approach to cognition in old age has proven its advantages to understand individual development across the lifespan (Hofer & Sliwinski, 2006; Schaie & Hofer, 2001). The inclusion of a dyadic partner in the examination and analyses of cognitive development, however, creates a number of new and additional empirical, theoretical, and methodological challenges. For example, if individuals regulate the performance of their partner, this may lead to decreases in the individual performance (Hertel, Deter, & Konradt, 2003; Sebanz, Knoblich, & Prinz, 2003). However, this decrease might be highly adaptive in the long run, because it may stabilize cognitive and emotional well-being of the dyad (Martin & Hofer, 2004), and thus improves openness to new cognitive challenges and well-being. In fact, dyadic cognition might be ideal to study the regulation of cognition in the sense that it is more obvious in dyads compared to individuals that cognitive performance takes place in the context of social interactions and socially relevant goals (see the chapter by Blanchard-Fields et al., this volume), and the estimation of a partner’s abilities may be seen as a social skill that is needed to regulate the well-being of a dyadic partner. Thus, examining dyadic cognition is situating cognition in the context of meaningful exchanges between persons, and may still be examined in the laboratory with experimental paradigms. However, adding a dyadic perspective to the examination of individual cognitive development widens our horizon with respect to adaptive
capacities and plasticity individuals may possess. It also alludes to the fact that individual performance may be underestimated without including the dyadic perspective, because what may lead to a lower individual performance in one test at one time point, may be supporting the best possible developmental trajectory of a dyads’ aptitude well into old age. Along similar lines, the performance of an individual within a dyad is typically dependent upon the actions of the partner. Therefore, it is difficult to independently measure the individual ability for dyadic cognition. Here, the selection of control groups, experimental control of the partner’s actions, e.g., by using virtual partners or experimenters instructed to follow a limited set of rules in the interaction, may prove useful in the future. With more empirical research on different types of dyadic cognition and with a similar developmental approach made possible through repeatable testing procedures, we will be increasingly better able to understand the contribution and adaptive capacities of dyadic interactions on the cognitive performances of individual members of social dyads.

References


List of Tables

Table 1: Studies examining old adults’ dyadic memory

Table 2: Studies examining old adults’ dyadic planning

Table 3: Studies examining old adults’ dyadic decision making
Table 1: Studies examining old adults’ dyadic memory

<table>
<thead>
<tr>
<th>Paradigms</th>
<th>Sample</th>
<th>Different couples (age, familiarity, gender etc)</th>
<th>Within-subjects-design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 1: 84 young, unacquainted adults (M age = 24.4) and 84 old, unacquainted adults (M age = 67.9). Experiment 2: 10 young (M age = 29.4; M marriage = 3.02) and 10 old (M age = 71.6; M marriage = 40.15) couples</td>
<td>84 young, unacquainted adults (M age = 28.5; M marriage = 3) and 10 old couples (M age = 70.7; M marriage = 40)</td>
<td>20 young dyads (M age = 26.30) and 20 old dyads (M age = 69.52). Half unacquainted, half couples (M marriage young = 3; M marriage old = 40)</td>
<td>30 young couples (M age = 26; M marriage = 4) and 30 old couples (M age = 67.4; M marriage = 44). Worked either with spouse or unfamiliar other gender partner first</td>
</tr>
<tr>
<td>Yes. Experiment 1: Young, old, unfamiliar, same-sex</td>
<td>Yes. Young, old, unfamiliar, same-sex</td>
<td>Yes. Young, old, married, unacquainted</td>
<td>Yes. Married and unacquainted</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes and no. Same people in dyads and couples. Not the same in young and old</td>
</tr>
<tr>
<td>Causal mechanisms suspected to influence performance</td>
<td>Experiment 1: Age, individual versus dyad</td>
<td>Age, elaboration characteristics such as denotative and annotative elaborations</td>
<td>Age differences in story structure, story content, interactions of collaborators</td>
</tr>
<tr>
<td>----------------------------------------------------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>Individual and dyadic measurements</td>
<td>Experiment 1: Yes Experiment 2: No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Measurement of relationship indicators</td>
<td>Experiment 1: No Experiment 2: Couples' expertise questionnaire (no age difference in knowledge about one's partner)</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 2: Studies examining old adults’ dyadic planning

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Sample</td>
<td>6 young (M age= 29.7) married couples</td>
<td>24 young women, 24 young men (M age = 19.98), 25 old women and 24 old men (M age = 71.14) worked either alone or with same-sex friend</td>
<td>98 old married couples (M age = 72.90; M marriage = 45.81), each participant (196) completed task independently and in dyads (52 with spouse, 46 with stranger of opposite sex)</td>
</tr>
<tr>
<td>Different couples (age, familiarity, gender etc)</td>
<td>Yes. Young and old couples</td>
<td>Yes. Young, old, same-sex, familiar dyads</td>
<td>No. Just old couples</td>
</tr>
<tr>
<td>Within-subjects-design</td>
<td>No</td>
<td>No</td>
<td>Yes and no, same task individually and in dyads, but half with spouse and other half with stranger</td>
</tr>
<tr>
<td>Causal mechanisms suspected to influence performance</td>
<td>Age differences in interaction style.Coding into high-affiliation and low-affiliation interactions</td>
<td>Age, collaboration</td>
<td>Collaboration, gender, and familiarity (actor–partner method), collaborative as well as task specific expectations, evaluations, and competitiveness</td>
</tr>
<tr>
<td>Individual and dyadic measurements</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Measurement of relationship indicators</td>
<td>High and low-affiliation interactions</td>
<td>No</td>
<td>Open-ended interview to find out about daily collaboration</td>
</tr>
</tbody>
</table>
Table 3: Studies examining old adults’ dyadic decision making

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Vacation decision making task</td>
<td>Social dilemmas</td>
<td>Wisdom paradigm</td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td>6 young (M age = 29.7, M marriage = 5.5) and 6 old (M age = 70.8, M marriage = 41.2) couples</td>
<td>98 old married couples (M age = 72.90; M marriage = 45.81), each participant (196) completed task independently and in dyads (52 with spouse, 46 with stranger of opposite sex)</td>
<td>122 participants with partners. Total 244 participants (148 women, 96 men). Half young adults (20-44) and half older adults (45-70)</td>
</tr>
<tr>
<td>Different couples (age, familiarity, gender etc)</td>
<td>Yes. Old and young married couples</td>
<td>No. Only old couples</td>
<td>Yes. Young and old adults with partners brought along</td>
</tr>
<tr>
<td>Within-subjects-design</td>
<td>No</td>
<td>Yes and no, same task individually and in dyads, but half with spouse and other half with stranger</td>
<td>Yes and no, same task individually and in dyads, but half with young and half with old dyads</td>
</tr>
<tr>
<td>Individual and dyadic measurements</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Measurement of relationship indicators</td>
<td>High-and low affiliation interactions</td>
<td>Open-ended interview to find out about daily collaboration</td>
<td>Questions about relationship with person, who they interacted with</td>
</tr>
</tbody>
</table>