Is Joint Attention Detectable at a Distance? Three Automated, Internet-Based Tests

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Context: Joint attention is the shared focus of two or more individuals on the same object. Sensory cues, such as detecting the direction of another person's gaze, play a major role in establishing joint attention. It may also involve a kind of mental resonance that might be felt by the people involved.

Objective: The aim of this study was to find out whether people could feel when another person was looking at the same picture at the same time, even when the participants were many miles apart.

Method: Participants registered online with their names and e-mail addresses, and worked in pairs. After they both logged on for the test they were simultaneously shown one of two photographs, with a 0.5 probability of seeing the same picture. After 20 s they were asked if their partner was looking at the same picture or not. After both had registered their guess, the next trial began, with a different pair of pictures. The main outcome measure was the proportion of correct guesses, compared with the 50% mean chance expectation. This test was symmetrical in that all participants were both "senders" and "receivers."

Results: In the first experiment, with 11,160 trials, the hit rate was 52.8% ($P < 1 \times 10^{-6}$); in the second experiment with 2720 trials, 51.3% ($P = .09$). The third experiment involved music as well as pictures, and with 8860 trials, the hit rate was 51.9% ($P = .0003$). Some partners were more than 1000 miles apart, but there were no significant effect of distance. Participants who received immediate feedback about whether their guess was right or wrong did not score significantly better than those without feedback.

Key words: automated test, joint attention, internet experiment, mental resonance

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INTRODUCTION

Joint attention is the shared focus of two or more individuals on the same object, and is a common feature of social life. The development of the ability to experience joint attention in young children has been studied in detail,[1] as has joint attention in chimpanzees and other mammalian species.[2] However, in humans this ability seems to go beyond what other animals experience, in that it involves more than two or more individuals experiencing the same thing at the same time, it includes *knowing* that they are sharing this experience. In developmental psychology, joint attention is widely seen as fundamental for the development of human culture and collaborative activity.[3]

Joint attention is usually explained in terms of sensory cues, such as detecting the direction of other people's gazes, or looking where they are pointing.[3] However, there is a further possibility—joint attention may also involve a kind of mental resonance when two or more minds are exposed to the same stimuli. If so, people might be able to feel this resonance and intuitively know whether others' attention is on the same object. One of us (R.S.) has investigated this possibility using a simple procedure in which two people were separated by a wall, for example, near a doorway, in such a way that both could see a particular object, such as an apple, but could not see each other.[4] In a randomized series of trials one of these people either looked or did not look at the object, and the other person guessed whether or not it was being looked at. These guesses were either right or wrong, and by chance the hit rate would have been 50%. In a total of more than 6000 trials, the average hit rate was 52.5% ($P = .00004$).

When joint attention is detectable by people who are physically close to each other, it is possible that they are responding to subtle physical cues rather than to a more mysterious mental resonance. Is joint attention still detectable when people are separated from each other, even by hundreds or thousands of miles? To explore this possibility we developed a series of online tests whereby two participants were either shown the same picture as each other, or were shown different pictures. After seeing the picture, they were both asked if their partner had been seeing the same picture or a different picture, and after giving their answer moved on to the next trial. If participants were just guessing if their partners were seeing the same picture or not, the expected hit

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rate would be at the chance level of 50%. Unlike telepathy tests in which one participant is a "sender" and the other a "receiver," these experiments were symmetrical: all participants were both "senders" and "receivers."

METHODS

Procedure

In order to carry out the test, a participant registered the group in advance through Rupert Sheldrake's (R.S.) website (www.sheldrake.org) choosing a group name and a password. When registering, participants gave their own name and e-mail address, and the name and e-mail address of their partner. They were also asked, "How well do you know each other?" They chose from the following options:

very well (close friend, partner or close family member)
well (friend, colleague, or familiar person)
slightly (acquaintance or person seen infrequently)
not at all (never met before)

They were also asked about their distance from each other, with the following options:

in the same building
in a different building less than a mile apart
more than a mile apart but less than 10 miles apart
more than 10 miles apart but less than 100 miles apart
more than 100 miles apart but less than 1000 miles apart
more than 1000 miles apart.

participants were given the following instructions for Experiments 1 and 2:

Joint attention test. Can you tell when someone is looking at the same photo as you? This experiment involves two people, and takes about 5 min to complete. You do 20 quick trials and receive the score at the end.

How the experiment works:

This test is symmetrical: both participants are "senders" and "receivers." One person registers both of you, gives the pair a nickname and a password. Both participants then log on to the experiment at a prearranged time. You can use the same nickname to do this test repeatedly.

In each trial, both people are shown a picture. In a random order you will sometimes see the same picture as your partner, and sometimes a different picture. After 20 s, each of you will be asked to answer the question, "Was your partner looking at the same picture?"

Each participant can choose whether to do the experiment with or without immediate feedback. If you choose to receive feedback, immediately after making each guess, you will be told whether your partner was shown the same picture or a different picture.

After each 20-trial test, you will be told your score; the chance level is 10.

Experiment 3 differed from Experiments 1 and 2 in that there were 10 trials instead of 20, and also some music was played while participants were looking at the pictures. Each picture has a different piece of music associated with it. Thus in each trial, either both participants saw the same picture and heard the same music, or saw different pictures and heard different music. For Experiment 3, participants were given similar instructions to those for Experiments 1 and 2, but they were modified to include the fact that the participants would hear music as well as seeing a picture, and told that there were 10 trials, with a chance level of 5. There was also an additional feature in the form of a sound test, described as follows: "*When you log on, you will be asked to do a sound test to make sure that your computer can play the sound tracks. If it cannot, you can still do the test, but you will be doing it with the pictures only and not the music.*" On the database for this experiment, the results for each participant included a record of whether or not sound had been used in the test.

A screenshot showing what a participant saw during one of the trials in experiment 3 is shown in Figure 1.

Programming

The coding was carried out in HTML, PHP (Hypertext Preprocessor version 5.4.34) and Javascript. Randomization for the experiment was provided by the system-level randomizer supplied with the Linux operating system running on the web server. This randomizer was technically represented by the /dev/random1 device, and generated random numbers based on an "entropy pool" of random numbers. New randomness was added to this pool when unpredictable events happened, such as the pressing of a key by the user at a particular time. Experiment data and logs were stored in a MySQL database, version 5.0, which could be accessed online by the experimenter with the use of a password for viewing. The database was also used for achieving synchronisation across the two participants during the experiment. Only when both participants had successfully logged in and reached the experiment initialization page, the first run was started synchronously on their respective browsers such that their viewing experience was coordinated. The experiment only

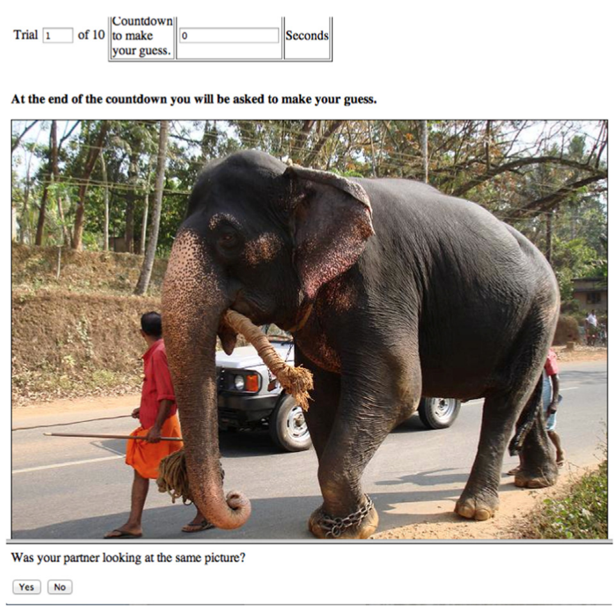

Figure 1. Screenshot of the image on a participant's screen during a trial in Experiment 3.

progressed to the initialization of the next run when both participants' responses to the current run had been successfully received by the server and stored in the database. By managing state information in the database, the coding ensured that participants progressed through the experiment in synchrony.

The random decision as to whether the partners would see the same or different pictures was made independently for each trial, and thus in some tests there were more occasions when they saw the same than different pictures, and vice versa. In other words, participants could not guess what would happen in the next trial on the basis of what had happened in previous trials. Overall the number of "same" and "different" trials was different. In completed tests in experiment 1, there were 5510 same and 5650 different; in Experiment 2, 1314 same and 1406 different; and in Experiment 3, 4872 same and 5068 different.

Statistical Analysis

The data were inspected prior to statistical analysis to look for any suspicious patterns that could have indicated cheating. In Experiment 1, there were two tests, both by the same pair of people, in which both participants scored 100% hits on both tests. Since no other participants scored 100% on any test, we assumed that these people must have been cheating and eliminated their results from the analysis.

The data were analyzed by the exact binomial test; the expected probability of a hit by chance was 0.5. The null hypothesis was that hit rates would be at the chance level. One-sided tests were used. The combined results from the three experiments were analyzed using the Stouffer meta-analysis procedure, adding the *z*-score from each experiment and dividing the total by the square root of 3. The comparison of paired data sets from different groups (e.g., with and without feedback) was carried out using the 2 × 2 chi-squared test.[5] The comparison of multiple conditions, as in the analysis of the effects of relationship and of distance, was carried out using a linear analysis of variance (ANOVA). Cohen's effect size *d* was calculated according to the formula: $d = P$ (hits observed)−0.5/square root (0.5 × 0.5).

RESULTS

Experiment 1

The aim of the first experiment was to find out if an automated online test could give consistent results. We collected data from a large number of trials, more than 10,000, to see whether there was a significant positive effect or not.

In each test there were 2 participants and 20 trials. In each trial there was a pair of matched photographs, either of animals, people, flowers, or landscapes. At random, in each trial the two participants either saw the same photograph or different photographs. Each participants was both a "receiver" and a "transmitter" in the sense that each had to guess whether or the other was looking at the same picture or a different picture. Over the course of a 20-trial test, each participant made 20 guesses, and thus there was a total of 40 guesses per test.

Table 1. Hit Rates in Experiments 1, 2, and 3

Experiment	Trials	Hits	Hits (%)	*P*	+	−	=	*P*
1	11,160	5901	52.8	$<1 \times 10^{-6}$	278	206	72	.0006
2	2720	1395	51.3	.09	59	55	22	.39
3	8860	4594	51.9	.0003	354	306	226	.03

Data from completed tests showing both the hits as a percentage of the number of trials, and the number of people scoring above (+), below (−), or at (=) the chance level.

There were 278 completed tests, with 11,160 guesses, of which 5901 were correct (52.8%), significantly more than the 50% hit rate expected by chance ($P < 1 \times 10^{-6}$) (Table 1). The effect size (Cohen's *d*) was 0.06.

Some people who registered for the test did not actually perform it, and a few pairs of participants completed only part of the test. In the incomplete tests the hit rate was 41 out of 104 trials (39.4%), below the chance level. When combined with the data for the complete tests, the overall hit rate, 52.8%, was still very significantly above chance ($P < 1 \times 10^{-6}$).

The data for complete tests were also analyzed by a method that gave an equal weighting to each participant. In 278 tests, there were 556 20-trial scores, of which 278 were above the chance level of 10, and 206 below the chance level; 72 were at the chance level. By chance, the number of people scoring above and below 10 would have been the same, but significantly more people scored above than below ($P = .0006$) (Table 1).

In order to examine how robust the effect was, we trimmed the overall data to exclude the top and bottom 10% of the scores. The hit rate by this method was 52.4% ($P = .000003$), confirming that the observed effect with untrimmed data was not dependent on a few outlying high scores.

The pictures used in the test were grouped thematically. There were pairs of photographs of animals in trials 1–4, people in trials 5–12, flowers in trials 13–15 and landscapes in trials 16–20. The hit rates in these groups of trials are shown in Table 2. The hit rates were higher with pictures of animals or people than with flowers and landscapes, but these differences were not statistically significant.

There was also no clear trend in hit rates in successive trials (Figure 2).

Experiment 2

This experiment was a follow-up of Experiment 1 and involved the same photographs, except for the fact that the

Table 2. Hit Rates in Trials With Different Kind of Pictures

Pictures	Trials	Hits	Hits (%)	*P*
Animals	2240	1204	53.8	.0002
People	4480	2407	53.7	$<1 \times 10^{-6}$
Flowers	1680	870	51.8	.07
Landscapes	2800	1460	52.1	.01

Data from 280 complete tests.

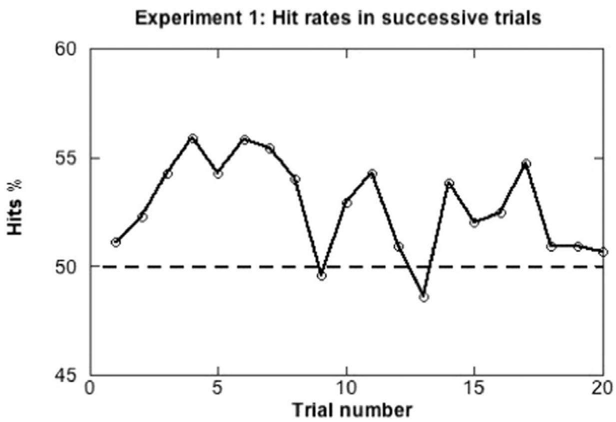

Figure 2. Hit rates in successive trials in Experiment 1. The chance hit rate of 50% is indicated by a horizontal dashed line.

photographs were paired at random. In Experiment 1, in a give trial the pairs of photos were both of animals, people, flowers, or landscapes; in Experiment 2, a landscape might be paired with a person, or an animal with a flower, or any other random combination. The aim was to see if greater differences between the pictures in each pair would lead to larger or smaller effects in this test.

As in Experiment 1, in each completed test there were 2 participants and 20 trials. There were 68 completed tests, with 2720 guesses, of which 1395 were correct (51.3%), only slightly higher than the 50% hit rate expected by chance ($P = .09$, Table 1).

Some participants completed only part of the test. In the incomplete tests the hit rate was 92 out of 174 trials (52.9%). When combined with the data for the complete tests the overall hit rate was 51.4% ($P = .07$).

The data from complete tests were also analyzed with an equal weighting for each participant. The difference between above and below-chance scores was not significant statistically (Table 1). When the top and bottom 10% of scores were trimmed from the data for complete tests, the overall hit rate was 50.6% ($P = .29$).

A Comparison of Experimental Conditions in Experiments 1 and 2

The overall data from Experiments 1 and 2 were the sum of two different experimental procedures. Most participants were recruited though the website of R.S. and carried out the test at home or at work, here called "the standard method." But a subset of the participants was recruited and tested very differently, at a summer festival in England called the Secret Garden Party, from 24 to 27 July, 2008. These tests were organized by Prof. Chris French and his team from the Anomalous Psychology Research Unit (APRU), at Goldsmiths College, London. Some of these participants were allocated at random to Experiment 1 and others to Experiment 2. The participants were tested in separate booths that had been set up for this purpose at the festival, and they were videotaped while they were doing the test to ensure that there was no possibility of cheating.[6] The hit rate in the APRU tests was almost exactly at the chance level (Table 3). The hit rate by the standard method was above chance in both Experiment 1 ($P < 1 \times 10^{-6}$) and in Experiment 2 ($P = .05$). The difference between these two methods was significant at the $P = .02$ level for Experiment 1 but non-significant for Experiment 2.

Experiment 3, With Music

This experiment was designed to investigate whether the effects of joint attention would be enhanced when the pairs of participants saw the same picture and also heard the same music. The pictures used in this experiment were different from those in Experiments 1 and 2, and the number of trials per test was reduced from 20 to 10.

In the 443 completed tests, there were 8860 guesses, of which 4594 were correct (51.9%), more than the 50% hit rate expected by chance ($P = .0003$) (Table 1). The effect size was 0.04.

Some pairs of participants did not complete the test, and in the incomplete tests the hit rate was 524 out of 1184 guesses (44.3%). When all the results were added together to include both complete and incomplete tests, the hit rate of 5118 out of 10,044 (51.0%) was still above chance ($P = .03$).

The data were also analyzed with an equal weighting for each participant. There were 354 participants who scored above the chance level of 5 out of 10, and 306 below the chance level; and 226 ties, with scores at the chance level of 5 out of 10. By chance, the number scoring above and below 5 would have been the same, but significantly more people scored above 5 than below ($P < .03$) (Table 1). In this experiment there was a higher proportion of ties than in Experiment 1. This may reflect the fact that in Experiment 1 there were twice as many trials, 20 rather than 10, and therefore a wider dispersion around the chance level.

When we trimmed the data from complete tests to exclude the top and bottom 10% of the scores, the hit rate was 51.5% ($P = .003$).

Table 3. Scores in the Joint Attention Test in Experiments 1 and 2 by the Standard Method and in Tests Conducted by the Anomalous Psychology Research Unit (APRU)

Method	Experiment 1				Experiment 2			
	Trials	Hits	Hits (%)	P	Trials	Hits	Hits (%)	P
Standard	10,200	5445	53.4	$<1 \times 10^{-6}$	1480	773	52.2	.05
APRU	1000	496	49.6	NS	1240	622	50.2	NS
Total	11,200	5941	52.6	$<1 \times 10^{-6}$	2720	1395	51.3	NS

Figure 3. Hit rates in successive trials in Experiment 3. The chance hit rate of 50% is indicated by a horizontal dashed line.

The pattern of hit rates in successive trials showed no clear or significant tendency to increase or decrease (Figure 3).

Not all computers were able to play the music that was part of this test, so when participants first logged on, they heard a sample of music if their computer's sound system was working. They were asked if they heard the music, and answered "yes" or "no." For the music to play a part in joint attention, both participants in each test would need to hear it. So the results of tests in which both participants heard the music were compared with tests in which one or both did not hear the music. With music, there were 2788 hits in 5300 trials (52.6%) compared with 651 hits in 1280 trials without music (50.8%). This difference was not significant at the $P = .05$ level.

Factors Affecting the Hit Rate in All Three Experiments

Response bias. In all three experiments, there was a response bias in favor of saying that the partner was seeing the same picture. Overall around 55% of the guesses were that the picture was the same as the one the partner was seeing, and 45% that it was different (Table 4). This meant that when both were shown the same picture, the percentage of correct guesses was elevated and conversely with different pictures, the number of correct guesses was depressed. However, this response bias could not account for the overall positive effect, because the response bias alone would have elevated scores with the same picture and depressed those with different pictures. If there were exactly equal numbers of trials with same and different pictures, these biases would cancel out, giving an overall hit rate of 50%. In fact in all three experiments there were slightly fewer trials with the same pictures rather than with different pictures, and hence this bias would have had a slightly negative effect on the overall score. We calculated that this bias would have reduced the hit rates shown in Table 1 by 0.1% in Experiments 1 and 3 and 0.2% in the case of Experiment 2.

Table 4. Guesses That the Other Person was Seeing the Same or a Different Picture, Irrespective of Whether These Guesses Were Right or Wrong

Experiment	Same	Different	Same (%)
1	3204	2929	54.8
2	748	759	55.4
3	2475	2453	55.6

Effects of feedback. Before they began the tests, all participants were asked to choose whether or not they would like to receive feedback. Those who asked for feedback received a message immediately after making each guess saying either "Your partner was shown the same picture" or "Your partner was shown a different picture."

In all three experiments, hit rates with feedback were higher with than without feedback (Table 5), but in no case were these differences statistically significant.

Table 5. Comparison of Hit Rates With and Without Feedback in Experiments 1, 2, and 3

Experiment	Feedback			No feedback		
	Trials	Hits	Hits (%)	Trials	Hits	Hits (%)
1	6900	3684	53.4	4340	2283	52.6
2	1320	679	51.4	1400	716	51.1
3	4560	2409	52.8	4300	2185	50.8

Effects of the relationship between partners. When participants registered for the test, they were asked how well they knew their partner, with four options.

In none of the experiments was there an overall statistically significant effect of relationship. The detailed patterns in all three experiments are shown in Figure 4.

Effects of the distance between partners. When participants registered for the test, they were asked how far apart they were from their partner. There was no significant effect of distance in any of the experiments. Moreover, when all the tests not in the same building were added together, in all the three experiments the hit rates in different buildings not significantly different from those in the same building. The detailed pattern of results for all three experiments is shown in Figure 5.

DISCUSSION

In all the three experiments, the overall results were positive, suggesting that, on average, participants were able to guess when their partners were looking at the same picture or not. However, the effect was quite small: in Experiment 1, the hit rate in all trials combined was only 2.9% above the chance level; in Experiment 2, 1.4%; and in Experiment 3, 1.0%. When the statistical analyses were combined using the Stouffer method for meta-analysis, the P value was $<1 \times 10^{-6}$. These consistent positive scores suggest something was going on. But what?

We can rule out one possible explanation: optional stopping. In our automated procedure, participants could only

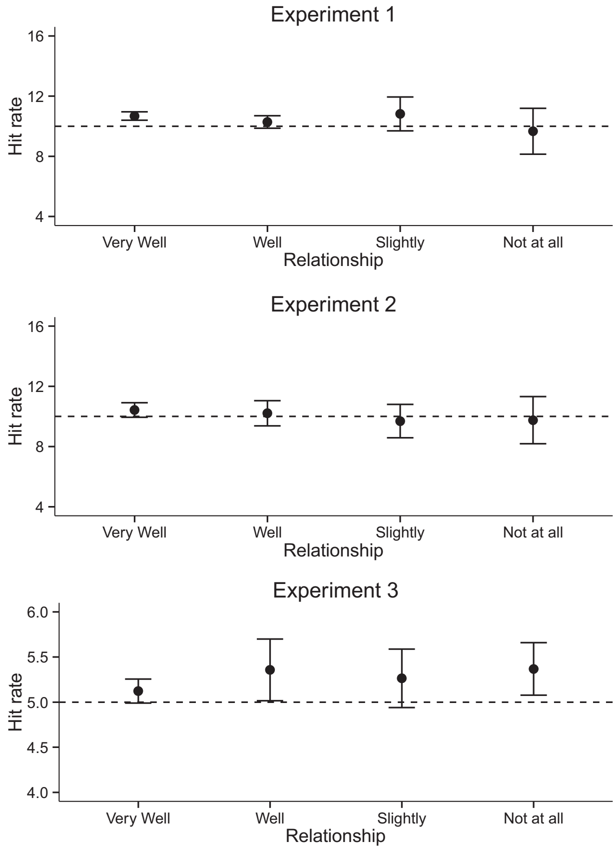

Figure 4. Effect of relationship between the participants on average hit rates in Experiments 1, 2, and 3. In Experiments 1 and 2 there were 20 trials per test, and hence the chance hit rate, indicated by a dashed horizontal line, was 10. In Experiment 3 with 10 trials the chance hit rate was 5. The error bars show 95% confidence intervals.

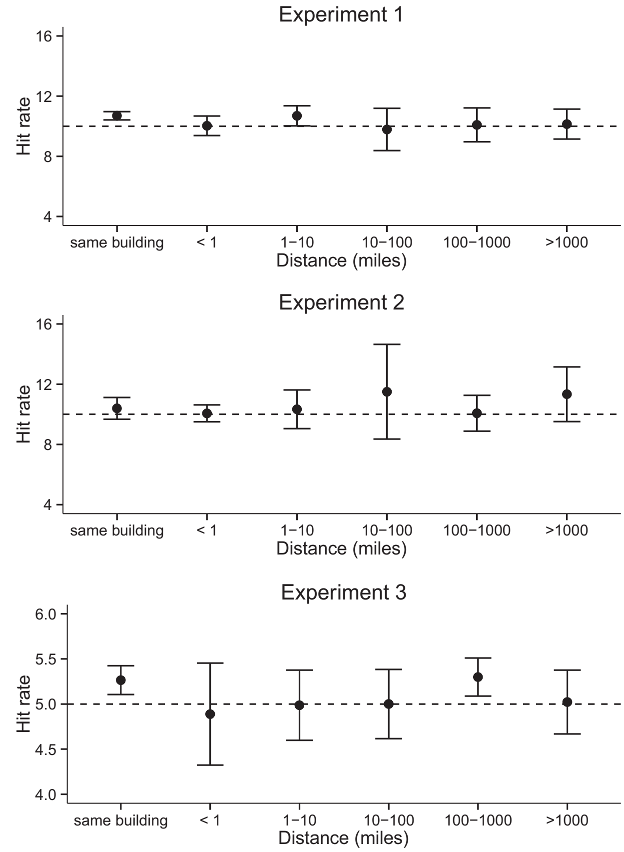

Figure 5. Effect of distance between the participants on average hit rates in Experiments 1, 2, and 3. In Experiments 1 and 2 there were 20 trials per test, and hence the chance hit rate, indicated by a dashed horizontal line, was 10. In Experiment 3 with 10 trials the chance hit rate was 5. The error bars show 95% confidence intervals.

take the test if they pre-registered, and we therefore have records from all participants (including some who registered but did not commence the test). Some pairs of participants started the test but did not complete it. In some cases this could have been because of optional stopping, whereby people might have given up if they were receiving feedback and not scoring well. But in fact most participants in incomplete tests were not receiving feedback, and hence would not have known how well they were doing. Probably a more common reason for a failure to complete tests was that there were technical glitches, which forced people to stop. In any case, in Experiment 2 the scores in incomplete tests were higher, not lower, than in complete tests. When we included all data from the tests in our analysis, including data from incomplete tests, the overall results were still positive.

Most of these tests were unsupervised, and there is therefore a possibility that some participants were cheating, or that there was some kind of sensory leakage. Participants could conceivably have cheated by doing the test in the same room, speaking to each other on the telephone, or by sending text or instant messages. In Experiment 1, one pair of participants did indeed score 100% in two tests. We therefore assumed that they had been cheating and excluded their results from the analysis. (No other data were excluded from the results reported above.) No one else scored 100%. In Experiment 1, where the maximum score for each participant was 20, out of 556 individual scores, no one scored 19, 1 person scored 18, no one scored 17, and 2 scored 16. When we trimmed the results, excluding the top 10% and bottom 10% of scores, the overall hit rates were similar to the untrimmed results. Thus the pattern of results showed that the positive overall hit rates were not a result of a few people scoring far above chance, but rather of many people many people scoring slightly above chance. This conclusion is reinforced by the data for the total number of tests with above-chance scores compared below-chance scores (Table 1). Combining the results from all the three experiments, 691 tests had above-chance scores and 567 below. It is implausible that so many pairs of partners decided to cheat and did so very subtly.

Direct sensory leakage might be possible when people did the test within the same building, especially in Experiment 3, involving sound. But if this were the case, hit rates should have been higher in the same building compared with tests when the participants were in different buildings, often many miles apart. But this was not the case: the hit rates were almost the same (Figure 5). Moreover in Experiment 3, hit rates in the same building in tests with and without sound showed as slightly higher hit rate without sound than with, 53.2% as opposed to 52.6%. It is of course possible that some participants who said they were far away were in fact in the same room, and we did not record participants' IP addresses, which could have enabled us to check for this possibility. It is also possible that some people pretended that they could not hear the sound when in fact they could. But such deception seems highly unlikely.

Nevertheless, in the test conducted under filmed conditions by the team from APRU, the hit rates were almost exactly at chance (Table 3). This would at first sight seem to support the cheating hypothesis: scores dropped to chance levels when participants were under close surveillance, so perhaps the above-chance scores when they were not under surveillance were obtained by cheating. However, there could be another explanation. The participants were being tested in booths at an outdoor summer music festival, which was a very different situation from people doing the experiment in more familiar and less distracting surroundings. Moreover, the APRU team from Goldsmiths College was working under the direction of Prof. Chris French, who was at the time editor of *The Skeptic* magazine, and a well-known media skeptic in the UK. Participants were aware they were being tested by this team from Goldsmiths and had to sign a formal consent form agreeing to be filmed, as well as filling in a questionnaire. Knowing that they were being tested by skeptics and being treated as if they were potential cheats could have made them more nervous and self-conscious than people doing the test under more relaxed conditions at home. Their psychological state could have inhibited their psychic sensitivity.

Even though the overall results were positive, except for the APRU tests, the effect size was small: the biggest effect was in Experiment 1, where Cohen's d was only 0.06. We made several unsuccessful attempts to enhance the hit rates in the joint attention tests in the hope of finding a more robust effect. In Experiment 1, we compared different kinds of pictures, in order to test the hypothesis that pictures of people and animals might be more engaging for most people than landscapes or flowers. Although hit rates were somewhat higher with animals and people than flowers and landscapes, this effect was not significant (Table 2). In Experiment 2, we tested the hypothesis that an increase in the contrast between the paired pictures compared with Experiment 1 might enhance the effects of joint attention in comparison with divergent attention to more contrasting stimuli, but there was no increase in hit rate (Table 1). In Experiment 3, we added music to enhance the similarity of stimulus when participants were shown the same pictures, but overall hit rates were lower than in Experiment 1 in which there was no music (Table 1). Some pairs of participants in Experiment 3 could not use sound, and although they had lower hit rates than those who did have sound, this effect was not statistically significant.

We also explored whether hit rates could be improved with feedback, so that people would find the test more engaging and potentially learn to how to become more sensitive. Although hit rates were slightly higher with feedback in all three experiments, this effect was not statistically significant (Table 5).

In experiments on telepathy, hit rates are generally higher with familiar people than unfamiliar people[7] and we expected that similar principles would apply here, but there was no consistent or significant pattern (Figure 4). Incidentally, this result suggests that cheating was an unlikely explanation for the results, since it would hard to conspire to cheat with a stranger, unless potential cheats were so subtle that they pretended to be strangers when in fact they were not.

There were no significant effect of distance, and the effect did not fall off even when participants were more than 1000 miles apart (Figure 5). A lack of distance dependence is frequently found in experiments on telepathy.[7]

The results of these experiments were frustrating in that they showed only small effects, and none of the factors that we hypothesized would lead to larger effect sizes did so. On the other hand, the results were encouraging in that they were consistent with an ability of people to detect that others were attending to the same stimulus at the same time, even though they were unconscious of how this ability biased their guesses.

The symmetrical experimental design in these experiments had the advantage that all participants were both senders and receivers, and thus we obtained twice as much data as in a classic setup in which one person is a sender and the other a receiver. The disadvantage was that participants were distracted by having to divide their attention between looking at the picture, and at the same time trying to feel whether their partner was experiencing the same or a different stimulus. This division of attention may have inhibited their ability both to "transmit" and "receive." By creating such an artificial situation we may have inhibited the very effect we were trying to study.

We suggest that in further research it would be better to revert to a conventional sender–receiver design, where the senders are engaged solely in paying attention to stimuli while the receiver tries to detect whether or not the sender is attending to the same stimulus.

Another way of studying joint attention would be to take advantage of the mass media. At any given time, the attention of thousands or millions of people is fixed on particular programmes on television or on the radio. We envisage an experiment in which subjects are exposed to live broadcasts or to comparable recorded broadcasts, and asked to guess which are live. Can they feel when millions of people seeing and/or hearing the same things at the same time? Of course for this experiment to give valid results, the live and recorded programmes would have to be of similar technical quality, and would probably have to be from foreign countries so that the subjects did not know by normal means which programs were being broadcast at any given time. Streaming radio and TV on the internet make this experiment technically feasible.

CONCLUSIONS

These experiments suggest that joint attention is indeed detectable at a distance, but the effect is small. Further efforts to study this phenomenon in online tests may give a larger effect if one of the participants is a "sender" and the other a "receiver," rather than both participants playing both roles simultaneously.

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