Testing for Telepathy Using an Immersive Virtual Environment

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Abstract

Within this paper we report on the use immersive virtual reality (IVR) as an experimental environment and medium for the study of telepathy. Our own Telepathy Immersive Virtual Environment (TIVE) uses three-dimensional computer graphics technology to generate artificial environments that afford real-time interaction and exploration in conjunction with head mounted displays (HMDs), sound, instrumented data gloves which allow participants to interact with virtual objects. Here we report the results of a test of telepathic communication using TIVE. A total of 200 participants (88 males, 112 females, mean age = 28.9, range 16-64 yrs, SD = 9.13) were tested in pairs, once as a sender and once as a receiver. This study did not find support for the psi hypothesis, either in terms of directional hitting or in a post hoc magnitude analysis, where the outcomes were no different from what would be expected by chance. Suggestions for this outcome are discussed along with suggestions for further work.

Introduction

The ganzfeld has become the most favoured and successful experimental method for the assessment of general ESP performance, such as telepathy, in modern parapsychology (Milton, 1999; Bem, 1993). This method is comprised of three stages, the preparation period, the sending and receiving period and the judging stage. The procedure involves a telepathy ‘sender’ and ‘receiver’. The Receiver sits and relaxes in a reclining chair in a room, which is acoustically isolated or sound-attenuated. Translucent halved ping-pong balls are then taped over the Receiver’s eyes (which are kept open during the session) and a light directed toward the eyes to create a uniform field of unpatterned vision. The visual field in the ganzfeld is red in the majority of the ganzfeld literature (e.g., Avant 1965; Bertini et al., 1964; Honorton and Harper, 1974). Headphones are placed over the ears through which the Receiver usually hears white noise, which produces a homogenous auditory field.

Prior to hearing white noise, the Receiver typically listens to a series of progressive relaxation instructions, which are employed to further reduce internal somatic “noise”. The Sender is located in a separate room, which is also acoustically isolated. The role of the Sender is to concentrate on a target (often a visual stimulus) which has been randomly selected from a large pool of such stimuli. The Receiver is encouraged to provide a continuous verbal account of any mental imagery and thoughts experienced during the ‘sending period’. This lasts for about half an hour, after which time there is a review of the imagery experienced during the sending period, followed by the judging stage. Here, the Receiver is presented with a choice of usually four stimuli, one of which is the target. The stimuli are arranged into four orthogonal sets. Without knowing the identity of the target, the Receiver is then asked to rate the degree to which each of the four stimuli matches the imagery and mentation experienced during the ganzfeld period. In some experimental designs, independent judges address the similarity between the target and the imagery of the Receiver (Milton, 1991). A 'hit' is scored if the Receiver assigns the highest rating to the target stimulus (Bem and Honorton, 1994). ESP or an anomaly ('psi') is inferred from performance (the number of correct identifications of the 'target' or hits), when this is significantly above what would be expected by chance (or below chance in psi-missing).

The current climate in parapsychology is one of an interim phase of self-assessment and evaluation regarding the future of the ganzfeld. This is in the wake of the publication of a meta-analysis of the results of recent ganzfeld experiments that found a null overall effect size in terms of ESP performance (Milton and Wiseman, 1997; 1999). Meta-analysis is a tool for statistically synthesising large bodies of work to ascertain the true level of the replicability of an effect (Utts, 1991). It is a means of addressing a database in a way that does not simply add up the number of statistically significant outcomes, but considers the effect size (a measure of the outcome of a study which also incorporates sample size and the power of a study). The Milton and Wiseman (1997; 1999) findings challenge the results of several previous, meta-analyses undertaken on ganzfeld studies which yielded significant outcomes (Bem and Honorton, 1994; Honorton, 1985; Hyman, 1985; Radin, 1997), and they argue that there is not a replicable psi ganzfeld effect (Milton and Wiseman, 2002; cf. Navarro and Lawrence, 2002; Storm and Ertel, 2002).

<u>Target characteristics of targets in ESP research</u>

Although it is often unclear whether the source of ESP is an aspect of the agent's mental processing of the target or some aspect of the target itself (Morris, 1978), some researchers have argued that the nature and the way that the target is experienced by the Sender should be considered in more detail in ESP investigations. ESP experiments vary in the extent to which an agent is active or passive; they may focus on the target material and try to communicate it to the percipient or they may be less actively oriented to the target material (Morris, 1978).

Target materials as employed in the ganzfeld for example have often been purely visual; most researchers have employed pictures or video clips, while some researchers have employed objects and geographical locations as targets (Milton, 1991). It has been suggested that psi-conducive targets are more dynamic and multi-sensory and may have a psychological impact on the Receiver (Delanoy, 1989). Target types have comprised both dynamic and static stimuli. Honorton et al. (1990) described dynamic targets as comprising films, documentaries and cartoons, while static targets are comprised of art-work, photographs and magazine advertisements.

Attempts to address the nature of a good target have demonstrated that there is a preference for dynamic target clips compared to static ones (Honorton et al, 1990), and a trend toward a preference for complex (colourful) target clips over simple (black and white) targets (Watt, 1996). These relate to perceptual-like and emotive experiences that are reported in the real world.

Several authors have found a relationship between psi-hitting and aspects of the target. For example, Parker, et al. (1998) found a suggestive relationship between emotionality and effects of change in emotional tone of target material and psi-hitting. Dalkvist and Westerlund (1998) found a negative relationship between target emotionality and psi-hitting in a forced choice design. However, this was not replicated in a recent experiment (Dalkvist and Westerlund, 2004).

It is of interest that real events and locations were successfully employed as targets in the “remote viewing” experiments conducted by Targ and Puthoff and other researchers in the 1970’s (c.f. Tart, Puthoff and Targ, 2000). The dream ESP series at Maimonides (e.g., Ullman, Krippner, and Vaughan, 1973) were also very successful in terms of ESP outcomes (see Sherwood and Roe

(2003) for a review of dream ESP studies conducted since that time). It is of note that here the agent often attempted to act out aspects of the pictorial target material.

The above literature suggests a need to develop and employ more realistic target material in future assessments of ESP in the laboratory. Given that the standard ganzfeld recipe seems to be more successful (Bem, et al, 2003), one possible experimental scenario might be a ganzfeld-style ESP test using a virtual environment to enhance the target experience for the Sender or to increase the reality of the target experience for the Receiver.

Immersive virtual reality and its potential for telepathy research

Virtual reality (VR) denotes the use of three-dimensional computer graphics technology to generate artificial environments that afford real-time interaction and exploration. While virtual environments can be presented on desktop computer displays, a sense of immersion is often promoted through the use of head mounted displays (HMDs). These can present stereo images and sound to create a perceptually encompassing computer environment. A sense of 'presence' or telepresence (presence-at-a-distance), of feeling 'there' in a virtual environment is, perhaps, the ultimate aim of VR research. This calls for a dampening of awareness in 'reality' and a heightened 'acceptance' of the surrounding virtuality (Sheridan, 1992).

In previous work (Murray, Simmonds, and Fox, 2005; Murray, Howard, Fox, Caillette, F, Simmonds-Moore, and Wilde, 2006; in press) we have commented on a particular problem which can be identified with telepathy research and one which until relatively recently was impossible to overcome: namely, the dislocation of Sender (S) and Receiver (R). In extant research S and R are separated by physical space, be they separate rooms or buildings in a research institution, or in their own homes several miles apart. S is required to try and transmit some information (a name, a picture, an emotion, etc.) and R is required to identify the target from a pool of possible targets.

Much experimental research in psychology involves methodological choices about experimental control and ecological validity. Concern with the former arises from the importance placed on the precise manipulation of independent variables, while the latter emerges from an emphasis for experiments to approximate as close as possible situations which are experienced in day-to-day life (Aronson and Carlsmith, 1969). Optimal experimental designs which seek to control extraneous variables usually involve laboratory environments and stimuli which are simple and ‘unrealistic’. This is because as the complexity of the experimental environment and stimuli increase the experimenter finds it more difficult to conduct precise manipulations of independent variables and to control extraneous variables.

However, one reason for inculcating ecological validity or mundane realism in experiments is to aid participants’ full engagement within experimental situations and to increase their sensitivity to manipulations of independent variables (see Korn, 1997) [1], and as a consequence increase the degree to which such manipulations affect participants as intended. However, one drawback of increasing mundane realism in experimental psychology is that this is accompanied by a loss of experimental control.

One way in which the unnaturalness of the experimental laboratory may be alleviated would be if S and R could experience the same environment within which the target is located. If they were allowed to interact with the target pool (such as a book, a vase, or a chair) this might also facilitate both the acts of sending and receiving. However, there are a number of difficulties with this. First, having both S and R in the same place and time as when the target is available introduces the possibility of fraud and sensory leakage. R could enter the room after S has left, but this still allows the possibility of fraud, and has the added drawback of the temporal separation of S and R's involvement in the experimental trial. These problems may seem insurmountable; however we believe recent technological advances provide a remedy for these problems. Such a technological advance is Immersive Virtual Reality.

Researchers of ostensibly paranormal abilities have been at the forefront in embracing and incorporating into their research the developments and increased sophistication in technology (see Broughton, 1993). Such technological developments have aided researchers in increasing mundane realism while minimising the negative impact to experimental control. Immersive Virtual Reality (IVR) has been documented as providing participants with a compelling sense of personal, social, and environmental presence (Witmer and Singer, 1998). Blascovitch et al. (2002) outline how the use of IVR in experimental psychology circumvents a considerable amount of the problem involved in making choices about control versus mundane realism. The researcher gains optimal control over the experimental environment and actions that take place within it, while increasing the mundane realism of the experiment and the full engagement of the participant.

In support of the use of virtual environments for facilitating ESP performance, the environment around the target has often served as part of the target, even if this was not intended by the experimenter (Morris, 1978). This implies that the mind of the Receiver may seek to put the target into the wider context, e.g., of the room in which the target material is being played/viewed. Real world ESP experiences often involve an event which occurs for one person (the agent) which is then experienced in some form by another person (the percipient). These experiences are often meaningful or emotionally affective to the percipient and agent (c.f. Irwin, 1999). In modern ESP experiments free response methods have been adopted to increase the level of ecological validity with regard to every day psi experiences. However, target materials still seem somewhat limited and may not often accurately mimic real world ESP. IVR, with its dynamic, three-dimensional representation of stimuli which can be handled by both Sender (S) and Receiver (R) in identical virtual environments, would seem to offer an opportunity to address these issues.

The use of IVR would also go some way to addressing some of the problems with telepathy research identified by researchers such as Braude (1982), who argued against a purely visual transfer model of telepathy. This move to more complex (on a number of levels) target material would also seem supported by the literature reviewed earlier (e.g. Honorton et al., 1990; Watt, 1996). Personal handling of target pool objects by both S and R might be expected to add other aspects to the telepathic communication process usually absent in the methodological design of research on this topic. As the relationship between S, R and the target pool objects becomes more interactive this might facilitate the transfer of emotions, meanings and experiences that better convey what these are. An object which can be handled might be expected to make accessible the personal meanings, purposes of use, and so on, of the object for S and R than might possibly be achieved via a static (or even moving) image or written name (which are more commonly used in telepathy research studies). [2]

Methods

Participants

Participants were recruited via poster and email advertisement at the University of Manchester. A total of 200 (88 males, mean age = 30.06, range 16-64 yrs, SD = 9.96; 112 females, mean age = 27.99, range 17-50 yrs, SD = 8.34) people took part in the study (whole sample: 200, mean age = 28.9, range 16-64 yrs, SD = 9.13).

Immersive Virtual Telepathy Set-up

Physical Spatial Arrangements

The study took place in two rooms in same building (housing the Division of Psychology, University of Manchester) arbitrarily called ‘Study Room A’ and ‘Study Room B’. Room A was always the Sender’s (S) room, and room B was always the Receiver’s (R) room. (The possibility of sensory leakage is minimized as these rooms are approximately 150 feet apart, on different floors, and have 7 doors in between them.)

Immersive Virtual Reality Equipment

A V6 stereoscopic head-mounted display (HMD) was used to transmit the visual elements of the virtual environment to the participants. This has a 640 x 480 (307,200 colour elements) pixel resolution per eye, and a 60° diagonal field-of-view. The participant was able to ‘look around’ the virtual environment by making corresponding movements of their physical head. The Sender (S) heard the sound made by objects via an in-ear phone (left-ear). They were also able to hear (with their right ear) the spoken mentation of R via speakers placed close by. The Receiver (R) heard the sound made by objects via headphones built in to the V6.

The physical interaction of participants within the IVR was achieved via the use of an instrumented glove (the 5DT-14 wireless lycra data glove) which allowed the ‘handling’ of virtual objects. The glove facilitates the measurement of finger flexure (2 sensors per finger) as well as the abduction between fingers. This enabled participants to interact with virtual objects but did not provide tactile or haptic feedback. A sensor attached to an elasticated band was placed around the wrist, and one around the elbow. A third sensor was attached to the top of the HMD. A Polhemus cube was placed on a tripod approximately 50cms in front of the participant. This device relayed the information received from all three sensors to a Polhemus Fastrak box which translated them into corresponding movements of the participant's virtual body in the virtual environment.

Immersive Virtual Reality Environment

A virtual reality environment was created for use in this project. The environment itself resembled a virtual room containing four walls, ceiling, floor, a door, two windows, and a wall mounted shelving system, similar in appearance to a bookshelf. The operator was free to turn around and take in a 360^0 view of the room. They were able to see their virtual body in a similar fashion to the way we see our own real bodies, i.e. arms, legs and parts of the torso, but were unable, for instance, see their own face, head or back. Movement was restricted within the environment to motions that only served the purpose of the experiment. So, a participant was free to move their right arm, hand and fingers in virtual space, but they could not move their left arm or 'virtually walk' anywhere around the room. The target objects appeared in the virtual room on the shelving mentioned above. Targets were selected from the shelf via a gesture of the hand (the participant bent their thumb in towards the palm of their hand) that the equipment registered as a selecting gesture (this will described in more detail in the procedure section). When an object was selected, it moved from the shelf and affixed itself to the participant's virtual hand. They were then free to interact with the object (more details of this will be described in the procedure section) (see Figure 1). At no time was the Sender or the Receiver able to see their experimental partner's virtual body in the room with them. Essentially, although the environment they inhabited was identical in nearly all respects, it should be viewed and treated as two separate rooms.

[Insert figure 1 about here]

Computer Equipment and Set-up

The experimental set-up was identical for both the Sender and Receiver, in their respective rooms, as follows. For each participant we used two computers. The first is a small-form-factor "XPC" from Shuttle Inc., running Ubuntu Linux. This computer hosted the V6 stereoscopic head-mounted display, computer monitor, Polhemus Fastrack and the data-glove.

The software running on the Shuttle was a bespoke application implemented by the authors for this project. The software used C++ for logic and control, OpenGL for graphics, and OpenAL for sound management. The software communicated with the identical Shuttle in the other (Receiver's) room using a standard Internet "socket" library, connecting with the other Shuttle via a standard ethernet (Internet) connection. This received instructions from the Sender's computer /software. Real-time actions by participants in the virtual world were displayed on computer monitor in each room, again enabling the experimenter to view and record what was happening.

The Sender's first computer governed the selection and randomization of target pools, sets and objects. It also governed the presentation of objects during the judging phase. We based the random selection of objects on the Linux (Unix) system called rand() [], which returns an integer selected from a pseudo-random sequence initialized the system called srand(seed) which was seeded with the current system time (in milliseconds) at which the software was started. Thus for every run of the system (i.e., for every trial) a completely different psuedo-random sequence was guaranteed.

The second computer in each participant room was a standard office PC running Windows XP. This computer hosted the Skype voice-over-Internet Protocol telephony software which enabled the Sender to hear the mentation of the Receiver (via a microphone), via Skype also running on the PC in the Receiver's room. In the original experimental design, we intended

Skype to run on the Shuttles, but during system testing we found that this was not technically possible, because the Skype software "locked" the Shuttle’s soundcard, preventing the OpenAL software from functioning and producing the sounds associated with each object. A solution to this problem was not achievable within the project timescale, and thus led to the deployment of the additional PC to host the Skype software. The experimenters were able to communicate with one another using the text ‘chat’ function of Skype. This allowed the experimenters to synchronize activities, such as when Experimenter 1 (with the Receiver) signaled that they were stopping the trial and beginning the judging procedure (during which the Sender’s speakers were turned off by Experimenter 2). After each completed study the record of each Skype session, containing the dialogue between experimenters, was saved for future reference.

In order to translate participant gestures into commands in the virtual environment we wrote software to recognize two simple glove gestures only: the recognition of a movement of the thumb into the open palm (to select an object from the virtual shelf), and the recognition of a fully closed palm (a fist, to replace an object back on the virtual shelf). In order to cater for differing hand and finger sizes among participants, we provided a simple “sensitivity” control which the experimenter could use to adapt the software to the participant, and such adaptations were made before the start of the experiment proper. The Graphical User Interface allows the Sender’s experimenter to input a participant-pair ID, to stipulate their participant is the Sender (in the Receiver’s room the experimenter would just check the Receiver role option, then press start), and to select the object set.

Target Pools and Objects

One demonstration set (comprised of four doors) and one target pool (in total comprising of four different sets and a total of sixteen objects) were generated especially for this study. In order to familiarize participants with the experimental procedure, and the procedures for selecting and de-selecting objects, S and R first saw a demonstration set. This was a set of four doors, with different colours, and different knocking or bell-ring sounds. There were four sets of four objects which collectively made up the target pool, a total number of 16 objects.

<u>Procedure</u>

Prior to arriving at the University participants received a participant information sheet and a consent form. They were asked to read the information and (if they wished to take part) complete the consent form and bring both documents along with them. Spare copies of the participant information sheet and consent forms were available should they forget. The computers in both study rooms were started in advance and the network connections tested. When participants arrived at the university, they were greeted by the researchers and given a short tour of the study rooms where the experiment took place. This orientation procedure allowed participants to gain some physical spatial awareness of the facilities, to ask questions about the study, to get to know the research staff they would be working with, and to feel more comfortable with their surroundings. During the tour, participants were given a verbal description of what would happen during the testing period, which incorporated all of the main points of the procedure described herein. Once the tour was complete, participants were asked to decide between them which role each would prefer to take first, that of receiver or sender, for the first trial. When they had made their choice, the first experimenter remained with the Sender in Study Room A, while the second experimenter took the Receiver to Study Room B. Participants were asked to complete a battery of questionnaires and psychometric tests. (The findings of this data will be reported elsewhere.)

Trial 1

The date, time, session and trial number, study room ID, participant ID code, participant role and experimenter ID code were recorded at the start of the trial. Once the participants had completed the questionnaires, they each received a set of verbal, standardized instructions about what they were asked to do in this part of the experiment. Both S and R were then fitted with a head-mounted display and instrumented glove. The equipment was adjusted to the participant's comfort and calibrated in order to ensure that the instrumented glove could pick up the necessary gestures required to select objects (described in detail later).

In each room S and R first experienced the demonstration set. During this time there was a two-way audio link between the Sender and Receiver rooms. Once participants felt comfortable with the task, equipment, and had mastered the selection/deselection gestures, the microphone in the Sender's room was physically disconnected for the remainder of the study. This isolated the receiver from any verbal cues the sender may have given. Study 1 then formerly began. The Sender's computer selected one of the four object sets randomly from the target pool. It then presented the four objects in the chosen set in random order on the virtual shelf in each of the virtual environments (the same random order in each environment). In the Sender's environment, they saw one object which was randomly selected as the target from the object set, and three square opaque panels. The placement of the target object was randomized. In the Receiver's environment they initially saw four square opaque panels. These panels hid the objects from the view of both participants. Prior to the trial the Sender was briefed that, once the target object had been presented, they should then focus their attentions on the target and ignore the three remaining objects on the shelf. This method was intended to minimize contamination of the Sender's thoughts by visual experience of the other objects on the virtual shelf (however, they could hear the Receiver's verbal description of these objects if they chose to provide them). In order to facilitate a more complete focusing of attention on the target object, the Sender was free to explore the object by pointing at it and making a gesture with the hand that the instrumented glove interpreted as a selecting action. The object then came off the shelf and affixed itself to the Sender's virtual hand. At the same time an associated sound was played through the headset headphones on a loop for as long as the Sender manipulated the object. The Sender was then free to interact with the object, turning it around, looking at it from different angles, and was able to carry out object-specific actions. For instance, if the object was a cup, then the Sender could simulate drinking motions by lifting the cup up to the mouth. When the Sender was finished with the object they were able to perform a gesture (making a fist) which returned it to the virtual shelf.

Concurrently, in the Receiver's virtual environment, the participant was free to explore all four objects in the same fashion as the Sender. By pointing at one of the opaque panels and making a selection gesture, the partition disappeared and the object came into view on the shelf before traveling and becoming fixed to R's hand. Whichever object the Receiver chose to interact with, the relevant associated sound was played through the headset headphones on a loop for as long as the Receiver manipulated the object. When the Receiver was finished with an object they performed a (fist) gesture which returned it to the virtual shelf and replaced the opaque panel. They could then select another object using the same procedure as before.

Throughout the trial period the Sender concentrated upon the target object whilst the Receiver was able to manipulate any of the objects as they chose. Both participants were encouraged to verbalize their impressions, feelings and thoughts as they tried to send and receive respectively. A one-way audio connection between the Sender and the Receiver allowed the Sender to hear the Receiver's spoken aloud mentation. This provided the Sender with real time feedback on how well they were performing.

At the end of the first trial (which lasted 7 minutes) Experimenter 1 (with the Receiver) signaled to Experimenter 2 that they were stopping the trial using the text ‘chat’ function of Skype. Experimenter 2 then switched off the speakers in the Sender’s room and quit the Telepathy Virtual Environment. Judging in the Receiver’s room did not begin until the Experimenter had received confirmation via the Skype chat facility that the speakers in the Sender’s room were switched off. The Sender was then free to remove their HMD and to complete a questionnaire which assessed their degree of Presence in the TVE during the trial. Once the Presence questionnaire was completed they then signed a sheet to confirm what the target object was. The Receiver, however, kept their HMD on whilst they carried out the judging procedure. During this procedure the experimenter pressed a ‘reveal’ function on the keyboard and the Receiver was able to see all four objects simultaneously in the order they appeared on the shelf. First, the Receiver was asked to indicate whether they felt that there were any items which were definitely not the target (they could choose between 0-3 of the items). The Receiver was then asked to rate each object in terms of how much they felt each object was the target. This was expressed as a percentage (0-100) for each object. Receivers were asked not to duplicate their confidence ratings (they gave a different numerical rating for each object), which the experimenter wrote onto the judging sheet (with each object having a unique rating). These confidence ratings were then used to derive ranks for each object.). Once the judging procedure was complete, the Receiver removed their HMD and completed the first of their Presence questionnaires (the results of which will be analyzed elsewhere). The experimenter with the Receiver then confirmed with R what their first choice was before relaying this to the second experimenter in the Sender’s room using the Chat facility in Skype. This information was given to the Sender, and the actual target object was relayed back to the first experimenter in the Receiver’s room who relayed this to R.

Trial 2

Following Trial 1, the Sender and Receiver reversed roles and performed the second trial. For the current project S and R swapped physical locations (however, it is possible to reverse the roles by having the computer in room B make the pool and object selections instead of that in room A). S and R first meet approximately half-way, where they stopped and chatted with the experimenters about their performance before participants swapped experimenters and rooms. The second trial was essentially the same as the first trial; with the exception that this time the Sender's computer randomly chose the second object set from the three remaining sets in the study target pool. Following this, participants re-donned their HMDs, the one-way audio link from receiver room to sender room was re-established and the second trial began. The randomization of the order of presentation of objects in the virtual environment and the procedure for selection and manipulation of those objects were all the same as for the first trial. Again, both participants were encouraged to verbalize their impressions, feelings and thoughts as they tried to send and receive respectively. However, this was particularly stressed to the Receiver who was reminded that the Sender could hear them via the audio link. At the end of the second trial, the Sender removed their HMD and completed the second of their presence questionnaires. The judging process for the Receiver was the same procedure as for trial 1. The process of relaying R's choice and the actual target was the same as in Trial 1.

Results

Randomness Checks

Each participant pair was exposed to 2 of its 4 available sets. Table 1 shows the frequency with which each object set appeared for each trial.

[INSERT TABLE 1 ABOUT HERE]

Each object set would be expected to appear 50 times over 200 trials, 25 times in each trial. There do not appear to be any peculiarities with regards to the frequency with which an object set appeared. An object set was chosen from a second pool of objects (to be used in a second study) in human error on one occasion. A series of chi-square goodness of fit tests were conducted to check if the computer was truly choosing object sets at random over the course of the 2 trials. No significant results were found for either trial 1 (χ^2 = 2.96, p<0.2, two-tailed) or 2 (χ^2 = 2.54, p<0.2, two-tailed) or for 1 & 2 combined (χ^2 = 1.70: *p*<0.2, two-tailed).

Frequency of object appearance and choice of objects: Tables 2 and 3 summarize how many times individual objects appeared in the virtual array, how many times they were selected by the computer to appear as targets, how many times they were chosen by participants as the target object (whether or not they were correct or incorrect), and how many times out of those choices that the participants chose the target object correctly.

[INSERT TABLES 2 and 3 ABOUT HERE]

Tests to check for participant bias in choosing a particular object position: A series of chi-square goodness of fit tests were carried out to check if receivers were more likely to choose an object in one of the four available positions. No significant results were found for either trial 1 (χ^2 = 4.24, p<0.2, two-tailed) or 2 (χ^2 = 7.76, *p*<0.05, two-tailed) or for 1 & 2 combined (χ^2 = 6.48, *p*<0.05, two-tailed).

Tests to check for participant bias in choosing a particular object from a particular set: A series of chi-square goodness of fit tests were run to test if participants showed any preference for choosing one object over another in each of the 4 sets of objects. Table 4 summarizes these results.

[INSERT TABLE 4 ABOUT HERE]

From Table 4 it can be seen that there was a significant result for object set 11 in both trial 1 and 2 and when both trials were combined (χ^2 = 21.26: p<0.001, two-tailed for trial 1; χ^2 = 14.80: p<0.01, two-tailed for trial 2; χ^2 = 32.22: p<0.001, two-tailed for trials 1 & 2 combined). Object set 11 contained the following objects (+ object ID code); Football (111), Telephone (112), Toaster (113) & Toilet (114). Examination of the χ^2 equation cells revealed that participants were almost 2½ times more likely to choose the telephone than would be expected by chance. No significant results were found for any of the other object sets (12, 13 & 14) in Study 1 in either trial 1 or 2 or trials 1 & 2 combined.

Direct Hit Results and Post Hoc Analyses

Analysis of Direct Hits: There were 200 trials and 48 (24%) hits (equally spread in trial 1 and trial 2), where the mean chance expectation was 50 (25%) (p = .06, binomial test of significance, z=-0.33, Cohen's d=-0.44).

Comparison against chance: The percentage ratings given by participants to targets and non targets were converted in to z-scores, for later correlational analyses. A one sample t-test for directional scoring found no significant effect (*t*=-.245, *p*=.807). These findings are not surprising given the results of the planned analysis.

Psi magnitude analyses: Results were also analysed in terms of ESP magnitude effects. This was undertaken by regrouping the ranks into extreme (1 and 4) versus middle (2 and 3) ranks and undertaking a binomial test to address whether participants were more likely to rank the target as 1 (indicative of psi hitting) or 4 (indicative of psi-missing) than a 2 or 3. There were 200 trials of which 48% (96) were extreme ranks and 52% (104) were middle ranks, where the mean chance expectation would be 50% (100). These groups were not found to be significantly different from one another when compared by a binomial test, $p = .621$.

Experimenter Effects: Post-hoc analyses (binomial tests of significance) found no experimenter pairings produced any significant results (16 trials for DW and CM: $p = .16$, binomial test of significance, $z=0$, Cohen's $d=-0.21$; 10 trials for DW and CS: $p = .17$, binomial test of significance, $z=0.52$, Cohen's $d=-0.19$; 69 trials for DW and FC: $p = .07$, binomial test of significance, $z=-0.49$, Cohen's $d=-0.41$)

Discussion

Within this paper we have reported the findings of a telepathy study using an immersive virtual environment. This study did not find support for the psi hypothesis, either in terms of directional hitting or in a post hoc magnitude analysis, where the outcomes were no different from what would be expected by chance. As such, this indicates that the virtual reality experiment (as it is currently designed) is not conducive to above chance findings, or alternatively, that psi does not exist in the first place. For proponents of telepathy these results will be disappointing, particularly as they do not come close to the significant effect found in much ganzfeld research.

There are a number of potential criticisms of the present work which we will address here. First, although we drew upon previous ganzfeld work as providing the theoretical underpinnings for much of our rationale for why immersive virtual reality may optimize the conditions expected to be conducive to observing telepathy in the laboratory, our studies differ in other, perhaps more crucial ways to ganzfeld work. For instance, our study did not include any relaxation period which has been proposed by some researchers to be in part responsible for the significant effect found in some ganzfeld studies (e.g. Parker, 2000). Second, we did not select a particular 'special' population (e.g. 'meditators' and 'creatives') to take part in the study which previous work has suggested obtain better hit rates than student samples (e.g. Dalton 1997; and Parker, 2000). A third criticism may be that, again unlike the ganzfeld where trials frequently last as long as two hours, our own trials lasted 7 minutes each. Some researchers may feel that this is too short a time to inculcate the necessary conditions for the occurrence of telepathy in the lab. A further argument maybe that in the present study participants took the role of a Receiver and Sender only once each, and an increased number of trials testing participants in the same roles might be more successful in demonstrating an effect.

As discussed earlier, previous researchers have suggested that psi-conducive targets are more dynamic and multi-sensory and may have a psychological impact on the receiver (Delanoy, 1989). We envisaged that IVR would provide a much more dynamic and multi-sensory rendition of target stimuli than has been achieved in previous research, and therefore provide an increased opportunity for the correct identification of the target by the Receiver. However, it may be that more meaningful targets might improve the potential psi-conducive nature of this type of study. The relationship of participants to the stimuli might be important in the likelihood that a correct identification will be obtained (e.g. see Dalkvist, and Westerlund, 1998). For instance, one extension of the present work which we propose is the inclusion of people with a variety of phobias and the use of phobic material or objects such as spiders, snakes, blood and needles. The use of such participants and stimuli might be expected to increase the likelihood of correct target identification when such stimuli are the targets (or to inhibit this (psi-missing) when such material acts as a distracter).

The virtual environment itself could be modified further to include increasingly realistic objects which allow for more participant interaction. A qualitative analysis of how participants interact with the objects used in the TIVE has found that certain objects with make up the object sets enable particular types of interactions which others preclude, or invite particular types of interactions which the technology at present does not afford (Murray, Wilde, et al. 2006). Rather than placing all objects within a set for the Receiver, it would be possible to construct 4 virtual rooms which, with an object in each, could holistically function as targets in themselves. If this were the case, then participants could explore and interact with objects in a series of rooms rather than an object in isolation, e.g., a target might be the hairdressers, a pub, an office, and so on.

Future papers will explore correlates of psi performance within the same study. This approach takes the view that the psi process may function differentially according to state of consciousness and personality factors. The null effect overall reported here may therefore reflect a systematic balance of psi hitting and psi missing.

End Notes

[1] Fox (2005) notes that it is an assumption that participants are actually ‘participating’ in ganzfeld experiments, at least in the manner desired by the experimenter and what might be most conducive to demonstrating psi effects.

[2] Such a view would find support from work in ecological psychology, particular Gibson’s (1986) work on optical flow and affordances.

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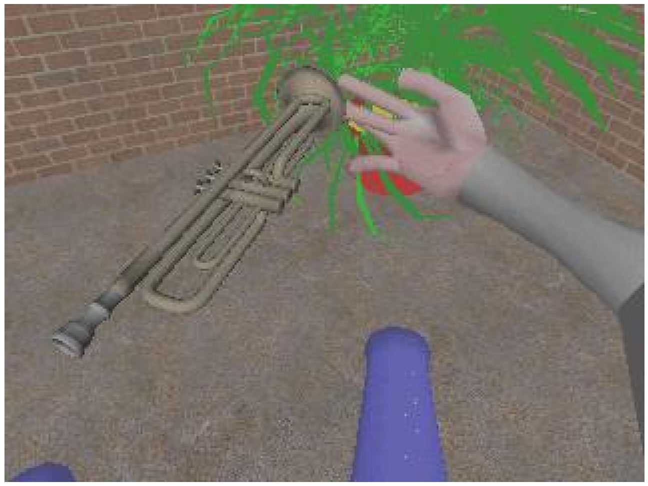

Fig. 1 An example of one of the virtual objects (a trumpet) as it appears to a participant in the Telepathy Immersive Virtual Environment.

Table 1. A summary of the frequency with which an object set appeared in each trial.

Object Set	Trial 1	Trial 2
1	31	20
2	22	30
3	27	27
4	20	22
5	*	1
Total	100	100

Table 2. Study 1, trial 1: The frequency of object set and target object appearance, and participants' object choices

Object Set	Object	No. times each object set appeared in the trial	No. times object was chosen by computer to be the target	No. of times object chosen by participant	No. times object correctly chosen as target by participant
11	Football	31	7	8	2
	Telephone		5	18	3
	Toaster		9	1	0
	Toilet		10	4	0
12	Trumpet	22	9	5	2
	Ping Pong Bat		3	9	1
	Rubber Stamp		8	2	2
	Maracas		2	6	0
13	Balloons	27	9	9	5
	Cleaver		7	3	1
	Electric Drill		6	5	1
	Tambourine		5	10	3
14	Electric Hair Dryer	20	4	1	0
	Plunger		7	8	3
	Teapot		3	6	0
	Coil Spring		6	5	1
	Total =	**100**	**100**	**100**	**24**

Table 3. Study 1, trial 2: The frequency of object set and target object appearance, and participants' object choices

Object Set	Object	No. times each object set appeared in the trial	No. times object was chosen by computer to be the target	No. of times object chosen by participant	No. times object correctly chosen as target by participant
11	Football	20	6	2	0
	Telephone		4	12	3
	Toaster		5	5	1
	Toilet		5	1	1
12	Trumpet	30	9	4	1
	Ping Pong Bat		4	7	0
	Rubber Stamp		10	8	4
	Maracas		7	11	2
13	Balloons	27	6	7	3
	Cleaver		8	5	2
	Electric Drill		3	6	0
	Tambourine		10	9	3
14	Electric Hair Dryer	22	9	6	1
	Plunger		5	2	1
	Teapot		6	8	1
	Coil Spring		2	6	0
22	Roast Chicken	1	1	1	1
	Crayons		0	0	0
	Hammer		0	0	0
	Sewing Machine		0	0	0
	Total =	**100**	**100**	**100**	**24**

Table 4: Summary of χ^2 goodness of fit tests for object response bias for Study 1

Trial	Object set	*P* value*	χ^2
1	11	<0.001	21.26
	12	>0.20	4.55
	13	>0.10	4.85
	14	>0.10	5.20
2	11	<0.01	14.80
	12	>0.20	3.33
	13	>0.20	1.30
	14	>0.20	3.45
1 & 2 combined	11	<0.001	32.22
	12	>0.20	3.85
	13	>0.10	5.41
	14	>0.20	2.38

**All p-values are two tailed*

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