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Joint perception: Gaze and social context

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Abstract

We found that the way people looked at images was influenced by their belief that others were looking too. If participants believed that an unseen other person was also looking at what they could see, it shifted the balance of their gaze between negative and positive images. The direction of this shift depended upon whether participants thought that later they would be compared against the other person or would be collaborating with them. Changes in the social context influenced both gaze and memory processes, and were not due just to participants' belief that they are looking at the same images, but also to the belief that they are doing the same task. We believe that this new phenomenon of joint perception reveals the pervasive and subtle effect of social context upon cognitive and perceptual processes.

Introduction

What is the difference between experiencing something by yourself and experiencing it at the same time as another person? When a student hovers over your shoulder while you read their paper, does it influence your evaluation? When someone sits down on the sofa while you are watching TV, does their presence intrude upon your experience of the show? What if you are watching a show alone, but know that a friend across town is also tuned in? In this paper, we investigate the phenomenon of *joint perception*: the changes that happen when people believe that they are experiencing something at the same time as another person. To isolate these effects from the demands of social interaction, we made the difference between perceiving something alone and jointly as small as possible. We presented images to participants, tracked their gaze, and manipulated - on a trial by trial basis - whether or not they believed that an unseen other person was looking at the same sets of images.

Social context, the real or imagined presence of other people (Allport, 1954), is a ubiquitous psychological force. Cognition is enveloped by social context (Smith & Conrey, 2009; Smith & Semin, 2004). Yet the effects of social context upon cognition often fall between the cracks of social and cognitive psychology. In cognitive and perceptual laboratories, we typically place participants in an experimental quarantine, away from the confounds of social influence. As a consequence, we have many elegant demonstrations of the different behavioral and neurological responses to social versus non-social stimuli (e.g., Birmingham, Bischof & Kingstone, 2008; Cacioppo, Visser & Pickett, 2005; Senju & Johnson, 2009; Wu & Kirkham, 2010), but little idea of how these and other stimuli are processed in a social versus a non-social context.

In contrast, a founding principle of social psychology is that the processes and representations of individuals are related to the groups around them (e.g., Asch, 1951; Festinger, 1950; Heider, 1958;

Sherif, 1935). For example, in the theories of Gestalt psychologists such as Lewin (1947), behaviour was determined, moment by moment, by a field that incorporated both an individual's goals, intentions and desires, and the goals and intentions of those around them. Indeed, one of the very first experiments in social psychology showed that people performed better in presence of others (Triplet, 1898), and later work expanded this effect of social facilitation to a range of contexts, and even other species (Zajonc, 1965; Zajonc, Heingartner, & Herman, 1969). Recent work has revealed specific influences that the race of the experimenter (Lowery, Hardin & Sinclair, 2001) or the gender of a partner (Most, Laurenceau, Graber, Belcher, & Smith, 2010) can have on a participants' behaviour and social judgments. When people interact, they are motivated to form a 'shared reality' (Hardin & Higgins, 1996): a speaker will adapt the content of their message to align with the beliefs of their audience, and consequently come to believe that message themselves (reviewed by Echterhoff, Higgins & Levine 2009). Beliefs and judgments are not formed in cognitive isolation, but always in the context of the thoughts and opinions of those around us (Smith & Semin, 2007). Our goal was to take these lessons from social psychology, and apply them to a simple perceptual process that was either done alone, or in the belief that it was being done with another.

In a precursor to these studies, Fridlund (1991) showed clips of a comedy show to participants. If they were sitting next to a friend they smiled significantly more than when watching alone, as measured by EMG levels in their facial muscles. Importantly, exactly the same increase in smiling was found if they were alone but told that their friend was also watching the show in a room next door. This surprising finding showed that smiling cannot be entirely due to self presentation and top down control of expressions, as it occurs in solitude; but neither can it be simply a response to the stimulus, as it is changed by beliefs about social context. Recently, Shteynberg (2010) found intriguing evidence that social context can influence the 'psychological prominence' of stimuli: When participants were told that

other people like them were performing the same experimental tasks with the same stimuli, their memory and decision-making performance improved.

In the current experiments we explored the effects of social context through the lens of joint perception. Rather than an overt social behaviour, such as smiling, we used eye tracking as an index of online cognitive processing (Spivey, Richardson, Dale, 2008). Rather than comparing participants in different social contexts, we determined sensitivity to social context by varying participants beliefs about each other on a trial-by-trial basis.

To pre-empt our results, a surprising reversal of the joint perception effect between the first two experiments uncovered an interesting interaction between social context and participants' expectations, tasks and beliefs. These results connect the phenomenon of joint perception to recent work on joint action (Galantucci & Sebanz, 2009), the cognitive mechanisms at work when people act together (Brennan, Chen, Dickinson, Neider, & Zelinsky, 2008; Sebanz, Bekkering, & Knoblich, 2006), and the notion of cognition situated in a social context (Barsalou, Breazeal & Smith, 2007; Robbins & Aydede, 2009).

Experiment 1

Our initial exploration of joint perception presented participants with a set of four images on screen for eight seconds. On different trials, participants either believed that, in a cubicle next door, another participant was looking at the same images, or that the person next door was looking at a set of unrelated symbols (Figure 1). In each set of images, there was one picture with a negative valence (e.g., crying child), one with a positive valence (e.g., a smiling couple) and two neutral images with no strong valence (e.g., a person reading). Work such as Shteynberg (2010) has established that people will be attuned to stimuli that an experimenter identifies as shared: the fact that someone else is looking at a

stimulus increases its salience. By presenting a set of four pictures at once, we can address an importantly different issue. How does the fact that a whole set of images is shared or seen alone change which images are salient and which are not? In other words, how does social context shape attention?

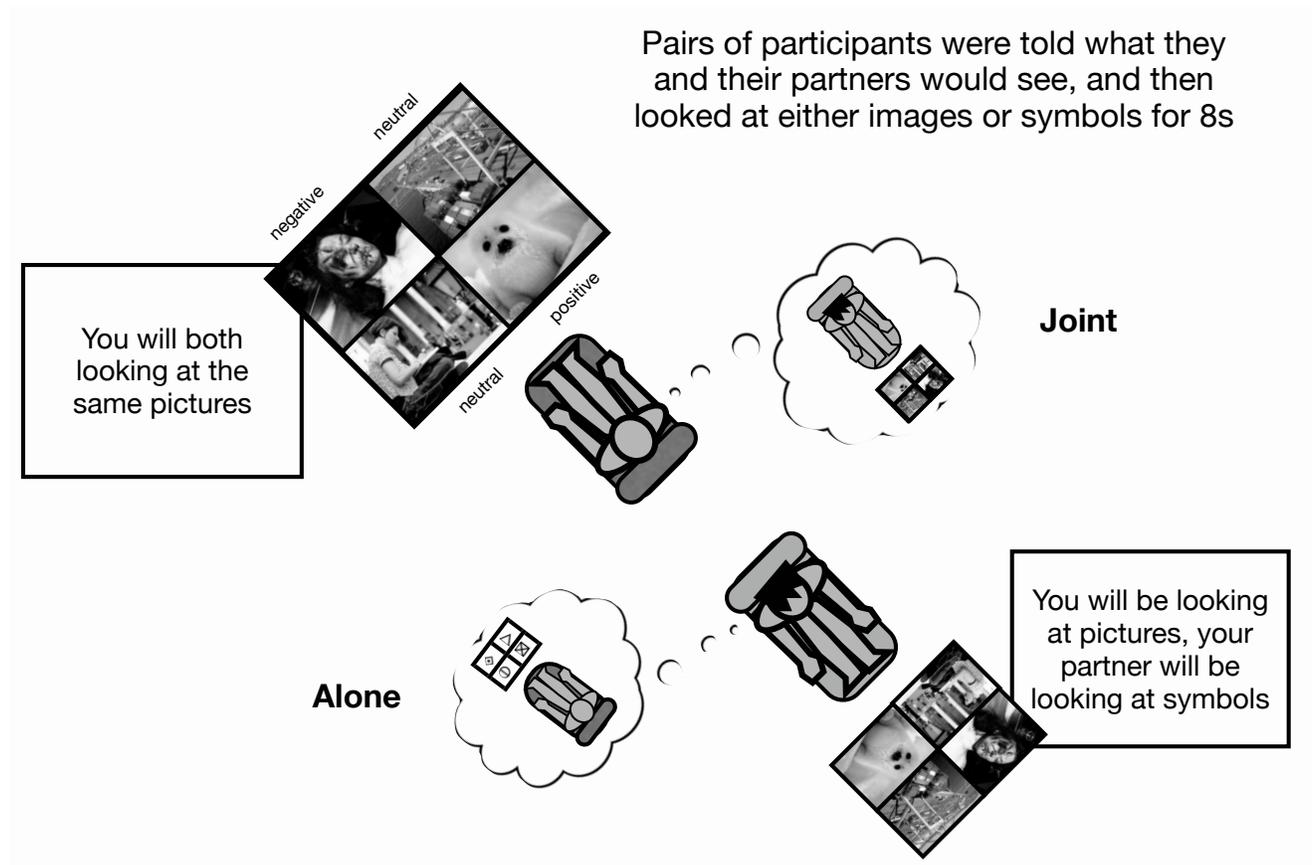


Figure 1. Trial schematic

Methods

Participants

Twenty-seven undergraduates from the University of California, Santa Cruz took part in the experiment in exchange for course credit. We did not collect data from 6 due to failures to calibrate. Although we ran pairs of participants in the lab, each participants' data were analysed independently as they could not see each other or interact. Therefore, twenty-one participants' data were analysed.

Apparatus

Participants sat in adjacent cubicles in a reclining chair looking up at an arm mounted 19" LCD screen approximately 60cm away. A custom built remote eye tracker was mounted at the base of each display. The participants wore a headset, through which they could hear the stimuli and speak to the experimenter. Two iMacs calculated gaze position for each participant approximately 100 times a second, presented stimuli and recorded fixation position parsed into regions of interest. The experimenter's computer saved an audio-video record of what the participants saw, heard and said during the experiment, superimposed with their gaze positions.

Design

32 trials were presented in a random order. Figure 1 provides a schematic. At the start of each trial a prerecorded voice and text message informed participants about the type of images they were about to see, and what their partner would see. Half the time participants saw a set of four pictures, and half the time they saw a set of four symbols. Counterbalanced with the image type, participants were either (truthfully) told that their partner would be looking at the or a different image type. In each set of four pictures there were two neutral images, one positive and one negative image. The pictures in this experiment were collected according to the subjective opinion of the experimenters (a normed stimuli set was used in subsequent experiments). The symbol sets, which served only as filler items in this design, were taken at random from a set of geometric patterns found in various font sets. The images were displayed onscreen for 8s. Following a blank screen for 1s, the next trial began.

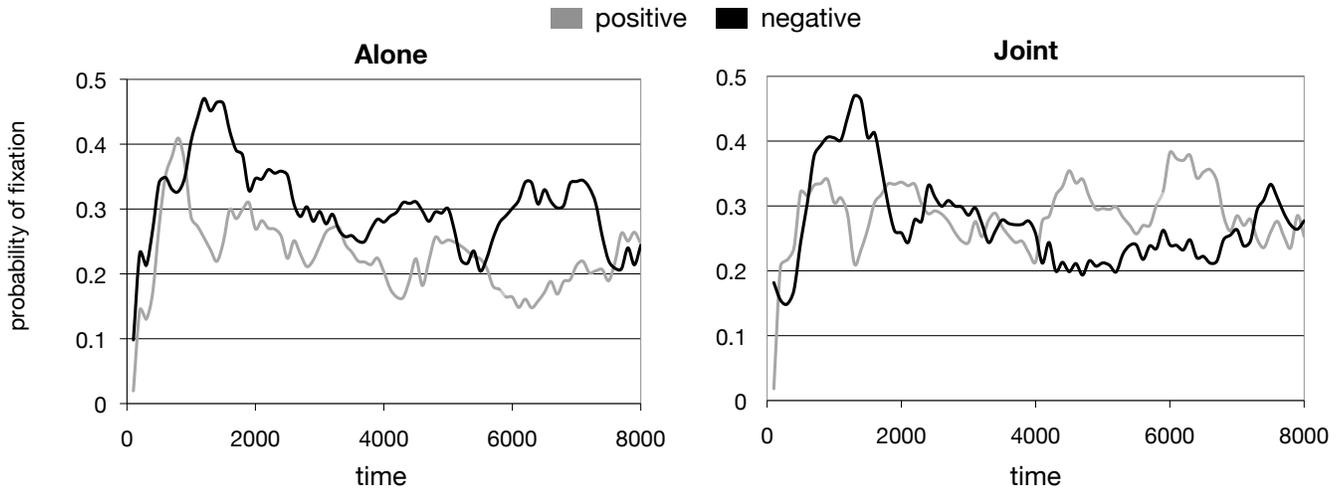


Figure 2. Time course of gaze probabilities, Experiment 1

Results and Discussion

Figure 2 shows the time course of the probabilities of the positive and negative images being fixated during the 8s of the trial. People are generally very responsive to unpleasant or threatening things: Negative images are considered more potent than equivalently-valenced positive images (for reviews, see Baumeister et al., 2001; Rozin & Royzman, 2004). Negative stimuli are likely to receive attention more quickly (Norris et al., 2004; Smith et al., 2003) and for longer (Hajcak & Olvet, 2008). This effect can be seen in our data in an initial spike in looks to the negative images in the first few seconds of the trials in both conditions. After that point however, the looking patterns diverge.

Our hypothesis simply concerns whether there is an effect of social context that is specific to positive versus negative images in the course of a trial. We had no a priori expectation that the effect would emerge with a particular time signature. Therefore, to test for differences between conditions, we calculated the total looking times to the positive and negative images, as shown in Figure 3 (a). We found that when participants believed that they were looking alone, they looked more at the negative stimuli (Tukey's HSD $p < .05$). Conversely, they looked more equally at the positive and negative stimuli

when they thought their partner could see the same thing. A 2 (picture valence: negative or positive) x 2 (social context: joint or alone) ANOVA revealed a significant interaction ($F(1,20)=5.52, p<.05, h_p^2=.21$), with no main effects (all $F_s < 1$), indicating that beliefs about the social context modulated how viewers distributed their gaze to positive and negative images.

Participants in this experiment could not see or interact with each other. Yet their gaze was systematically shifted if they believed that another person was looking at the same images. When two people are instructed to perform a visual task together, their gaze patterns reveal that they are able to divide their attention with ease, searching the non-overlapping areas with efficiency (Brennan et al, 2008). In our experiments, participants were not instructed to perform a task with each other or coordinate their activity: they simply viewed pictures by themselves with the belief that someone else is doing the same thing, or not. It was not simply that shared images received greater attention (Shteynberg, 2010). Indeed, in this paradigm there was no main effect on looking times overall. More specifically we found here that when set images were believed to be shared, the distribution of participants' attention shifted. This initial result demonstrates how social context can shape a low level perceptual process on a trial-by-trial basis.

Experiment 2

We sought to replicate the joint perception effect using an expanded and normed stimuli set. A weakness of our first experiment was that the images were categorised according to experimenters' intuition. The categories were divergent enough that it was deemed extremely unlikely, for example, that what one person would call an unpleasant image, another would call pleasant. However, in order to draw conclusions about responses to negative and positive images, we used the International Affective Picture System (IAPS), a set of photographs that have been extensively normed on a range of attributes (Lang,

Bradley & Cuthbert, 2005). Whereas the initial experiment took place in California, Santa Cruz, this study was carried out at a new laboratory in London, UK.

Methods

The experiment was identical to Experiment 1 apart from the following details.

Participants

20 undergraduates from University College London took part in the experiment in exchange for course credit. We did not collect data from 2 due to equipment problems and failures to calibrate.

Apparatus

Rather than adjacent cubicles, the participants sat in opposite corners of a 5m² room. They could not see each other or each other's displays.

Design

There were 64 trials presented in a random order, but the structure and randomisations remained the same as Experiment 1. The four pictures in each trial were randomly chosen from normed sets created using Lang et al's (2005) valence ratings. There were two neutral images (valence from 4.8 to 5.2, mean 5), one positive (7.6 to 8.3, mean 8), and one negative (1.6 to 2.4, mean 2).

Results

For the trials in which the participants saw pictures, we calculated the total looking times to the positive and negative images. These times were different when participants were looking alone versus jointly, as shown in Figure 3 (b). A 2 (picture valence: negative or positive) x 2 (social context: joint or alone) ANOVA showed a significant interaction ($F(1,17)=9.96, p=.006, h_p^2=.37$), and a significant difference between valence conditions only in the joint condition (Tukey's HSD, $p<.01$). When they believed that

their partner was looking at the same stimuli, participants looked more at the negative images. There was no significant difference when they believed they were looking alone. There was a main effect of picture valence ($F(1,17)=5.24, p=.04$) but not of social context alone ($F < 1$).

We compared Experiments 1 and 2 directly. A 2 (valence) x 2 (social context) x 2 (experiment) ANOVA found a significant three way interaction ($F(1,37)=9.061, p=.005, h_p^2=.20$), but no other significant interactions or main effects. The interaction between valence and social context was significantly changed between the two experiments. In other words, the preference for negative pictures when viewing alone, in Experiment 1, reversed to a preference for negative pictures when viewing jointly, in Experiment 2.

Discussion

Once more, we found an effect of joint perception: when participants believed that another person was looking at a set of images at the same time as them, it influenced how they looked at a set of images. To our surprise, however, the direction of this influence was different in this experiment. As a comparison of Figure 3 (a) and (b) shows, whereas the participants in Experiment 1 looked more at the negative images when alone, participants in Experiment 2 looked more at the negative images when looking jointly with each other.

There were several differences between the US and UK laboratories, both in terms of their physical arrangement and their participant populations. Which of these caused a reversal in the direction of the joint perception effect? We decided to focus on one source of indeterminacy in the paradigm: the way in which participants construed the situation. A valid criticism of the experiments so far is that participants were not given reasons for looking at the images, or told why the person next door was sometimes doing

the same thing. We reasoned that participants could make very different assumptions about whether, for example, they might be evaluated against the other person, or whether they might be interacting with the other person later. It is conceivable that different construals could be reached by participants in the different labs, and that these could influence participants differently in the joint perception conditions. We tested this line of reasoning by giving participants explicit task instructions in our next experiment, and assessing their influence on the direction of the joint perception effect.

Experiment 3

The experiment was the same as Experiment 2, with the same population of UK participants, but they were told either that we would be comparing their picture preferences (comparison task), or that they would be collaborating with each other on a memory task (collaboration task).

Methods

The experiment was identical to Experiment 2 apart from the following details.

Participants

24 undergraduates from University College London took part in the experiment in exchange for course credit. We did not collect data from 4 due to failures to calibrate.

Design

Participants were randomly assigned to either the *compare* or the *collaborate* condition. After the calibration screen, but before the trials began, participants read an instruction screen informing them that sometimes they would be looking at the same things as their partner, sometimes different things. In the *compare* condition it stated that we were interested in comparing “your preferences for different pictures

and symbols with your partner's". In the *collaborate* condition, participants were told the focus was on, "how well you and your partner can remember the pictures and symbols together".

Results

The task that participants were assigned influenced the direction of the interaction between social context and picture valence, as shown in the lower half of Figure 2. These differences are supported by a significant three way interaction between task, social context and valence ($F(1,18)=8.49$, $p=.009$, $h_p^2=.32$). People who were told that they were collaborating looked more at the negative images in the joint condition (Tukey's HSD, $p<.01$), like the UK participants who did not get task instructions in Experiment 2. In contrast, people who were told they were being compared to each other tended to look at the negative pictures more when alone (Tukey's HSD, $p<.01$), like the US participants in Experiment 1. There was a main effect of valence ($F(1,18)=8.45$, $p=.009$), but no other main effects or interactions were significant.

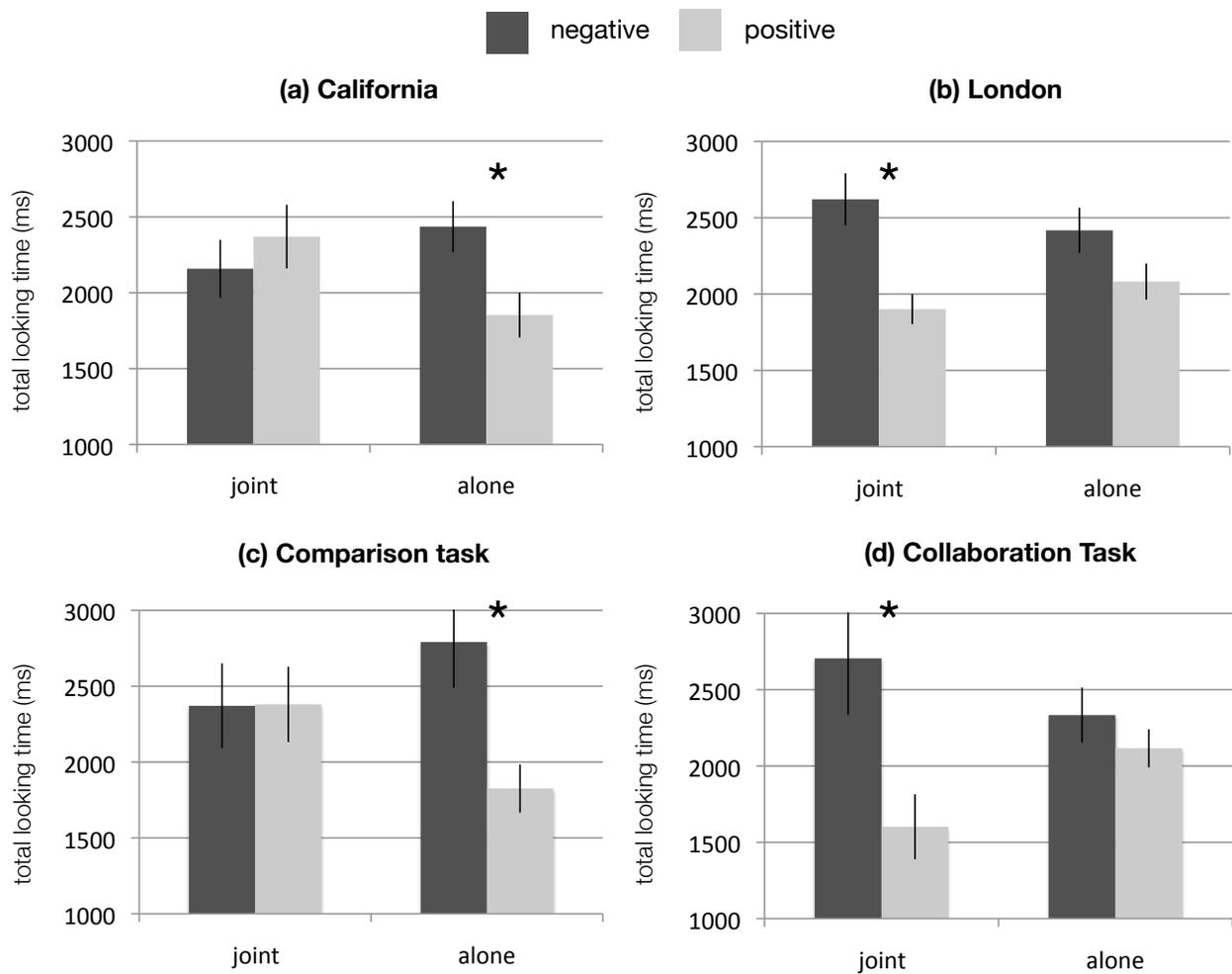


Figure 3. Results from (a) Experiment 1, (b) Experiment 2 (c) and (d) the two conditions of Experiment 3

Discussion

There could be many reasons, of course, for the reversal of results between Experiments 1 and 2. The stimuli, the lab configuration and the participants were all slightly different. But the results of this experiment show that one plausible reason is that in the absence of instructions, the participants interpreted the task in different ways. We can only speculate why the participants in Experiment 1 might have felt that they were being compared to each other, or how the physical setup of the lab in the UK (one big room rather than adjacent cubicles) engendered a feeling of collaboration. Regardless, these results have established two key points: that in all cases, participants reliably keep track of their

moment-by-moment social context, and that how they respond to changes in their social context is shaped by precisely how they construe their situation.

Our discussion so far has not touched upon one question: why is it that the effect of joint perception is sometimes to increase looks to the negative pictures, and sometimes to the positive images? It seems plausible that participants who thought that their viewing preferences were being compared to each other might want to look equally at the positive and negative images, since they may feel that ogling a disturbing image might not reflect well upon them. However, why is it that in the collaborative task participants looking together tend to look at the negative images?

When people collaborate in groups, they tend to align with the group emotion (Barsade, 1998; Hatfield, Cacioppo & Rapson, 1993; Wageman, 1995). When communicating with each other, they tune their messages and align them with the perceived group view (Hardin & Higgins, 1996). Perhaps then the minimal social context in our experiments is enough to turn on these processes of alignment, and magnify the individual's disposition to attend to negative stimuli. At present these remarks remain speculative, as our focus here is not on explaining the directionality of joint perception effects, but on the conditions that allow social context to influence perception.

Experiment 4

So far, we have only demonstrated that eye movements are influenced by beliefs about social context. One could argue, however, that eye movements are only indicative of lower level perceptual processing, that, in cognitive terms, they are epiphenomenal. Although there are theoretical and empirical arguments against this view (Spivey, et al., 2008), we wanted to investigate in this case whether the gaze differences produced by social context could be detected by a measure of cognitive performance: recognition memory. In this version of the paradigm, eye movement measures are not taken but,

following presentation blocks, participants' memory for the images is tested. We hypothesized that social context would determine which pictures attracted the most attention, and that this perceptual difference would lead to differing memory performance.

Methods

The experiment was identical to Experiment 2 apart from the following details.

Participants

36 undergraduates from University College London took part in the experiment in exchange for course credit. We did not use data from 8 because, at debriefing, the participants indicated some awareness of our hypotheses.

Design

Participants were run simultaneously in separate cubicles of a computer lab. At the start of the experiment, an instruction screen told them that they would be collaborating with a partner on a memory task, and that the computer had randomly paired them with another participant in the group. They saw a fake text message from the other participant greeting them, and were invited to respond with a short message. In fact, the participants were not paired with anyone and had no interaction with each other.

There were two identical blocks. In the presentation phase of each, participants saw 8 trials that were identical to those shown in Experiment 1: half were picture presentations, and half were symbols. On half the trials participants were told that they were looking the same images as their partners, and on the other half that they were looking at different images. Following that, there were 32 test trials, which consisted of a single picture presented until the participants made a yes or no response to indicate

whether they had seen it before. On half the occasions, the picture had been previously presented and was either one of the negative or one of the positive images.

Results

The dependent variable was the speed of the correct responses to pictures that had been seen previously. Accuracy was 85% and did not differ between experimental conditions. A 2 (valence) x 2 (social context) ANOVA found a significant interaction ($F(1,27)=6.98, p=.014, h_p^2=.21$). In the joint looking condition, the negative images ($M=758\text{ms}, SD=114$) were recognised faster than the positive ($M=794\text{ms}, SD=120$). Conversely, in the alone condition, positive images ($M=785\text{ms}, SD=113$) were recognised faster than the negative ($M=828\text{ms}, SD=155$). There was a main effect of social context ($F(1,27)=8.01, p=.009$), but not of valence ($F<1$).

Discussion

Looking at something together does not merely affect eye movements. The images that received more visual attention in previous experiments, according to their valence and the social context, were also remembered more efficiently in this study. This result echoes Shteynberg (2010) finding that when participants believe other people are processing at the same stimuli as they are, those images become more ‘psychologically prominent’. But again, here we see that participants are selecting for themselves which images in each set become more prominent when they are believed to be shared. In our next experiment, we examine whether these effects are produced when just the stimulus is shared between people, or whether they must also be carrying out the same process as each other.

Experiment 5

What does it mean to say that people are looking at something ‘together’? There are at least two ways to understand that notion, which previously we have treated as a unitary construct. For the joint perception effect to occur, is it enough for participants to *experience* a set of images at the same time as each other? Or do participants have to believe that they are engaged in the *same task* as the other person? In the current experiment, unlike those described above, the participants always believed that they were looking at the same images as each other. They also believed that they were collaborating with their partner. What changed, trial-by-trial, was the task that they were doing, and the task that they believed their partner was doing. Inspired by the seminal work on *joint action* (Sebanz et al., 2006) that we discuss below, we predicted that joint perception effects would be strongest when participants believed that they were not just passively sharing an experience, but acting jointly.

Methods

The experiment was identical to Experiment 2, apart from the details below.

Participants

32 University College London students participated for course credit. Data from 4 participants were unusable due to equipment calibration problems.

Design

The instruction screen defined two tasks for the participants. In a memory task, they had to remember the pictures for a later test. In the search task, they had to look for a translucent X superimposed on one image, and press the mouse button that they held in one hand if they detected it. They were informed that their task could change from trial to trial, and their partner’s task would change from trial to trial, but that their partner would always be looking at the same pictures as them.

At the start of each trial, participants were told their task for the upcoming presentation. A large icon at the top of the screen represented the task (visual search or memory), and a smaller icon below showed their partner's task (shown in Figure 5). They also heard a voice say "You will be [memorising/searching]. Your partner will be [memorising/searching]".

There were 40 trials. In half the participant was told that they were to memorize the stimuli and in half they were told that they were searching for an X. Counterbalanced, they were told that their partner performed the same task half the time, and a different task the other half. On eight trials (spread evenly across conditions), an X appeared at a random location on one of the images.

Results

Participants looked more towards the negative images when they believed that their partner was doing the same task as them, regardless of what the task was. We calculated the total amount of time spent looking at the critical negative and positive images on trials where there was not an X present (we did not analyse the 20% of trials when there was an X present, as X and participants' responses to it would interfere with how they allocated their attention to each image). A 2 (valence) x 2 (own task: memory/search) x 2 (other's task: same/different) ANOVA was performed, and the means for each cell are displayed in *Figure 4*. There was a significant two way interaction between valence and other's task ($F(1,27)=10.08, p=.004$). Post hoc tests show that the difference between positive and negative images was significant when the participants believed they were doing the same task (Tukey's HSD $p=0.01$), but did not reach significance when they were doing a different task. There was also a main effect of valence ($F(1,27)=19.19, p<.0001$), but all other main effects and interactions were non significant (all $F_s < 1$).

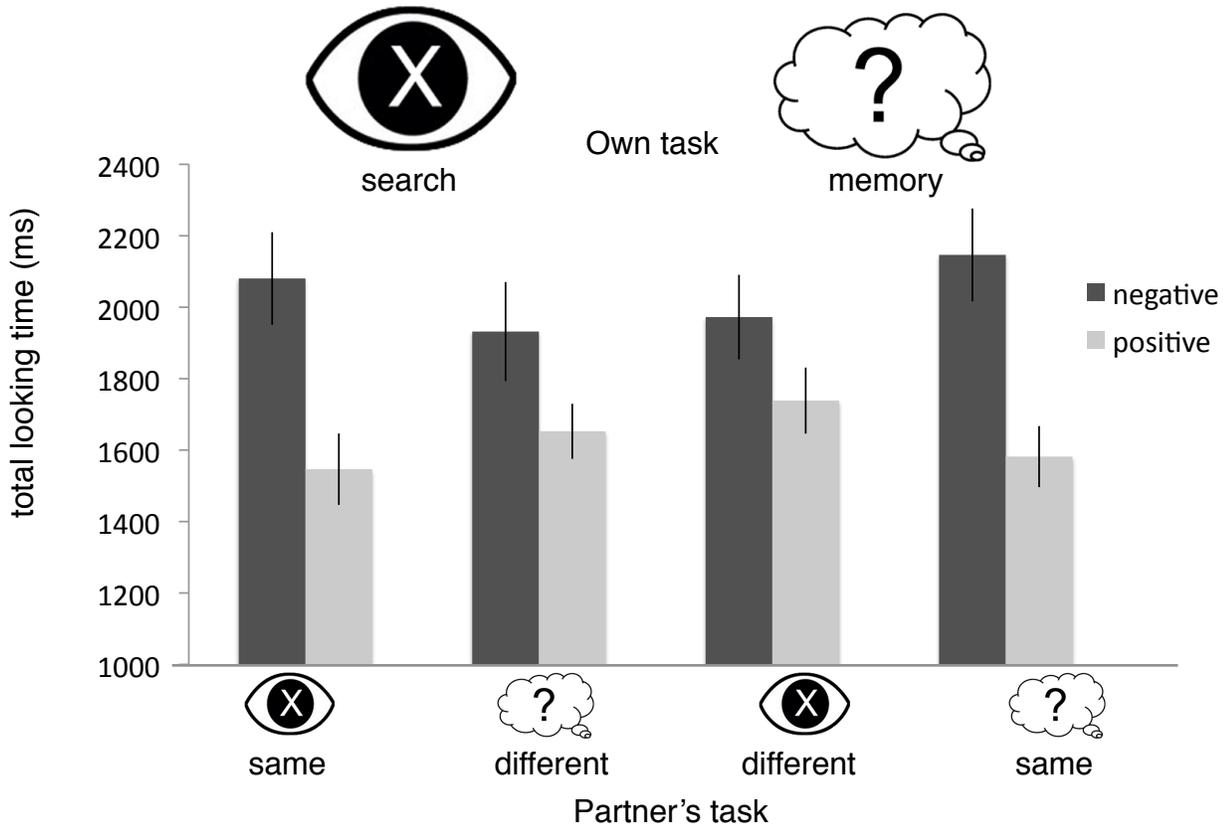


Figure 4. Looking times showed a significant interaction between valence and whether or not the participant's partner was believed to be doing the same or a different task

Discussion

The effects of joint perception do not occur simply when someone believes that another person is experiencing the same stimuli. It is necessary to believe that the other, unseen person is engaged in the same task as themselves. This task could be to memorise the pictures, which presumably would require processing the meaning of an image, or the task could just be to search for a visual feature, which requires only superficial processing. Regardless, the effect of joint perception arises whenever these tasks are believed to be done together. In each case, the effect of this co-engagement is to fixate the negative images more than the positive. Previous research has shown that when a stimulus is believed to

be shared, it will be processed more deeply (Shteynberg, 2010). This result shows that both the stimulus and the cognitive process form part of the social context and modulate perception.

General Discussion

Social context exerts a pervasive effect on perception. Even when the difference between looking alone and looking jointly is as small as possible, distinct behavioral and cognitive effects emerge. This conclusion has connections to work on language as a joint activity (Clark, 1996) and studies of behavioural coordination (Shockley, Richardson & Dale, 2009) and joint action (Galantucci & Sebanz, 2009).

Language is remarkably ambiguous. ‘Please take a chair’, could refer to a variety of actions with a variety of chairs in a room. Conversations do not grind to halt, however, because people are very good at resolving ambiguous references by drawing on knowledge about the context and assumptions that they have in common (Schelling, 1960). For example, when presented with a page full of items, such as watches from a catalogue, participants agreed with each other which one was most likely to be referred to as ‘the watch’ (Clark, Schreuder & Buttrick, 1983).

When we enter into any conversation, such coordination is all important (Clark, 1996). When we talk, we implicitly agree upon names for novel objects (Clark & Brennan, 1991), align our spatial reference frames (Schober, 1993), use each others’ syntactic structures (Branigan, Pickering & Cleland, 2000), sway our bodies in synchrony (Shockley, Santana & Fowler, 2003; Condon & Ogston, 1971) and even scratch our noses together (Chartrand & Bargh, 1999). When we are talking and looking at the same images, we also coordinate our gaze patterns with each other (Richardson & Dale, 2005), taking into account the knowledge (Richardson, Dale & Kirkham, 2007) and the visual context (Richardson, Dale & Tomlinson, 2009) that we share. In short, language engenders a rich, multileveled coordination between

speakers. Perhaps in our experiments, the instruction stating that images were being viewed together was enough to turn on some of these mechanisms of coordination, even in the absence of any actual communication between participants.

Recently, researchers have argued that the characteristics of language, as a joint activity, can be found more widely in other forms of cooperative behavior (Sebanz, Knoblich & Bekkering, 2006). Studies of situated cognition (Barsalou, Breazeal & Smith, 2007; Robbins & Aydede, 2009) show that cognition ‘in the wild’ is intimately linked not only to representations of the external world, but also to the cognitive processes of others. For example, Hutchins (1995) observed the ways that navy navigators distribute cognitive processes between themselves by using external tools and representations, such as maps and notations. Experimental methods are starting to reveal the sensitivity we have to mental states of those around us (Crosby, Monin & Richardson, 2008) and the mechanisms involved in acting jointly (Sebanz et al., 2006).

Social context can modulate even the simplest of tasks. For example, in a traditional stimulus-response compatibility task, participants make a judgment about one stimulus property (color) and ignore another stimulus property (location). If there is an incompatibility between the irrelevant property and the response (e.g. the stimulus is on an opposite side of the screen to the response button) then reaction times increase (Simon, 1969). Sebanz, Knoblich & Prinz (2003) divided such a task between two people. The participants sat next to each other, and each person responded to one color: in effect, each acting as one of the fingers of a participant in Simon’s (1969) experiment. Though each person had only one response to execute, they showed an incompatibility effect when acting together. There was no incompatibility effect when performing the same single response task alone. When acting jointly, participants represented their partners’ actions as if they were their own.

Joint action effects do not occur if the participant is simply sat next to another person (Tsai et al., 2006), or if that person's button pressing actions are not intentional (their finger is moved by a mechanical device). Also, if the participant is acting jointly, but with a computer program (Tsai et al., 2008) or a marionette's wooden hand (Tsai & Brass, 2007) there is not a stimulus-response incompatibility effect. Therefore, participants only form representations of another when that person's genuine, intentional actions are engaged in the same task. Our results fill out this picture. We have shown that a participant's perceptual process is changed when they believe that another person is co-acting with them: they do not have to see the person (c.f. Tsai et al., 2008), and the 'actions' do not have to be overt behavior. If the participant thinks that the other person is memorising or scanning the images with the same intention, then that mutual cognitive process will shape their gaze patterns.

In finding an effect of a minimal social context on behavior, our experiments echo a point that social psychologists have made from the outset. However, in only looking at a minimal social context, our experiments have ignored the findings of social psychology from that point onwards. That is to say, we have not yet examined how perception might be influenced by a *rich* social context: how joint perception is modulated by the individuals' view of themselves and what they think of the other person, how their the motivations and goals might change the way they coordinate, and how differences between people may produce differences in cooperative behaviour. For example, tantalising results in our ongoing work suggest that there is a significant difference in how participants from individualistic and collectivist cultures perform in this paradigm (Markus & Kitayama, 1991). Future work will investigate these differences, and explore how processes of social cognition feed in the the joint perception effect.

Conclusion

We have known from the founding of social psychology that the presence and actions of others can have a powerful effect on an individual's motivations, goals and judgments (Allport 1954). Our results have shown for the first time that even a minimal social context - the sparse belief that an unseen other person is sharing an experience - exerts an influence over cognitive and perceptual processes. This finding provides support for the Gestalt notion that it is not simply the viewer and the stimulus properties that determines attention, but a wider context, or field, that includes the presence of others around them (Lewin, 1947). The pervasive effects of social context have theoretical implications for how we view cognition (Robbins & Ayded, 2008), and raise an unexamined question about how we consume media and communicate.

The relationship between our experiences and those of others is changing. For example, thirty years ago in the UK, the Christmas special edition of the Morecambe and Wise TV show was seen, simultaneously, by 29 million people. 50% of the entire population shared the experience. Now, with many more channels, and the advent of recorded content, only 18% watched the most popular TV show last Christmas. Conversely, technology has turned traditionally solitary activities into shared experiences. Rather than putting a letter in the post and waiting for a colleague's reply, first email then instant messaging, texting and now video conferencing have brought collaborators closer together in time and (virtual) space. Our results indicate that these changes in the commonality of experiences may have a deep cognitive significance. Although these studies have only begun to unravel the mechanisms at work, the mere belief that someone else shares your perceptual experience appears to shape and direct that experience.

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References

- Allport, G.W. (1954/1979). *The nature of prejudice*. Cambridge, MA: Perseus Books.
- Asch, S. E. (1951). Effects of group pressure upon the modification and distortion of judgement. In H. Guetzkow (Ed.) *Groups, leadership and men*. Pittsburgh, PA: Carnegie Press
- Barsade, S.G. (2002). The ripple effect: Emotional contagion and its influence on group behavior. *Administrative Science Quarterly*, 47(4), 644-675.
- Barsalou, L.W., Breazeal, C., & Smith, L.B. (2007). Cognition as coordinated non-cognition. *Cognitive Processing*, 8, 79-91.
- Baumeister, R.F., Bratlavsky, E., Finkenauer, C., & Vohs, K.D. (2001). Bad is stronger than good, *Review of General Psychology*, 5(4), 323-370.
- Birmingham, E., Bischof, W.F., & Kingstone, A. (2008). Social attention and real world scenes: The roles of action, competition, and social content. *Quarterly Journal of Experimental Psychology*, 61(7), 986-998.
- Brennan, S. E., Chen, X., Dickinson, C. A., Neider, M. B., & Zelinsky, G. J. (2008). Coordinating cognition: The costs and benefits of shared gaze during collaborative search. *Cognition*, 106, 1465-1477.
- Cacioppo, J.T., Visser, P. S. & Pickett C. L. (Eds.) (2005). *Social neuroscience: People thinking about thinking people*. Cambridge, MA: The MIT press.

- Chartrand, T. L., & Bargh, J. A. (1999). The chameleon effect: The perception-behavior link and social interaction. *Journal of Personality and Social Psychology*, 76, 893-910.
- Clark, H.H. (1996). *Being there: Putting brain, body, and the world together again*. Cambridge: MIT Press.
- Clark, H.H., Schreuder, R. & Buttrick, S. (1983). Common ground and the understanding of demonstrative reference. *Journal of Verbal Learning and Verbal Behavior*, 22, 245-258.
- Condon, W., & Ogston, W. (1971). Speech and body motion synchrony of the speaker-hearer. In D. Horton & J. Jenkins (Eds.), *The Perception of Language*. Columbus, OH: Charles E. Merrill.
- Echterhoff, G., Higgins, E. T. & Levine, J. M. (2009). Shared reality experiencing commonality with others' inner states about the world. *Perspectives on Psychological Science*, 4, 496-521.
- Festinger, L. (1950). Informal social communication. *Psychological Review*, 57, 271-282.
- Fridlund, A.J. (1991). Sociality of solitary smiling: Potentiation by an implicit audience. *Journal of Personality and Social Psychology*, 60, 229-240.
- Galantucci, B., & Sebanz, N. (2009). Joint action: Current perspectives. *Topics in Cognitive Science*, 1, 255-259.
- Hajcak, G., & Olvet, D.M. (2008). The persistence of attention to emotion: Brain potentials during and after picture presentation. *Emotion*, 8(2), 250-255.
- Hardin, C. D. & Higgins, E. T. (1996). Shared reality: How social verification makes the subjective objective. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: The interpersonal context* (Volume 3, pp. 28-84). New York: Guilford.
- Hatfield, E., Cacioppo, J.T., & Rapson, R.L. (1993). Emotional contagion, *Current Directions in Psychological Science*. 2(3), 96-99.
- Heider, F. (1958). *The psychology of interpersonal relations*. New York: John Wiley & Sons.

- Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT Press.
- Kelly, D., Miellet, S., & Caldara, R. (2010). Culture shapes eye movements for visually homogeneous objects. *Frontiers in Perception Science, 1*.
- Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2005). *International affective picture system (IAPS): Digitized photographs, instruction manual, and affective ratings* (Tech. Rep. A-6). Gainesville: University of Florida, Center for Research in Psychophysiology
- Lewin, K. (1936). *Principles of Topological Psychology*. New York: McGraw Hill
- Lowery, B.S., Hardin, C.D., & Sinclair, S. (2001). Social influence effects on automatic racial prejudice, *Journal of Personality and Social Psychology, (81)*, 842-855.
- Most, S. B., Laurenceau, J.-P. P., Graber, E., Belcher, A., and Smith, C. V. (2010). Blind jealousy? romantic insecurity increases emotion-induced failures of visual perception. *Emotion, 10*, 250-256.
- Nisbett, R. E., & Masuda, T. (2003). Culture and point of view. *Proceedings of the National Academy of Sciences of the United States of America, 100*, 11163-11175.
- Norris, C.J., Chen, E.E., Zhu, D.C., Small, S.L., & Cacioppo, J.T. (2004). The interaction of social and emotional processes in the brain. *Journal of Cognitive Neuroscience, 16(10)*, 1818-1829.
- Richardson, D.C & Dale, R. (2005). Looking to understand: The coupling between speakers' and listeners' eye movements and its relationship to discourse comprehension. *Cognitive Science, 29*, 1045–1060.
- Richardson, D.C., Dale, R., & Kirkham, N.Z. (2007). The art of conversation is coordination: Common ground and the coupling of eye movements during dialogue. *Psychological Science, 18(5)*, 407-413.
- Richardson, D.C., Dale, R., & Tomlinson, J.M. (2009). Conversation, gaze coordination, and beliefs about visual context. *Cognitive Science, 33(8)*, 1468-1482.

- Robbins, P. & Aydede, M. (Eds.) (2009). *The Cambridge Handbook of Situated Cognition*. Cambridge, UK: Cambridge University Press.
- Rozin, P., & Royzman, E.B. (2001). Negativity bias, negativity dominance, and contagion. *Personality and Social Psychology Review*, 5(4), 296-320.
- Schelling, T. C. (1960). *The Strategy of Conflict*, Cambridge, Mass.: Harvard University Press.
- Schober, M.F. (1993). Spatial perspective-taking in conversation. *Cognition*, 47(1), 1-24.
- Sebanz, N., Bekkering, H., & Knoblich, G. (2006). Joint action: Bodies and minds moving together. *Trends in Cognitive Sciences*, 10(2), 70-76.
- Senju, A., & Johnson, M.H. (2009). Atypical eye contact in autism: Models, mechanisms and development. *Neuroscience and Biobehavioral Reviews*, 33(8), 1204-1214.
- Sherif, M. (1935). A study of some social factors in perception. *Archives of Psychology*, 27(187)
- Shockley, K., Richardson, D.C., & Dale, R. (2009). Conversation and coordination structures, *Topics in Cognitive Science*, 1, 305-319.
- Shockley, K., Santana, M-V., & Fowler, C.A. (2003). Mutual interpersonal postural constraints are involved in cooperative conversation. *Journal of Experimental Psychology: Human Perception and Performance*, 29(2), 326-332
- Shteynberg, G., (2010). A silent emergence of culture: The social tuning effect. *Journal of Personality and Social Psychology*, Online Aug 16, 2010.
- Simon, J.R. (1969). Reactions toward the source of the stimulation. *Journal of Experimental Psychology*, 81(1), 174-176.
- Smith, E. R., & Conrey, F. R. (2009). The social context of cognition. In P. Robbins & M. Aydede (Eds.), *Cambridge Handbook of Situated Cognition* (pp. 454-466)

- Smith, E. R., & Semin, G. R. (2004). Socially situated cognition: Cognition in its social context. *Advances in Experimental Social Psychology*, 36, 53-117
- Smith, N.K., Cacioppo, J.T., Larsen, J.T., & Chartrand, T.L. (2003). May I have your attention, please: Electrocortical responses to positive and negative stimuli. *Neuropsychologia*, 41, 171-183.
- Spivey, M., Richardson, D., & Dale, R. (2008). Movements of eye and hand in language and cognition. in E. Morsella & J. Bargh (Eds.), *The psychology of action, Vol. 2*. New York: Oxford University Press.
- Triplett, N. (1898). The dynamogenic factors in pacemaking and competition. *American Journal of Psychology*, 9, 507-533.
- Tsai, C.C., & Brass, M. (2007). Does the human motor system simulate Pinocchio's actions? Co-acting with a human hand versus a wooden hand in a dyadic interaction. *Psychological Science*, 18(12), 1058-1062.
- Tsai, C.C., Kuo, W.J., Hung, D.L., & Tzeng, O. J-L. (2008). Action co-representation is tuned to other humans. *Journal of Cognitive Neuroscience*, 20(11), 2015-2024.
- Tsai, C.C., Kuo, W.J., Jing, J.T., Hung, D.L., & Tzeng, O. J-L. (2006). A common coding framework in self-other interaction: Evidence from joint action task. *Experimental Brain Research*, 175, 353-362.
- Wageman, R. (1995). Interdependence and group effectiveness. *Administrative Science Quarterly*, 40, 145-180.
- Zajonc, R. B. (1965). Social facilitation. *Science*, 149, 269-274
- Zajonc, R.B., Heingartner, A., & Herman, E.M. (1969). Social enhancement and impairment of performance in the cockroach. *Journal of Personality and Social Psychology*, 13, 83-92.