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# Individualism-Collectivism and Interpersonal Memory Guidance of Attention

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**Abstract**

Recently it has been shown that the allocation of attention by a participant in a visual search task can be affected by memory items that have to be maintained by a co-actor, when similar tasks are jointly engaged by dyads (He, Lever, & Humphreys, 2011). In the present study we examined the contribution of individualism-collectivism to this 'interpersonal memory guidance' effect. Actors performed visual search while a preview image was either held by the critical participant, held by a co-actor or was irrelevant to either participant. Attention during search was attracted to stimuli that matched the contents of the co-actor's memory. This interpersonal effect correlated with the collectivism scores, and was enhanced by priming with a collectivistic scenario. The dimensions of individualism, however, did not contribute to performance. These data suggest that collectivism, but not individualism, modulates interpersonal influences on memory and attention in joint action.

**Keywords**

Interpersonal processes; Individualism-collectivism; Working memory; Attention; Priming

## Introduction

You are a big fan of whiskies and recently interested in some books about whiskies. You searched online and kept a note of several titles before heading for a bookstore. At the door of the bookstore you met a friend, who talked to you briefly about his recent passion for interior design and showed you some books he just bought. In the bookstore, while you were searching for the food-and-drink section suddenly your attention was captured by some books about interior design, even though you did not care about it at all. In this kind of scenarios information relevant to others is also influencing us even it is not helping us in any way. The question is: why and how does this happen? In the current research, we studied one interpersonal cognitive process, namely the interpersonal memory guidance effect of attention (i.e., the influence on one person's visual attention from the knowledge about another co-acting person's memory representation; He, Lever, & Humphreys, 2011), and investigated the relationship between this effect and the collectivistic and individualistic traits of the co-acting individuals.

*Interpersonal cognitive processes*

We very often engage with others in actions as human beings are social animals and constantly influenced by social contexts. In the most basic form, the mere presence of others influences individual performance. As a result, simple actions are facilitated whereas complex actions are impaired (Aiello & Douthitt, 2001; Zajonc, 1965). Apart from the general effect from another individual's presence, aspects of one's performance can also be affected by tasks carried out by others. For instance, when one is observing another person performing a certain action, one has the tendency to perform this action (Prinz, 1997; Rizzolatti & Craighero, 2004). In more complex situations, two or more persons can be involved in the same set of tasks. In these interaction situations, social cognition is fundamentally different from that when only presence or observation is involved (De Jaegher, Di Paolo, & Gallagher, 2010; Schilbach et al., 2013). Possible scenarios include following another person's attention to objects and events (Eilan, Hoerl, McCormack, & Roessler, 2005; Mundy & Newell, 2007), mutually sharing attention to physical objects with a co-actor (Pfeiffer et al., 2012), encoding information to and recalling from memory together (Wegner, 1986), and adjusting actions to co-workers' actions to achieve a common goal (Knoblich & Sebanz, 2006; Richardson, Marsh, & Baron, 2007).

In investigations of the cognitive consequences of tasks being performed by two actors, Sebanz and colleagues (Sebanz, Knoblich, & Prinz, 2003, 2005) demonstrated that action planning is affected by a co-actor's action alternative even when the participants are asked to perform independent tasks. Previously, Simon (1969) found that when participants are making two-choice responses to visual stimuli with two hands, reaction times (RTs) are longer when the stimulus's spatial information is not compatible with the responding hand (e.g., responding to a stimulus on the left with the right hand) than when they are spatially compatible (e.g., responding to a stimulus on the right with the right hand), an effect called spatial compatibility effect. Sebanz et al. extended the finding by showing that this effect is observed when people perform alone a two-choice RT task, where both response alternatives are at their disposal (e.g., responding with right hand to red and with left hand to green), and when they perform a go/nogo task with another person, where only one response alternative is at their disposal (e.g., responding to red while another participant is responding to green). Performing a go/nogo version of the task alone (e.g., responding to red but not to green when there is no co-actor present), however, eliminates this effect. These data suggest that shared aspects of the task context (e.g., the spatial locations of stimuli and responses) are represented when participants engage in joint action.

Several studies suggest that acting together also modulates attention in action. Inhibition of return (IOR) is an effect showing slowed responses for previously attended locations, and represents a bias discouraging attention from going back to previously attended locations (Klein, 2000). Welsh and colleagues (Welsh et al., 2005, 2007) studied this IOR effect between persons by asking two participants (sitting opposite each other) to complete a series of rapid reaching movements to target stimuli. They found that IOR occurs not only within, but also across people: movements to a target that appeared at the same location as a previously presented target were slower than responses to a target that appeared at a new location, when one participant responded to the first and the other to the second stimulus. In this case participants were affected by the context of where stimuli fell on their partner's response trial, when the participants engaged in the same task but across different trials. There can also be negative priming across two people each taking turn to act (Frischen, Loach, & Tipper, 2009). For example, when one of two participants has to ignore a distractor located close to his/her hand, the other participant can show delays in responding to stimuli presented at this location on the subsequent trial. These findings suggest that interacting with a co-actor's action can trigger similar processes of inhibitory attention as performing the action oneself.

Joint performance also relies on shared experiences between the co-acting persons. For example, in Richardson et al.'s study (2012), people showed a gazing preference and memory advantage for negative images in comparison to positive images only when they believed that other people were performing the same task with the same stimulus set. A similar joint action enhancement was found for effects of mood on attitude formation. Participants' attitude towards the stimuli was more influenced by the mood when a co-actor was sharing the same experience compared with the condition when the experience was not shared by a co-actor, and was most affected when the task sharing was among people using similar avatars (Shteynberg et al., 2013). Another study echoed these findings by showing that people are more successful in pursuing a goal if this goal is shared with others, especially when these others are similar to themselves (Shteynberg & Galinsky, 2011). The importance of experience sharing, interestingly, is not restricted to similarity of the tasks, but also extends to the simultaneity of task execution, which also benefits the joint task performance (Shteynberg & Apfelbaum, 2013).

*Interpersonal memory guidance*

It has been documented that when a participant performs a search task alone, attention is drawn to stimuli that match information held in the participant's working memory (WM; Chelazzi, Miller, Duncan, & Desimone, 1993). For instance, when participants are searching for a target in the search display while holding a picture in the WM, RTs are shorter if the target is by the side of the memorised picture (the picture provides valid information about the target's location) than if the target is far away from that picture (the spatial information is invalid) (Soto, Heinke, Humphreys, & Blanco, 2005). In addition to RTs, this WM guidance process also affects the first eye movements made in search, modulates the perceptual discriminability of the target, and can even operate in an involuntary fashion, when stimuli in WM are irrelevant to the task (Downing, 2000; Soto et al., 2005; Soto, Wriglesworth, Bahrami-Balani, & Humphreys, 2010).

Recently, we studied this coupling between WM and attention in a joint action setup, and showed that shared task representations can affect attention through each actor coding in memory information relevant to only one of the participants (He et al., 2011). Participants were tested in pairs performing a speeded visual search task, in which RTs were recorded, while one participant held an image in WM. The research replicated the standard (intrapersonal) WM-based attentional guidance effect on RTs, showing shorter RTs to targets next to the images the participant had to memorise than to targets falling at locations different from the memorised images. More interestingly, it was found that this effect takes place interpersonally as well – that is, when a participant was aware that the co-actor was memorising a certain image, the participant responded faster to targets flanking this image compared with conditions in which targets were flanking another irrelevant image. This suggests that participants form a co-representation of WM items relevant to their co-actor and use this representation to guide their own attention.

Other evidence indicates that joint action effects are modulated by social factors. For instance, effects of co-representation in joint action tasks are observed when participants are interacting with a person, but not with a non-human agent (Tsai & Brass, 2007). Furthermore, the joint action effect is present for single participants who believe they are interacting with others (Atmaca, Sebanz, & Knoblich, 2011; Tsai, Kuo, Hung, & Tzeng, 2008). Looking into the effect of group membership on social interactions, Shteynberg and colleagues went further to show that social learning, goal pursuit, infusion between mood and attitude, and prominence judgement of stimuli are all enhanced when joint action is performed by similar, compared with dissimilar, actors (Shteynberg, 2010; Shteynberg & Apfelbaum, 2013; Shteynberg & Galinsky, 2011; Shteynberg et al., 2013). Also addressing the group membership issue, our previous studies showed a more complicated pattern. He et al. (2011) tested three groups of participants: Caucasian strangers, Caucasian friends, and Chinese living in Britain. The participants from the latter two groups were considered social ingroup members based on mutual friendship (Caucasian friends) or common cultural and language background (Chinese living in Britain). Neither set of ingroup members, when acting together, showed an interpersonal WM guidance effect, in contrast to when the tasks were performed by outgroup participants (Caucasian strangers). This suggests that the interpersonal WM guidance effect is reduced for social ingroup members. Another study (He, Sebanz, & Humphreys, in preparation) however found evidence that shared racial group membership has a different influence on the interpersonal WM guidance effect, by showing that this effect occurs between pairs of British Caucasians, and between pairs of South Asians, but not between Caucasian-and-South-Asian participant pairs. To account for their results, He et al. suggested that members of a close ingroup (Caucasian friends, Chinese in the UK) have high inter-personal trust and so do not take their co-actor's task so strongly into account. Paired actors from a less closely, but more fundamentally, knitted group (white British and South Asian stranger pairs) affiliate more to each other and therefore pay more attention to their co-actor's action. As a consequence, interpersonal memory effects result.

The findings from the above discussed studies provided a showcase of social influences on joint action effects, and raised the possibility that the degree to which participants are affected by their co-actors may be modulated by other social factors too. In particular, participants who are oriented towards collective action may pay attention to their co-actor relatively more than participants who are more individualistic and so not attend to the other person's task.

*Collectivism and individualism*

Individualism-collectivism (IND-COL) scales are measures or constructs of social patterns reflecting the degree to which participants view themselves as members of a social group or as an individual. Individuals scoring high in collectivism are thought to take on group values and norms. In contrast, individualistic individuals view themselves as loosely connected to other people and choose to operate autonomously. For individualistic people, personal goals usually receive a higher priority than any collective goal (Hofstede, 1980; Schwartz, 1990; Triandis, 1995).

The IND-COL distinction was initially proposed as a single dimension at the cultural level, with individualism and collectivism being the two extremes of a bipolar continuum. As a collective entity, a culture has an established IND-COL trait; and any culture can be mapped somewhere along this continuum (e.g., Hofstede, 1980; Hui, 1988). Linked to the IND-COL distinction is the notion of whether people perceive themselves as independent or interdependent in relation to other people. In an individualistic culture the self is independent while it is interdependent in collectivistic cultures (Hofstede, 1984; for reviews, see Kitayama, Duffy, & Uchida, 2007; Markus & Kitayama, 1991).

In contrast to this initial view of single continuum, subsequent evidence however suggests that individualism and collectivism are separate constructs (Brewer & Chen, 2007; Lehman, 2004; Oyserman, Coon, & Kemmelmeier, 2002; Schwartz, 1994; see also Oyserman & Lee, 2007). This is especially true for individuals from a single culture (Triandis, 2001; Triandis & Gelfand, 1998), as individual differences are also evident within any particular culture. With a higher probability adhering to the culture's construct, varied tendencies are observed among individuals (for reviews, see Markus & Kitayama, 1991; Triandis, 1995).

In addition, Triandis and colleagues proposed the dimension of horizontal/vertical which is orthogonal to IND-COL (Singelis, Triandis, Bhawuk, & Gelfand, 1995; Triandis, 1995). The horizontal dimension refers to whether the individual is similar to others on attributes and status; groups can be considered horizontal when people are equal to each other and there is high group cohesion. In contrast, the vertical dimension reflects the degree to which people accept inequality/hierarchy within a group. Then it follows that the IND-COL dimension can be expanded to cover four measures: horizontal collectivism (HC), vertical collectivism (VC), horizontal individualism (HI), and vertical individualism (VI). As Triandis (1995, 2001) concluded, horizontal collectivistic people are cooperative, and merge themselves with other members in the group as equal entities; vertical collectivistic individuals readily accept hierarchy, and are willing to follow authorities and sacrifice themselves for the benefit of the whole group. In contrast to this, horizontal individualistic people are more independent and believe that all individuals are more or less comparable in their power and status. VI individuals, on the other hand, emphasise on competition and achievement, and accept inequality between individuals (Triandis, 1995, 2001).

The HC and VC dimensions have clear similarities, with HC weighing the relationship between individuals and VC reflecting the relationship between individuals and the collective (Brewer & Chen, 2007; Chen, Meindl, & Hunt, 1997). This is confirmed by Triandis and colleagues (Triandis, 1995; Triandis & Gelfand, 1998) who showed that HC and VC scores for individuals are highly correlated. Hence they were often combined to form a single collectivism measure (e.g., Oyserman et al., 2002). In contrast, HI and VI were designed as distinct measures (Oyserman et al., 2002; Triandis, 1995), with the VI having a critical and exclusive orientation towards competition and winning, which conception is related to power distance (Hofstede, 1980) and personal power/achievement (Schwartz & Bilsky, 1987). Consistent with this, prior studies have shown that HI and VI scores either do not correlate significantly or they may even correlate negatively (Oyserman et al., 2002; Triandis, 1995; Triandis & Gelfang, 1998). Because the VI dimension of Triandis's IND-COL scale is atypical among various IND-COL scales, Oyserman and colleagues dropped this VI dimension when comparing various IND-COL scales (Oyserman et al., 2002). Nevertheless, the VI dimension reveals another important aspect of individualism, and should be taken into account in studies looking at individual-group relationship.

In the current study, we aimed at investigating the contribution of IND-COL to the interpersonal memory guidance effect with the help of Triandis's IND-COL scale (Triandis, 1995). Because HC and VC dimensions are similar, we would combine them as a single collectivism scale if they are significantly correlated. In contrast, HI and VI would be treated as distinct measures following suggestions from previous research.

*Dynamic IND-COL*

An individual's scores on these dimensions are not necessarily static, but are dynamic. Every individual has collectivistic and individualistic components of self construal and, usually, cultural values are sampled as the default themes, and this sampling can be reinforced by just exposing individuals to the IND-COL questionnaire thus making them aware of their own self construal (Oyserman, Sakamoto, & Lauffer, 1998). Furthermore, the environment can modulate the weighting given to the individualistic-collectivistic components. For example, team-work situations are likely to remind individuals of their interdependencies, making the collectivistic components more dominant. Accordingly, individualism or collectivism can be selectively primed by introducing individuals to individualistic or collectivistic scenarios (Oyserman et al., 2002; Oyserman & Lee, 2007, 2008; Triandis, 1995). For instance, by asking participants to describe the ways in which they are different from or similar to their families or friends, individualism and collectivism may be respectively primed. Similar effects can be found by introducing participants to stories emphasising the abilities of individuals or background of a family (Trafimow, Triandis, & Goto, 1991; see also Brewer & Gardner, 1996; Gardner, Gabriel, & Lee, 1999).

These priming methods generally manipulate collectivism as a whole, and the horizontal dimension of individualism (HI is similar to other individualism measures, yet VI is not typically addressed by individualism scales). The VI dimension, as an exclusive measure of competition and winning (Oyserman et al., 2002; Triandis, 1995), may not be affected though.

Unfortunately, few studies directly manipulated this dimension. Following the definition of VI, we suggest that manipulating competition or competitiveness (e.g., Malhotra, 2010; Ruys & Aarts, 2010) will have an effect on how much the VI dimension is weighed in the sampling of self construal. Other researchers reasoned that VI also reflects the tendencies of interpreting power in personalised terms, and suggested that VI could be better understood to incorporate this personalised power status (Shavitt, Torelli, & Riemer, 2011). If this is the case, then VI can be manipulated by priming the power concept or powerfulness (Briñol et al., 2007; Rucker & Galinsky, 2009).

*The current study*

The contrasts in interpersonal attitudes and interactions between collectivistic and individualistic people are known to affect cognitive processes such as attention and perception. For instance, in a cross-cultural comparison, Masuda and Nisbett (2001) showed that people in a more collectivistic culture (Japanese) attended more to the view of a scene as a whole, whereas people from an individualistic culture (American) attended more to local details (see also Nisbett & Miyamoto, 2005; Nisbett, Peng, Choi, & Norenzayan, 2001). Similar findings have been obtained when participants were asked to replicate line drawings, with Japanese participants (from a collectivistic culture) more strongly influenced by the global context than Western individuals (from a more individualistic culture) (Kitayama, Duffy, Kawamura, & Larsen, 2003). In general, collectivistic cultures produce more holistic and relational perception, whereas individualistic cultures encourage a more analytic view of the environment (see Norenzayan, Choi, & Peng, 2007). Testing IND-COL effects in the same group of participants (within-group effects) also found a similar pattern – priming collectivism accelerates detection of global letters made up of smaller parts, and facilitates recognition of embedded figures, whereas priming individualism produced the opposite pattern (Kühnen & Oyserman, 2002; Lin & Han, 2008; see also Lin, Lin, & Han, 2008). Similarly, response delays to one feature with the presence of another incongruent feature (Stroop effect; Stroop, 1935) were reduced when individualism was primed in contrast to the collectivism priming condition where combined perception of features is reinforced (Oyserman & Lee, 2008).

Research in relation to the distinct VI dimension also suggested VI's effects on cognition, though of a more complicated pattern. Some studies have shown that co-representation of other's tasks does not take place in a competitive relationship (Hommel, Colzato, & van den Wildenberg, 2009; Iani et al., 2011, Experiment 2), and that higher personalised power promotes focusing on views from people's own mindset and reducing processing of other information (Briñol et al., 2007). Another study, however, demonstrated that competition enhances shared task representation in comparison to an independent condition (Ruys & Aarts, 2010). These works clearly showed us the influence of individualism and collectivism on cognition. Although the IND-COL discrepancy is generally based on cultural differences, and VI-oriented studies showed conflicting results, they nevertheless led us to speculate the possible interaction between these dimensions and interpersonal processes.

The current study aimed at further understanding the social nature of the interpersonal memory guidance effect. Different from our previous study (which discussed group membership), we took a different perspective by assessing the contribution of IND-COL.

Instead of relying on cultural differences, we measured and manipulated IND-COL at the individual level within a single culture to increase power and reduce confounds. As discussed above, HC and VC are very similar and highly correlated. Moreover, the inter-individual relationship (HC) and individual-and-collective relationship (VC) are hard, if not impossible, to be teased apart in person-to-person joint action scenarios. Therefore, HC and VC were combined as a single collectivism measure in the current study. At the same time, HI and VI were analysed separately as distinct measures.

Participants were tested in pairs, and were asked to carry out both a memory and a visual search tasks, with a memory cue appearing initially prior to a search display. The initial cue would re-appear in the visual search display, aligned either with the search target or a distractor (on valid and invalid trials respectively). There were three memory conditions determined by the category of the initial cue. If the cue was from one designated category, the participants carrying out the search task had to remember it (the own memory condition); if it was from a second category then the co-actor had to memorise (the other's memory condition); if the initial cue was from a third category, then neither participant had to memorise it (the baseline condition, testing for effects of mere presentation of the cue). We asked whether visual attention, which is measured by RTs in the search task, was affected by the initial cue (indexed by the effects of cue validity on search), whether this varied according to whether it was a cue from the own memory, other's memory, or baseline conditions, and whether any effects were modulated by the IND-COL profiles of the participants.

## Experiment 1: Regression against IND-COL measures

In this experiment, we measured the intrapersonal memory guidance effect based on the RT difference between valid and invalid trials in the own memory condition. Interpersonal memory guidance was measured as the RT difference between the different validity conditions for items falling in the other participant's memory condition. The RT difference when nobody needed to memorise (baseline condition) was used to test the effect of mere presentation of preview images. We then recorded participants' responses to an IND-COL questionnaire, and studied the relation between IND-COL scores and these effects.

**Method**

*Participants*

All volunteers were British Caucasians, participating as actor-confederate pairs. The actor group (seated on the right) consisted of 24 volunteers (21 females; 21 right-handed, 3 left-handed) of 18-27 years of age (*M* = 19.9 years, *SE* = 0.4 years). The confederate group (seated on the left) were another 24 volunteers (18 females; all right-handed) with an age range of 18-23 years (*M* = 19.8 years, *SE* = 0.2 years). In any pair, both the actor and the confederate had normal or corrected-to-normal vision, and had not met beforehand. The two participants in any pair were randomly assigned to the posts of actor and confederate. The two names were used to differentiate the two participants because one participant (the actor) took part in more tasks than the other (the confederate).

*Joint action setup*

We adapted the standard WM and visual search paradigm (e.g., Soto et al., 2005) for the purpose of testing two participants at the same time (He et al., 2011). The two participants (one actor and one confederate) in each pair sit side by side in front of a single monitor while performing their tasks independently. All participants took part in the WM task, whereas only the actors were engaged in the visual search task. Each participant's tasks were first introduced by text on the screen and further explained by the experimenter when the other participant was also listening. This was to make sure that each participant knew his or her co-actor's tasks in order to induce the interpersonal memory guidance effect. During the experiment, participants only focused on their assigned tasks (as they were not told to cooperate or compete) and were told to ignore their co-actors' tasks.

*Materials and procedure*

There were three image categories (40 images in each category) – one category (e.g., fruit) was designated for the memory task for the actor; a second category (e.g., musical instrument) was to be memorised by the confederate; the third category (e.g., animal) was irrelevant to either participant. This last category provided a baseline condition, to test if mere presentation of a stimulus in the initial display was sufficient to subsequently affect search. Picture category assignment to memory conditions was counterbalanced.

The experiment consisted of four 60-trial blocks. Each trial started with a 1,000-ms fixation cross, which was followed by a random image (2.1 × 2.1°) from one of the three categories. This image remained at the screen centre for 500 ms and had to be kept in memory by the corresponding participant if it was from the actor's or the confederate's category. Both participants ignored this image if it was from the third category (the baseline condition). After a 2,000-ms interval, a search display appeared for 1,000 ms or until the participant responded. Two pictures – the previewed image and another new picture that did not belong to any of the three primary categories (e.g., a watering can) – were presented randomly at two out of four positions (2.9° from fixation). Each picture was flanked by a pair of circles or squares (.6 × .6°). The circles were beside the previewed picture on 40% of the trials (valid condition, in which the previewed picture provides correct information about where the forthcoming circles would be), beside the other picture on 40% of the trials (invalid condition, in which the previewed picture provides wrong spatial information of the circles), and absent (squares appeared instead) on 20% of the trials (catch trials). The task was for the actor to make a speeded response to the presence of the circles by clicking the left mouse button no matter where the circles were (a simple RT task). No response was required on catch trials. If the previewed image was memorised by one of the participants, then on half of the trials, memory was tested after another 500-ms interval. Participants saw two pictures (3,000 ms or until response), which were exemplars from the same category as the preview on the trial, with one being exactly the same as the previewed image. The corresponding participant needed to indicate which picture matched the item in WM. To respond, the actors clicked the left and right mouse buttons, and the confederates pressed ‘c’ and ‘v’ on the keyboard, to the left and right images respectively. The next trial started after a 2,000-ms inter-trial interval (ITI) (Figure 1).

(Figure 1 about here)

After the experiment, each participant completed an IND-COL questionnaire as introduced by Triandis (1995, pp. 206-207). The questionnaire consists of four subscales (HI, VI, HC, and VC), each of which has eight items to be rated with a seven-point Likert-type scale (from 1 'strongly disagree' to 7 'strongly agree'). The actors' scores of the four subscales were calculated and analysed along with their task performance. At the end of the experiment participants performed a surprise free memory recall task where they were asked to put down as many of the images as they could by naming, describing, or drawing. Participants carried out the questionnaire and the free memory recall tasks independently.

## Results

### *IND-COL scores*

We first analysed the IND-COL questionnaire's attributes with all 48 participants' data. The IND-COL scales showed acceptable to very good reliabilities: HI's Cronbach $\alpha = .677$, VI $\alpha = .831$, HC $\alpha = .773$, VC $\alpha = .766$. Correlation analyses between the four subscale measures found no reliable correlation, *p*s > .11, except between HC and VC, $r = .395$, $p = .0055$. This agrees with Triandis (1995) in suggesting that HC and VC are correlated dimensions while VI is distinctively different from HI. We then used summed HC and VC scores to form a single Collectivism dimension. The reliability of items in this combined collectivism measurement was good, $\alpha = .814$.

### *Accuracies*

Actors showed an accuracy of 96.4% in the immediate memory test, demonstrating their successful maintenance of WM. For the visual search task, participants had a mean false alarm rate of 8.0%. These data were not normally distributed as indicated by

D'Agostino-Pearson $K^2$ tests, $K^2$s > 7.59, *p*s < .023. Therefore the dataset was analysed with a three-sample Friedman test, which showed that differences between memory conditions were approaching but did not reach significance, $\chi^2(2) = 5.34$, $p = .069$. This was due to that participants had slightly more false alarms for images from their own memory category (12.0%) than those from the co-actor's category (4.7%) and the baseline category (7.3%). This suggests that the participants could have had a marginally stronger tendency to respond to the visual search array when the initial image was from their own category, probably because this image category was most relevant to their tasks and therefore more likely to promote manual responses. The fact that the other's memory condition had much lower false alarm rate than the own memory condition (and comparable to the baseline condition) suggests that the participants did not pay unnecessary attention to the co-actor's image category.

All hit rate data distributions violated the normality assumption, $K^2$s > 13.35, *p*s < .0013, except for valid trials in the baseline condition, $K^2 = 4.47$, $p = .11$.Therefore we performed Wilcoxon tests contrasting valid and invalid conditions for the different memory conditions. There was a significant effect of validity for the own memory condition, $Z = -2.36$, $p = .018$, reflecting higher accuracy on valid (98.2%) than invalid trials (94.8%). This difference, however, was not reliable in the other's memory condition, $Z = -1.35$, $p = .18$ (valid 96.4% vs. invalid 98.2%), or in the baseline condition, $Z = -.46$, $p = .64$ (96.1% vs. 95.1%). These results suggest that there was no speed-accuracy trade-off. As the accuracies were too high (100% in most cases) for meaningful analyses, these data were not analysed any further.

*RTs*

For each participant, RTs three standard deviations (SDs) away from the mean value were removed from any further analysis. This procedure was followed for all the current experiments. The RT means from all participants were put to a D'Agostino-Pearson $K^2$ test for each condition and were confirmed as normal, $K^2$s < 2.57, *ps* > .27. These data were then analysed with a 3 Memory (own, other, neither) × 2 Validity (valid, invalid) analysis of variance (ANOVA). It showed a significant validity effect, $F(1,23) = 18.38$, $p = .00027$, $\eta^2 = .44$, and a reliable interaction between Validity and Memory, $F(2,46) = 5.46$, $p = .0074$, $\eta^2 = .19$. The main effect of memory did not approach significance, $F(2,46) = .39$, $p = .68$, $\eta^2 = .02$. The Validity × Memory interaction was then broken down by analysing the data separately for each memory condition. The validity effect was significant in the own memory condition, 497 ms vs. 539 ms, $F(1,23) = 13.43$, $p = .0013$, $\eta^2 = .37$. This effect, however, was marginal for the other's memory condition, 518 ms vs. 528 ms, $F(1,23) = 3.33$, $p = .081$, $\eta^2 = .13$, and clearly not reliable in the baseline condition, 518 ms vs. 526 ms, $F(1,23) = 1.93$, $p = .18$, $\eta^2 = .08$.

We then implemented multiple regression analyses for RTs under the three memory conditions separately. Because only the actor in each participant pair responded in the visual search task, the IND-COL and RT data from the 24 actors were used. The dependent measure was the memory guidance effect defined as the RT difference between the valid and invalid conditions (invalid – valid). The HI, VI, and Collectivism scores were input as independent variables. For the other's memory condition, we found a significant coefficient of collectivism, $\beta = 1.31$, $t = 2.92$, $p = .0086$ (Figure 2). There was no significant contribution from HI or VI, *t*s < .76, *p*s > .45. And there were no significant coefficients of the own memory and baseline conditions, *t*s < 1.36, *p*s > .19 (Footnote 1).

(Figure 2 about here)

(Footnote 1 about here)

*Memory recall*

A one-way ANOVA showed that actors had different recall performance across the memory conditions, $F(2,46) = 33.06$, $p = 1.3 \times 10^{-9}$, $\eta^2 = .59$. Recall was best for the participant's own memory category (34.7%), and better for the other's category (22.1%), compared with when the category of the initial stimulus was irrelevant to either participant (17.0%), all *p*s < .009. To show whether the relation between WM guidance and IND-COL scores received some contribution from long-term memory (LTM), we performed the same regression analyses for memory recall performance as for the attentional guidance effects. For all three regressions, none of the four predictors showed any significant contribution to recall, *t*s < 1.43, *p*s > .16.



**Discussion**

The validity effect in the own-memory condition replicates prior findings of WM guidance on attention (Downing, 2000; Soto et al., 2005). In particular the absence of this effect in the baseline condition suggests that effects in the own memory conditions were due to top-down guidance of search based on the contents of WM over and above effects from bottom-up activation (from the mere presence of the stimuli). Furthermore, the data agree with our previous finding that participants' attention can be influenced by a representation of the stimuli that a confederate had in memory (He et al., 2011). The images memorised by the confederate, however, were not relevant to the actors' tasks, suggesting that the guidance from WM is not due to participants deliberately attending to the memory item when it re-appears in the search display in order to refresh the WM for the following memory test (contrary to Woodman & Luck, 2007).

Furthermore, we found that the interpersonal WM effect on attention was reliably correlated with IND-COL scores: participants with higher collectivism scores showed stronger interpersonal WM guidance effects. This finding suggests that collectivism is related to the degree to which participants attended to the co-actor's task. Moreover, this process is specific to the interpersonal WM guidance effect, because the collectivism-guidance correlation was absent for the intrapersonal guidance effect and the mere-presentation (when no memorisation was involved) effect (in the baseline condition). In contrast to the data relating to collectivism, there was no significant correlation between any RT effect and the individualism scores, suggesting that individualism does not play an important role in integrating processes within the co-actor's task into the participant's own task.

It is also crucial to note that the influence from IND-COL on RT effects was not echoed in the LTM recall test. The memory recall performance was consistently better for the confederate's memory items relative to completely irrelevant items (in the baseline condition), and showed no correlation with the IND-COL scores. These data make it unlikely that the less collectivistic actors simply failed to attend to and encode the images in the confederates' category, raising the possibility that collectivism does not contribute to LTM encoding and longer-term retrieval. Instead, collectivism is more specifically involved in relation to whether a participant represents the content of the co-actor's task in WM and guides attention as the participant performs his or her own task.

**Experiment 2: Priming IND-COL constructs**

Experiment 1 correlated the memory guidance effects against the IND-COL scores, and found a reliable link between collectivism and the interpersonal memory guidance, suggesting that collectivism enhances interpersonal memory guidance of attention. However the data depend on regression analyses which do not directly demonstrate modulation by individualism and collectivism. To address these issues, Experiment 2 used an interventionist approach in which we primed participants with independent and interdependent constructs to actively facilitate access to individualistic and collectivistic themes respectively. We adapted the pronoun circling task, in which participants circle pronouns in a passage. This priming method has been proved successful in selectively activating the independent (individualistic) self when singular pronouns are detected and the interdependent (collectivistic) self when plural pronouns are detected, in both between-group (Brewer & Gardner, 1996; Gardner et al., 1999) and within-group manipulations (Sui & Han, 2007; Sui, Hong, Liu, Humphreys, & Han, 2013). If the effect from collectivism has a causal link to the interpersonal memory guidance effect, then we should expect to observe an enhancement of the interpersonal effect after collectivism priming in relative to the condition where no self-construal is primed. Because we hypothesised that individualism is not related to the interpersonal effect following Experiment 1, we should expect no such enhancement after individualism priming. In addition, any change in the intrapersonal memory guidance effect after any of these priming manipulations would be unlikely.

## Method

### *Participants*

A group of forty naïve participants with normal or corrected-to-normal eyesight were tested as actor-confederate pairs. The actors were 20 British Caucasian volunteers (15 females; 17 right-handed, 3 left-handed) between 18-28 years of age ($M$ = 21.2 years, $SE$ = 0.5 years). The confederate group were 20 Caucasian volunteers (15 females; 16 right-handed, 2 left-handed, 2 ambidextrous) with an age range of 19-31 years ($M$ = 21.8 years, $SE$ = 0.8 years). The actor and confederate in any pair were strangers before the experiment took place.

### *Materials and procedure*

As in Experiment 1, the actors performed both WM and visual search tasks, whereas the confederates only took part in the WM task. Because we were only interested in whether the intra- and inter-personal memory guidance effect are affected by manipulating IND-COL, and in order to reduce the duration of the experiment, we removed the baseline memory condition (in which the images were irrelevant to both participants). Furthermore, three priming conditions were introduced: interdependent self-construal (collectivism), independent self-construal (individualism), and neutral priming.

The experiment consisted six 50-trial blocks; two consecutive blocks for each priming condition. In each block, two image categories were assigned to the two participants, so that for each participant there was an own category and a co-actor's category. We used different image categories (36 images per category) across the priming conditions, making it possible to differentiate LTM memory performance (which was tested at the end of the experiment by a surprise free memory recall task) associated with images used for different priming conditions. The sequence of priming conditions and the assignment of categories for the two participants were counterbalanced across pairs. The trial procedure was the same as that in Experiment 1, except that the duration of the initial fixation cross was reduced from 1,000 ms to 500 ms, and that the ITI was changed from 2,000 ms to 1,500 ms (to further reduce the duration of the experiment).

Priming was realised with a pronoun circling task (Sui & Han, 2007; Sui et al., 2013). The participants were primed immediately before each block, so that priming was applied twice for each priming condition (as there were two blocks per condition) to maximise the priming effect. The priming manipulation was realised within-group to enhance statistical power given that the number of participants was limited due to the experiment's length. Participants were asked to read a short story, then circle certain words and check it before proceeding with the computer program. In the neutral priming condition, the story contained no interdependent or independent pronouns, and participants circled two nouns. In the other two priming conditions, participants were to circle pronouns in the stories, in which first-person singular pronouns (e.g., 'I', 'my') were used in the independent (individualism) priming condition, while first-person plural pronouns (e.g., 'we', 'our') were used in the interdependent (collectivism) priming condition. The story content and order were counterbalanced across pairs. This will remove any possible carry-over effect between different priming manipulations.

## Results

*Accuracies*

For accuracies, most data did not fit into normal distributions as revealed by D'Agostino-Pearson $K^2$ tests, therefore the data were analysed with non-parametric tests. In the immediate memory test, a Friedman test showed that actors' performance did not differ across the priming conditions, $\chi^2(2) = 1.47$, $p = .48$. The high overall accuracy (98.1%) suggested that the actors had no difficulties maintaining the images in WM.

For the visual search task, false alarms were analysed with two Friedman tests for the own and other memory conditions respectively. In the own memory condition, the false alarm rates had a mean value of 10.7%, and did not differ across priming conditions, $\chi^2(2) = 4.62$, $p = .099$. Performance was slightly better in the other's memory condition (8.0%), and did not vary across priming conditions either, $\chi^2(2) = .12$, $p = .94$. We then analysed the hit rate data with six Wilcoxon tests contrasting valid and invalid search conditions with varying priming and memory conditions. The hit rates were approaching ceiling (98.9% in average), and showed no significant difference for any test, $Z$s > -1.67, $p$s > .095. The accuracy data were not further analysed.

*RTs*

For each participant, RTs were trimmed with a three-SDs threshold. To statistically assess whether the collectivism/individualism priming treatment had different effects on intra- and inter-personal memory guidance, in comparison with the neutral priming baseline, we planned four two-way repeated-measures ANOVAs. These ANOVAs contrasted the validity effect in the collectivism or individualism priming condition against the neutral priming baseline in the different memory conditions separately.

First, we contrasted the collectivism priming against the neutral priming. We carried out two separate ANOVAs for the two memory conditions (own and other's). Each ANOVA had a 2 Priming (collectivism vs. neutral) × 2 Validity (valid vs. invalid) design. These data are summarised in Figure 3. For the intrapersonal memory guidance effects (own memory), the ANOVA revealed a significant validity effect, $F(1,19) = 32.53$, $p = 1.7 \times 10^{-5}$, $\eta^2 = .63$, showing a much shorter RT in the valid than in the invalid conditions, 455 ms vs. 490 ms. The main effect of Priming or interaction did not approach significance, *F*s < 1.58, *p*s > .22, $\eta^2$s < .077.

(Figure 3 about here)

The analyses for the interpersonal guidance effects (in the other's memory condition) revealed a different pattern. As before, we found a significant validity effect (valid 464 ms vs. invalid 479 ms), $F(1,19) = 14.03$, $p = .0014$, $\eta^2 = .43$. More importantly, there was a significant Priming × Validity interaction, $F(1,19) = 5.42$, $p = .031$, $\eta^2 = .22$, indicating that the validity effect was stronger when participants were primed with the collectivism treatment (collectivism priming: 461 ms vs. 486 ms; neutral priming: 468 ms vs. 472 ms). This priming effect, however, did not affect the overall RTs, evidenced in the lack of a main effect of Priming, $F(1,19) = .19$, $p = .67$, $\eta^2 = .010$. The D'Agostino-Pearson $K^2$ tests before the ANOVAs confirmed that the data were normally distributed, $K^2$s < 3.97, *p*s > .13.

We then compared the individualism priming data with the neutral priming data with two similar ANOVAs. The results are demonstrated in Figure 4. For the intrapersonal effects, the only significant result came from the validity effect (valid 450 ms vs. invalid 485 ms), $F(1,19) = 19.96$, $p = .00026$, $\eta^2 = .51$. Other effects were not significant, $F$s < .011, $p$s > .92, $\eta^2$s < .00055. The use of ANOVA was validated as the data for each variable fit into a normal distribution, $K^2$s < 5.52, $p$s > .063. The ANOVA for the interpersonal effects found no significant result at all, $F$s < 2.70, $p$s > .11, $\eta^2$s < .13. However, the data from one variable (the valid condition of other's category under individualism priming) were not normally distributed, $K^2 = 20.85$, $p = 3.0 \times 10^{-5}$, due to that one participant had a much slower response than others. After removing this single participant, a normal distribution was confirmed in all variables, $K^2$s < .93, $p$s > .62. We then re-ran the ANOVA and found similar results: all effects were insignificant, $F$s < 3.08, $p$s > .096, $\eta^2$s < .15. These results suggest that the individualism priming did not have an effect on interpersonal memory guidance (Footnote 2).

(Figure 4 about here)

(Footnote 2 about here)

*Memory recall*

Memory recall performance was analysed with two separate 2 Priming (collectivism vs. neutral, or individualism vs. neutral) × 2 Memory (own vs. other's) ANOVAs. In the ANOVA contrasting the collectivism against neutral priming, we only found that recall was better for the participant's own category than the co-actor's, 32.0% vs. 21.5%, $F(1,19) = 33.17$, $p = 1.5 \times 10^{-5}$, $\eta^2 = .64$. A similar result was obtained from the ANOVA analysing the individualism and neutral priming conditions, 33.2% vs. 20.6%, $F(1,19) = 28.98$, $p = 3.4 \times 10^{-5}$, $\eta^2 = .60$. Main effects of Priming and its interaction with Memory did not approach significance in either ANOVA, $F$s < 1.31, $p$s > .26, $\eta^2$s < .065.

## Discussion

When the participants were primed with collectivism (an interdependent construal), the interpersonal memory guidance effect was significantly enhanced compared with the neutral priming condition. In contrast, priming individualism (an independent construal) showed a similar result to that in the neutral priming condition, and non-reliable effects of interpersonal attentional guidance were found. The data support the results in Experiment 1, suggesting that collectivism is a key factor in the process of interpersonal memory guidance, whereas individualism is not.

Compared with the regression approach taken in Experiment 1, the priming manipulation in Experiment 2 is more direct and indicates a causal relationship with the outcome, giving us more confidence in suggesting that collectivism is one of the key factors driving the interpersonal attentional guidance effect. This guidance process needs two sequential components, namely the encoding of items from the co-actor's task in WM, and secondly the application of this representation to guide attention deployment. Given that there was no evidence that collectivism priming enhanced LTM for items from the co-actor's category, it can be argued that memory coding itself is not the source of the collectivism effect, but rather that collectivism modulates whether attention is oriented to the re-appearance of the stimulus relevant to the co-actor, after the stage of memory coding (see He et al., 2011). For example, in individuals low in collectivism, there may be some executive control exerted which militates against attentional deployment to stimuli related to the co-actor (Han & Kim, 2009). A further possibility is that individuals low in collectivism do not hold the co-actor's stimulus at the forefront of WM, though the mere encoding into WM is sufficient to modulate LTM performance (see Olivers, 2009, for arguments about holding items at the forefront of WM).

Regarding individualism, similar to Experiment 1, the data showed no evidence of any effect. This confirms that the absence of any individualism effect in Experiment 1 was not due to lack of measurement power.

## Experiment 3: Emphasising competition

Experiment 2 manipulated IND-COL by priming participants with independent/interdependent self construal. However, as we discussed in the Introduction, unlike HC and VC which are highly correlated and can be combined as a single measure, HI and VI are distinct measures. In contrast to the generally accepted traits of individualism such as 'independent, unique, and having more interest in the self than the collective', VI emphasises competition and winning (Oyserman et al., 2002; Triandis, 1995). Our priming study addressed collectivism (the combination of HC and VC) and HI, but may not have succeeded in manipulating VI.

In Experiment 3, we investigated the effect of VI by introducing a competition session, which was contrasted against a standard session. In the competition session, each participant was asked to compete with the co-actor. In the standard session, participants performed the tasks in a similar manner to individuals in Experiments 1 and 2. Any difference in behaviour patterns across the two sessions will show the effect of competition. In addition to this, we also correlated participants' performance against their scores on competition-related scales.

## Method

### *Participants*

Seventeen pairs of British Caucasian participants (23 females; 29 right-handed, 5 left-handed) with normal or corrected-to-normal eyesight took part. The two persons in any pair did not know each other, and none had participated in either of the first two experiments. They had an age range of 18-23 years ($M$ = 19.5 years, $SE$ = 0.2 years).

### *Materials and procedure*

The experiment consisted of a standard session and a competition session. In the competition session, an extra £10 bonus was to be split by the two participants according to their performance (a score that balanced RTs and accuracy). This incentive was introduced to encourage participants to compete with the co-actor. In the standard session, there was no mention of any extra information.

The two sessions took place at least three days apart ($M$ = 6.8 days, $SE$ = 1.1 days) to reduce any carry-over effect regarding competitiveness. In each session, three image categories (36 images in each category) were used, to produce three memory conditions for each participant: own memory, other's memory, and baseline (no WM). Different image categories were used for the two sessions. The sequence of the two sessions and the material usage were counterbalanced across pairs of participants.

Each experiment session consisted of six 60-trial blocks. The trial procedure slightly differed from that of Experiment 1. In order to introduce a competitive aspect to performance, we had both participants engage in visual search. To keep the experiment as close as possible to Experiments 1 and 2, we only asked one participant to respond in any single trial. To achieve this, a 500-ms cue ('X') was presented to one side of the screen simultaneously with the onset of the initial fixation cross, to indicate who was going to respond in this trial. In the immediate memory test at the end of each own-memory trial, only one image was shown. The corresponding participant made a choice response to report whether this image matched the memorised image in the trial ('Yes' or 'No') by clicking the left or right mouse button (for participants on the right) or by pressing 'c' or 'v' on the keyboard (for participants on the left). All other aspects remained the same as in Experiment 1.

After being introduced to the bonus scheme for the competition session, participants were asked to rate how strongly they felt that they were competitive in relation to their co-actor by using a 5-point Likert scale (from 1 'strongly disagree' to 5 'strongly agree'; the competitive feeling question). After completing the tasks on the computer, participants completed a competitiveness questionnaire, which aimed at measuring how competitive the participants were and whether the participants were actively engaged in the competition during the experiment. This questionnaire was a combination of three parts: a) Revised Competitiveness Index (RCI: 14 items; Houston et al., 2002), b) the competitiveness subscale of the Work and Family Orientation Scale (WOFO: 5 items; Helmreich & Spence, 1978; see Gill, 1986), and c) an additional item 'I have done my best to compete against my co-actor during the experiment' (the competitive effort question). They needed to indicate to what extent they agreed with these statements using a five-point Likert scale. A free memory recall test was carried out by the end of each session.

## Results

*Questionnaire scores*

Before the experiment, participants' responses to the statement 'I feel competitive in relation to my testing co-actor' averaged 3.25, not significantly higher than the central point, $t(33) = .14$, $p = .17$. However, being halfway between totally uncompetitive and totally competitive, this central point was more or less an arbitrary midpoint. The point of lacking any competitiveness on this scale was 1, where participants did not feel competitive at all. And this point was found significantly below the participants' feeling, $t(33) = 13.21$, $p = 9.9 \times 10^{-15}$. After the experiment, participants' rating on how much effort they had made in the competition was significantly higher than both the central point, $M = 3.97$, $t(33) = 6.26$, $p = 4.5 \times 10^{-7}$, and the uncompetitive end of the scale, , $t(33) = 19.16$, $p = 1.9 \times 10^{-19}$. These data suggest that participants were actively engaged in competing against the co-actor.

For the questionnaires, one participant did not give an answer to one question in RCI, and was deleted when RCI scores were needed in any analysis. The RCI data showed very good reliability, $\alpha = .855$. Data from the WOFO were also very reliable, $\alpha = .797$. The RCI and WOFO scores were highly correlated, $r = .780$, $p = 8.8 \times 10^{-8}$, suggesting that the two questionnaires have similar abilities in measuring competitiveness. We then correlated the RCI/WOFO scores with the competitive feeling/effort responses. The WOFO showed a strong correlation with each question, $r = .504$, $p = .0024$ (the feeling), and $r = .444$, $p$

= .0085 (the effort). The correlation between the RCI scores and the 'competitive feeling' responses reached significance as well, r = .383, $p$ = .023. The correlation between RCI and the competitive effort was weaker and only approached significance, r = .339, $p$ = .054. As revealed by a direct correlation analysis, the competitive feeling was significantly predictive of competitive effort, r = .416, $p$ = .014.

*Accuracies*

As the accuracy data generally were not normally distributed, we analysed these data using Wilcoxon tests. For the immediate memory task, participants performed well (96.5% accurate), and there was no significant difference between the two sessions, $Z$ = -.98, $p$ = .33. For visual search, false alarm rates were comparable to those in previous experiments ($M$ = 9.7%), and did not differ across sessions for any of the three memory conditions, $Z$s > -.76, $p$s > .44. Hit rates were analysed with six separate tests for different memory conditions and sessions. Overall accuracy was high (97.7%), and no significant difference was found, $Z$s > -1.04, $p$s > .29, apart from a small but significant validity effect in the baseline condition during the competition session, $Z$ = -.249, $p$ = .013 (valid 97.9% vs. invalid 96.1%). As the performance was approaching ceiling, these data were not analysed further.

*RTs*

All RT data in the visual search task had normal distributions, $K^2$s < 3.16, $p$s > .20. Then, similar to the analyses in Experiment 2, we analysed the RT dataset with three two-way ANOVAs, whose factors were Competition (competitive vs. standard) and Validity (valid vs.

invalid). These ANOVAs tested the effect of the competition treatment on the validity effects in different memory conditions separately. The ANOVA for the own memory condition found a significant of competition, $F(1,33) = 8.95$, $p = .0052$, $\eta^2 = .21$, showing that participants were faster in the competitive session (430 ms vs. 465 ms). A significant validity effect was observed as well, $F(1,33) = 29.30$, $p = 5.4 \times 10^{-6}$, $\eta^2 = .47$ (valid 437 ms vs. invalid 457 ms). The two factors did not interact, $F(1,33) = .44$, $p = .51$, $\eta^2 = .013$.

The ANOVA for the interpersonal memory guidance yielded similar results, with a significant competition effect, $F(1,33) = 9.09$, $p = .0049$, $\eta^2 = .22$ (competition 426 ms vs. standard 460 ms), and a significant validity effect, $F(1,33) = 4.77$, $p = .036$, $\eta^2 = .13$ (valid 439 ms vs. invalid 447 ms). The interaction was not significant, $F(1,33) = .067$, $p = .80$, $\eta^2 = .0020$.

For the baseline condition, where no WM was involved, the competition effect was significant as well, $F(1,33) = 8.99$, $p = .0051$, $\eta^2 = .21$ (competition 429 ms vs. standard 462 ms). Different from Experiment 1 though, the validity effect also reached significance, $F(1,33) = 7.37$, $p = .010$, $\eta^2 = .18$ (valid 440 ms vs. invalid 451 ms). No significant interaction was found, $F(1,33) = .69$, $p = .41$, $\eta^2 = .020$ (Footnote 3).

(Footnote 3 about here)

We then looked into whether the competition questionnaire scores were predictive of the intra- and inter-personal memory guidance effects and the baseline validity effect by putting the validity effects (measured as RT differences between the invalid and valid conditions) in the competition session into separate correlation analyses against the four questionnaire scores (RCI, WOFO, competitive feeling, competitive effort). There was a highly significant correlation between the competitive effort and the intrapersonal validity effect, r = .527, $p$ = .0014 (Figure 5). All other correlations, however, were not significant, $p$s > .16 (Footnote 4).

(Figure 5 about here)

(Footnote 4 about here)

*Memory recall*

Memory recall data were analysed with a two-way ANOVA: 2 Competition (competition vs. standard) × 3 Memory (own, other's, baseline). There was a significant main effect of Memory, $F(1,33) = 29.57$, $p = 6.8 \times 10^{-10}$, $\eta^2 = .47$. Pairwise comparisons showed that recall was better for the participant's own category (34.5%) than for the co-actor's category (23.0%) and the baseline category (19.7%), $p$s $< 1.1 \times 10^{-5}$. The recall performance also differed for the co-actor's and the baseline categories, $p = .045$. Performance in the competition session (27.0%) was slightly better than in the standard session (24.5%). However this difference was not significant, $F(1,33) = 2.48$, $p = .12$, $\eta^2 = .070$. The interaction did not approach significance either, $F(2,66) = .15$, $p = .86$, $\eta^2 = .0047$. We then correlated these six recall rates separately against the four questionnaire scores. The absence of any significant result ($p$s > .095) suggests that the scores were not predictive of LTM recall performance.

**Discussion**

We tested the effect of VI using a competition manipulation. The manipulation was successful, as participants reported feeling competitive and having made efforts to compete against their co-actors. Also, competition rendered the overall RTs significantly shorter. Data showed that the competitive effort was predictive of the intrapersonal WM guidance effect. This can be explained either by the tendency of participants to voluntarily use the memorised contents to guide attention even they were not relevant to the visual search task, or by participants implicitly holding the memorised images more at the forefront of WM (see Olivers, 2009), as a result of intensive engagement with their tasks in competition. Despite the significant contribution of competition effort, the competitiveness scores, however, did not correlate with the intrapersonal WM guidance. This seems to suggest that intrapersonal WM guidance is more related to the competition behaviour; the mere tendency for competition is not a factor strong enough to predict the WM guidance.

More importantly, we did not find any effect of competitiveness (the main theme of VI) or competitive effort on the interpersonal WM guidance. This suggests that neither competitiveness nor interpersonal competition itself influences memory guidance of attention interpersonally (guidance by co-representation of co-actor's WM), despite that competition affects attentional guidance by one's own WM. These data agree with the results we obtained in Experiment 1 by showing no effect of VI on the interpersonal memory effect, yet disagree with previous findings that competition affects joint action performance, either negatively (Hommel et al., 2009; Iani et al., 2011) or positively (Ruys & Aarts, 2010). The discrepancy of joint action performance between a variety of tasks hints that different cognitive functions may receive social influence in different manners. The interpersonal WM guidance effect, according to the data we gathered so far, is not affected by competition, implying that VI and interpersonal memory guidance are distinct processes which have little overlap. Moreover, as our previous study (He et al., 2011) and Experiment 1 in the present paper demonstrated, the interpersonal memory guidance is generally not a voluntary process as the representation of the co-actor's task is irrelevant to the participant's primary tasks. Unlike the intrapersonal effect, the interpersonal guidance does not receive influence from voluntary competitive engagement.

## General Discussion

In the present study, we replicated our previous findings of intrapersonal (own WM) and interpersonal (other's WM) memory guidance effects. In relation to the intrapersonal memory guidance effect, we replicated results from other studies that attention is drawn to stimuli that are concurrently held in WM, even when the contents of WM are not relevant to the search task (Soto et al., 2005). For the interpersonal guidance effect, the results additionally counter the argument that guidance reflects participants trying to 'top-up' their memory for the following memory task (see Woodman & Luck, 2007, for this argument), since the participant never underwent a WM test for items from their co-actor's category. To account for both the intrapersonal and the interpersonal memory effects, we suggest that participants hold cues in memory, both when the cues belong to their 'memorise' category and when they belong to the confederate's category. Once held in memory, the cue is matched against the upcoming search display. A match between a search item and the WM representation provides an input to the selection process, along with a match between a display item and the actual search target. When the cue and the target both direct attention to the same location (on valid trials) performance is speeded relative to when the cue and the target at different locations (on invalid trials) compete for selection.

More importantly the present study demonstrates additional, social influences on cognition. Most notably the results show that interpersonal memory guidance is affected by collectivism, which is a measure of interdependency between individuals and their association with their collective group. The stronger the collectivistic tendency, the larger the interpersonal guidance effect. This was demonstrated by a significant correlation between collectivism scores and the magnitude of the interpersonal guidance effect, and by the increased interpersonal guidance effect after participants being primed by an interdependent self construal. This last result further indicates that, just as the IND-COL is a dynamic social attribute, so the interpersonal memory guidance effect also varies across different social scenarios: the same individual is likely to show a stronger interpersonal memory effect when the interdependent construal is primed in contrast to the neutral priming condition (Experiment 2). When the independent construal is primed, however, the interpersonal memory effect does not seem to differ in size from that in the neutral priming condition.

The most intriguing question is how to better understand the enhancing effect of collectivism on interpersonal WM guidance. It is likely that individuals who are more collectivistic by their default self construal status (as measured by the IND-COL questionnaire), or when their collectivistic themes are selectively activated, are more likely to conceive that both actors in a pair are working together towards a common goal. This echoes the suggestion that shared experiences (e.g., tasks and goals) and identity similarity are crucial in the formation of interpersonal co-representation (e.g., Richardson et al., 2012; Shteynberg & Apfelbaum, 2013; Shteynberg & Galinsky, 2011; see also Schilbach et al., 2013). It is worth noting that the common goal in the current experimental setup is not made explicit to the participants as in other studies, but is rather embodied implicitly (as a general tendency) in the collectivistic self construal. The first implication of this proposal is that shared goals do not have to be made explicit before it can achieve influences on interpersonal interaction. Secondly, this also leads to a possible suggestion that the collectivism scale may be more capable of showing subtle effects of mutually shared conceptions than the seemingly more discrete manipulation of goal sharing. Whether this conjecture is correct or not, our results indicate that, when collectivism is emphasised, participants pay more attention to their co-actor's task and allow stimuli from that task to not only enter WM but also to guide their own attention. These findings extend our understanding of interpersonal processing by showing that self-construed interdependency is an important driving force of the interpersonal memory guidance effect.

Moreover, it is essential to discriminate the memory guidance effect (i.e. the application of WM contents in the process of guiding visual attention in space) from LTM encoding, tested here by a surprise recall task. For LTM recall there was no relation to collectivism and no difference across the social conditions (e.g., in Experiment 2). The results suggest that the effects of collectivism here modulate on-line memory-based attentional guidance, but do not alter the extent to which items enter LTM – though for all participants there was better recall of the other's items than items from the neutral category (irrelevant to both participants). This differs from studies which showed improved memory and learning when task sharing was elevated (Richardson et al., 2012; Shteynberg & Apfelbaum, 2013). One account of this is that all participants encode their co-actor's as well as their own memory items in WM, but only those high in collectivism hold their co-actor's item at the forefront of WM (see Olivers, 2009), promoting another form of memory advantage by allowing it to guide attention. However, the encoding through WM is nevertheless sufficient for subsequent LTM recall.

The current study provided some insights into the interaction between collectivism and interpersonal processes. However, it is important to remain cautious about directly linking these findings to studies investigating group membership (e.g., Miles, Lumsden, Richardson, & Macrae, 2011; Shteynberg, 2010). It is true that collectivistic individuals have close links with ingroup members whereas individualistic persons keep the links loose. However, it is more difficult for collectivists to take a person as an ingroup member, and they have fewer ingroups (Triandis, 1995). And collectivists' ingroups are fundamentally different from minimal groups (see Tajfel, Billig, Bundy, & Flament, 1971) imposed by applying an arbitrary criterion in many studies (e.g., Iani et al., 2011, Experiment 1; Miles et al., 2011). As a result, a direct comparison is not easy, and awaits further studies.

In contrast to collectivism, HI failed to affect the interpersonal memory guidance. This suggests that HI participants may emphasise personal interests and process information analytically, but this has little to do with how they perceive relations between co-actors and use global context (e.g., Brewer & Chen, 2007; Norenzayan et al., 2007). Furthermore, we failed to find any contribution from VI, not only with the manipulation of competition, but also by showing the absence of any correlation between the interpersonal WM guidance effect and the VI (Experiment 1) and competitiveness (Experiment 3) scores. These data convergingly suggest that, unlike some other joint action tasks (Hommel et al., 2009; Iani et al., 2011; Ruys & Aarts, 2010), the interpersonal WM guidance is not susceptible to the VI dimension of self construal.

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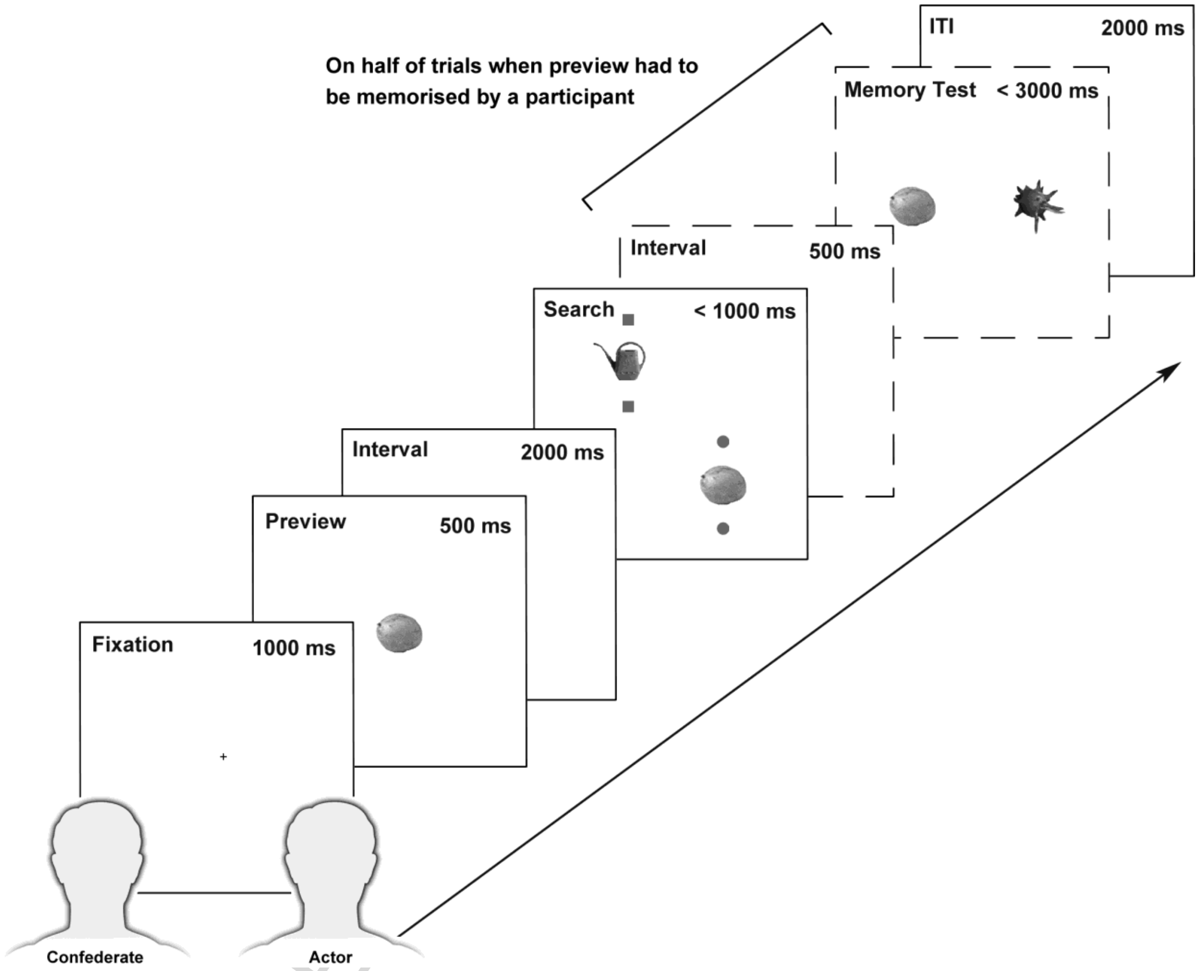


**Figure 1**. *Example of a trial in Experiment 1. Two participants were sitting in front of a single monitor performing working memory (WM) and visual search tasks. The preview image was kept in memory by the corresponding participant (either the actor or the confederate, if the preview was from his/her category), who performed the WM test on half of the to-be-memorised trials. The actor carried out a visual search task by making speeded responses to circles (simple reaction time task) while the preview was held in his/her own memory, in the confederate's memory, or in neither's memory (baseline condition).*

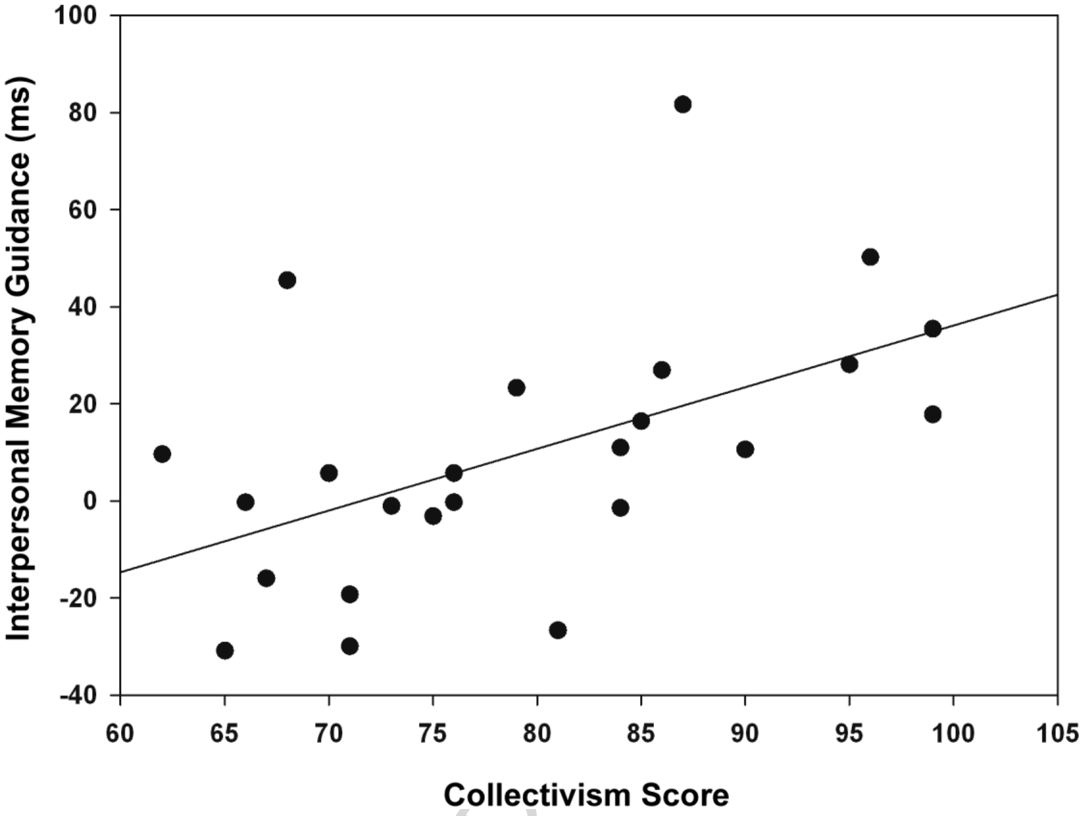


**Figure 2**. *Correlation between collectivism scores and interpersonal memory guidance effects in RTs (Experiment 1).*

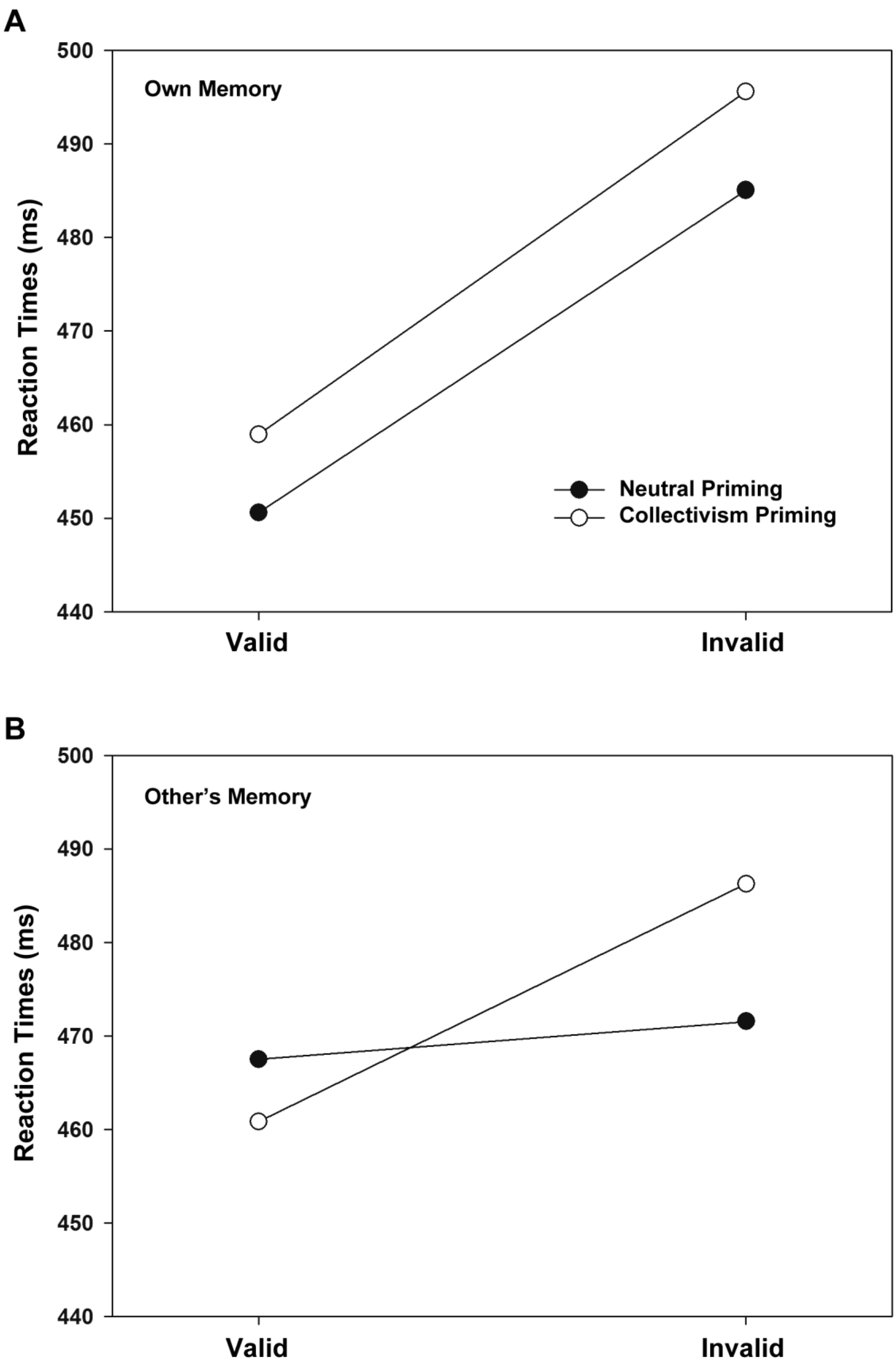


**Figure 3**. *Validity effects under collectivism and neutral priming in (A) the own and (B) other's memory conditions*, *in the latter of which the effect size differs (Experiment 2).*

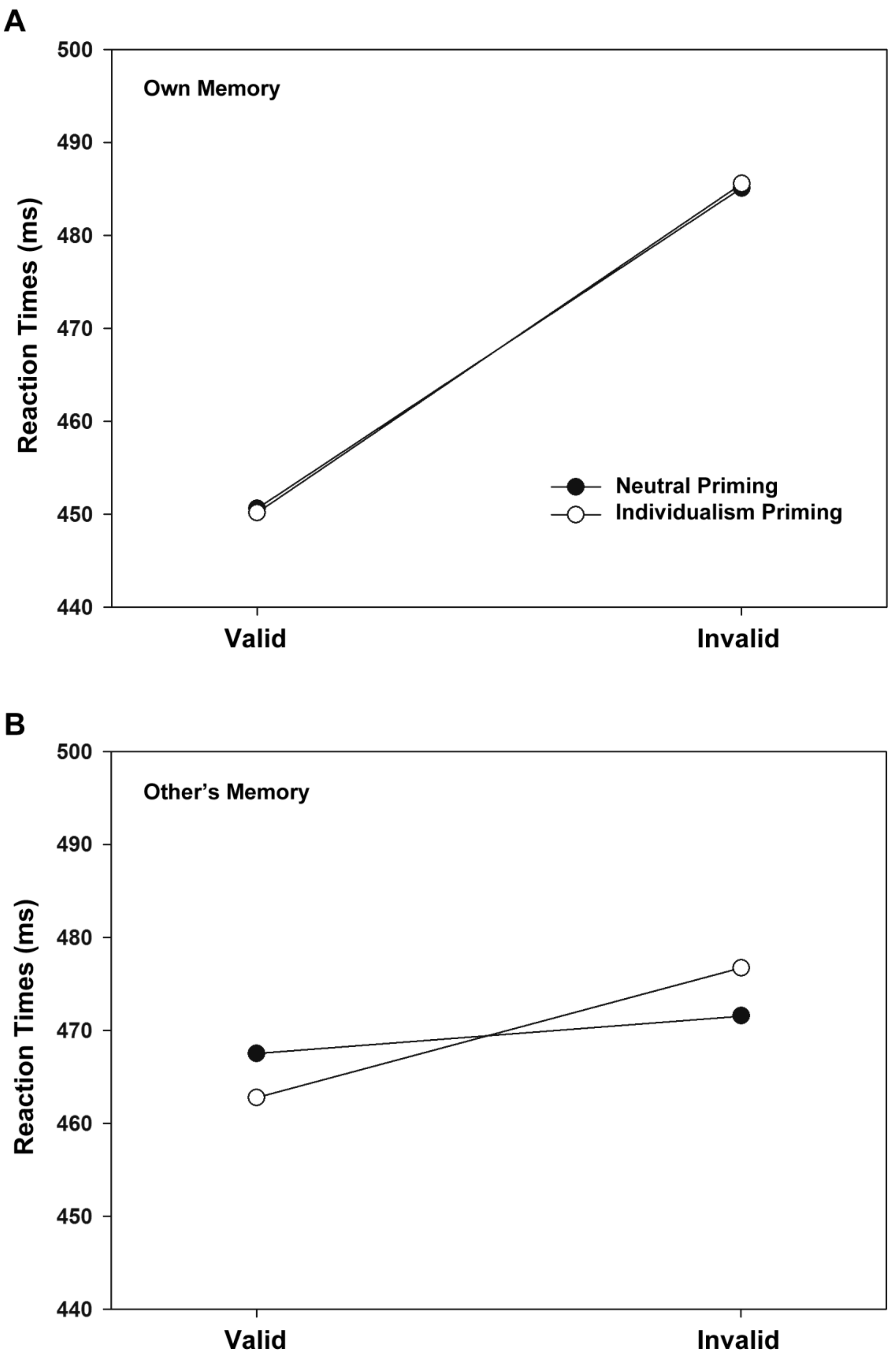


**Figure 4**. *Validity effects under individualism and neutral priming in (A) the own and (B) other's memory conditions*. *No differential priming effect is observed (Experiment 2).*

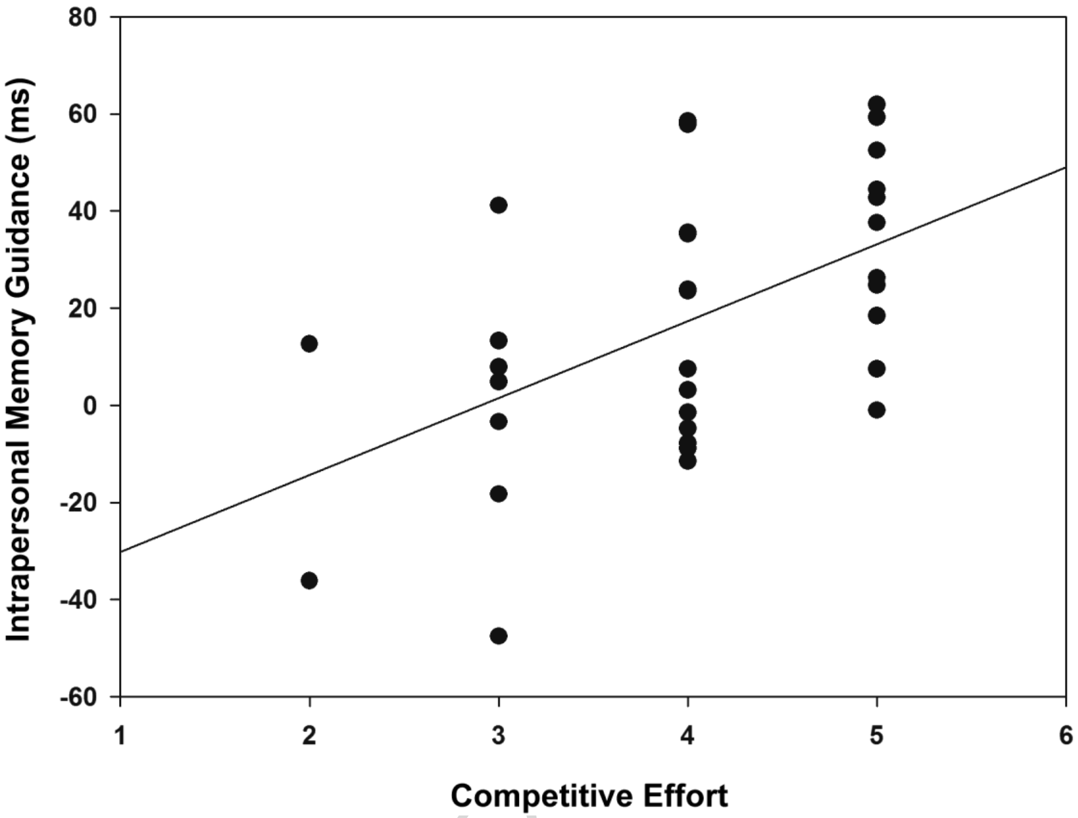


**Figure 5**. *Correlation between competitive effort scores and intrapersonal memory guidance effects in RTs (Experiment 3).*

**Footnote 1**. To provide some preliminary data, we also checked the gender difference in the RT dataset despite that it was not our aim and that we did not balance sample sizes of the two gender groups. Experiment 1 only had three males, making any analysis with the male group meaningless. The regression results from the female participants showed the same pattern – only a significant correlation between the interpersonal memory guidance effect and the collectivism score was found, $\beta = 1.35$, $t = 2.99$, $p = .0082$.

**Footnote 2**. We investigated the gender difference in two ways. First we carried out four three-way ANOVAs (for different memory conditions and priming contrasts) with an additional gender factor (Gender × Priming × Validity) to see whether there was any interaction involving gender. Results failed to find any of these, all *p*s > .12. Then we checked the two-way ANOVAs for female and male groups separately. Similar patterns were found for the two gender groups. For the female group, the collectivism priming produced marginally stronger interpersonal memory guidance than the neutral priming, $F(1,14) = 4.19$, $p = .060$, $\eta^2 = .23$. This effect had the same pattern but had a much lower significance level in the much smaller male group, $F(1,4) = 1.24$, $p = .33$, $\eta^2 = .24$. All other effects in these ANOVAs were far from significant, *p*s > .44.

**Footnote 3**. The effect of gender was also checked in the same way as in Experiment 2. The three-way ANOVAs (Gender × Competition × Validity, for the three memory conditions separately) revealed shorter RTs in the competition session, all *p*s < .016. Males were also faster than females, *F*s > 6.99, *p*s < .013. These analyses, however, did not show any influence from gender on any of the validity effects, all *p*s > .46. We then looked at the pattern for the male and female groups separately. Again, in all six two-way ANOVAs, the RT patterns were similar between the male and the female groups. Apart from the overall speed-up of RTs in the competition session, no other influence from competition was observed, all *p*s > .39. So far, the female and male groups showed similar behaviour patterns.

**Footnote 4**. Correlation analyses between validity effects and competition questionnaire scores were carried out for the two gender groups separately. The results from the female group echoed the main analysis – only a significant correlation between the competitive effort and the intrapersonal memory guidance was found, r = .51, *p* = .013. The correlation between the competitive feeling and the interpersonal memory guidance was approaching but slightly short of significance, r = .40, *p* = .055. We also found a marginally significant negative correlation between the competitive feeling and the validity effect in the baseline condition, r = -.39, *p* = .069. No other correlation was significant, *p*s > .1. The male group, with a smaller sample size, had a marginal correlation between the competitive effort and the intrapersonal effect, r = .58, *p* = .061, echoing the results from the female group. Different from the females, the males showed significant correlations between three competition scores (competitive effort, RCI, and WOFO) and the validity effect in the baseline condition, r = .68 ~ .89, *p*s < .023. All other effects were far from significance, *p*s > .24. The differential patterns between males and females might reflect different strategies in competition.

Highlights

* Visual attention can be guided by memory contents maintained by a co-actor.

* The contribution of individualism-collectivism to this effect is examined.

* The effect positively correlates with collectivism, but not individualism, scores.

* The effect is enhanced by collectivistic, but not individualistic, priming.

* Competitiveness, a measure of vertical individualism, does not contribute either.