TESTING FOR TELEPATHY USING AN IMMERSIVE VIRTUAL ENVIRONMENT

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ABSTRACT: Within this paper we report on the use of immersive virtual reality (IVR) as an experimental environment and medium for the study of telepathy. We argue that IVR has a number of advantages over ganzfeld work using static or dynamic stimuli, as well as telepathy studies using physical objects. Our own Telepathy Immersive Virtual Environment (TIVE) uses 3-dimensional computer graphics technology to generate artificial environments that afford real-time interaction and exploration in conjunction with head mounted displays (HMDs), sound, and instrumented data gloves that 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, *M* 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, in which the outcomes were no different from what would be expected by chance. Suggestions for this outcome are discussed along with suggestions for further work.

The ganzfeld has become the most favoured and successful experimental method for the assessment of general ESP performance, such as telepathy, in modern parapsychology (Bem, 1993; Milton, 1999). One reason that it is favoured concerns the development of computers as a central part of its experimental method, enabling the automation of the randomisation and selection of object sets and targets, minimising experimenter errors in recording participants' responses, and creating an electronic record that contributes to safeguards against fraud. Such work has also been argued to provide the most convincing evidence for psi. However, 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 by Milton and Wiseman (1997, 1999) of a meta-analysis of the results of ganzfeld experiments that challenge those of several previous meta-analyses undertaken on ganzfeld studies which yielded significant outcomes (Bem & Honorton, 1994; Honorton, 1985; Hyman, 1985; Radin, 1997), to argue that there is not a replicable psi ganzfeld effect (Milton & Wiseman, 2002). However, Bem, Palmer, and Broughton (2001) provide an analysis of those studies that adhere to a "standard" ganzfeld

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procedure and argue that there is a replicable effect which is diluted by the inclusion of studies which deviate from this procedure in significant ways.

The features of studies employing the ganzfeld technique have varied, with different "hit" rates that have led to discussion of what features of ganzfeld studies may be more or less conducive to higher hit rates (e.g., Bem et al., 2001). Target materials as employed in the ganzfeld have often been purely visual; most researchers have employed pictures or video clips, whereas 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 pools have been comprised of both dynamic and static stimuli. Honorton et al. (1990) described dynamic targets as comprising films, documentaries, and cartoons, whereas static targets are comprised of art work, photographs, and magazine advertisements.

Attempts to address the nature of a good target have suggested a preference for dynamic target clips compared to static ones (Honorton et al., 1990) and for more complex (colourful) target clips over simple (black-and-white) targets (Watt, 1996). 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 1970s (cf. Tart, Puthoff, & Targ, 2000). The dream ESP series at Maimonides (e.g., Ullman, Krippner, & Vaughan, 1973) were also very successful in terms of ESP outcomes (see Sherwood & 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. Such literature suggests a need to develop and employ more realistic target material in future assessments of ESP in the laboratory.

A second issue in such telepathy research is the dislocation of sender and receiver (which, as will be elaborated, until relatively recently was impossible to overcome). In extant research, and for sensible methodological reasons, the sender and receiver are separated by physical space, be they separate rooms or buildings in a research institution or in their own homes several miles apart. The sender is required to try to transmit some information (a name, a picture, an emotion, etc.) and the receiver 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, whereas the latter emerges from an emphasis on experiments to approximate as closely as possible situations that are experienced in day-to-day life (Aronson & Carlsmith, 1969). Optimal experimental designs that 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.

Contrastingly, 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),[2] 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 might be alleviated in telepathy studies would be if the sender and the receiver 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. Both of these features are in stark contrast to that ganzfeld work in which static or moving images are presented to participants in separate rooms. However, there are a number of difficulties with this. First, having both the sender and the receiver in the same place at the time the target is available introduces the possibility of fraud and sensory leakage. The receiver could enter the room after the sender has left, but this still allows the possibility of fraud and has the added drawback of the temporal separation of the sender and receiver's involvement in the experimental trial.

A second possibility would be to have participants in similar physical rooms with identical object sets. However, this also has a number of problems. First, unless the environments were physically identical it would not be possible for two participants to have the same visual experience. Second, the selection of object sets and the objects that comprise them, along with the storage of these objects, would be cumbersome, and the variety of objects which could be employed would be limited. Third, physical objects wear as they are used in experiments. This means that, unless sets of objects are replaced each time they are used, some objects may deteriorate more rapidly than others. As a result, object pairs, rather than being "identical," may begin to look different from one another, or certain objects which are handled more than others may change in appearance, which in turn may influence participants' choices in subsequent trials (e.g., worn items might be more or less likely to be chosen as the target). A final issue regarding the use of physical objects in telepathy studies is the possibility of anomalous information transfer that occurs when one participant touches an object which has been previously handled by another person (such as postulated in psychometry); for example, a person who handles an object

[2] 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.

may not choose it as a target because of negative impressions which arise from the personal meaning of the object evoked during physical contact by a previous participant.

These problems may seem insurmountable; however, we believe recent technological advances, in the form of Immersive Virtual Reality (IVR), provide a remedy for them (Murray, Simmonds, & Fox, 2005; Murray et al., 2006, in press). 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).

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 & Singer, 1998). Blascovitch et al. (2002) outline how the use of IVR in experimental psychology circumvents to a considerable degree 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.

The observation that the environment around the target has often served as part of the target in General ESP studies, even if this was not intended by the experimenter (Morris, 1978), adds further support to the proposed use of virtual environments for facilitating ESP performance. This suggests that the mind of the receiver may seek to put the target into the wider context, for example, of the room in which the target material is being played/viewed.

The use of IVR would also go some way toward addressing some of the problems with telepathy experiments 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 highlighted earlier (e.g., Honorton et al., 1990; Watt, 1996). Personal handling of target pool objects by both the sender and receiver 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 relationships among the sender, the receiver, and the target pool objects become 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 the sender and receiver than might possibly be achieved via a static (or even moving) image or written name (which are more commonly used in telepathy research studies).[3]

IVR also provides solutions to the problems identified earlier in using less technologically intensive methods, such as sets of physically identical objects: the sender and receiver could simultaneously experience an identical environment (albeit a virtual one) within which the target is located while avoiding the possibility of fraud and sensory leakage inherent in sharing a physical environment; they could physically interact with the target pool (unlike in those ganzfeld studies that use static or moving images), arguably making the targets richer and more dynamic and further facilitating the acts of sending and receiving. Virtual objects do not wear, so they are not subject to the same problems as physical objects, which may deteriorate and take on a different appearance over time. Finally, the possibility for detrimental anomalous information transfer between previous and subsequent participants is avoided.

As well as providing the above benefits, IVR enables the same advantages discussed earlier in relation to the development of ganzfeld work that incorporated computers and provided the automation of the randomisation and selection of object sets and targets, the minimisation of experimenter errors in recording participants' responses, and the creation of electronic records that contribute to safeguards against fraud.

Having detailed the potential of IVR for telepathy research, we now turn attention to describing our implementation of such a study. Here we report on the Telepathy Immersive Virtual Environment (TIVE), and the findings of an empirical study of telepathy using this technology.

Method

Participants

Participants were recruited via poster and e-mail 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).

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

Immersive Virtual Telepathy Setup

Physical spatial arrangements. The study took place in two rooms in the same building at the University of Manchester, arbitrarily called "Study Room A" and "Study Room B." Room A was always the sender's room, and Room B was always the receiver's room. (The possibility of sensory leakage was minimized as these rooms are approximately 150 feet apart, on different floors, and have seven 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 his or her physical head. The senders 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 the receiver via speakers placed close by. The receiver heard the sound made by objects via headphones built into 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. 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 another was placed around the elbow. A third sensor was attached to the top of the HMD. A Polhemus cube was placed on a tripod approximately 50 cm in front of the participant. This device relayed the information received from all three sensors to a Polhemus Fastrack box that 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 operators were free to turn around and take in a 360° 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, that is, arms, legs, and parts of the torso, but they were unable, for instance, see their own face, head, or back. Movement was restricted within the environment to motions that served only the purpose of the experiment. So, participants were 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 participants bent their thumb in toward the palm of their hand) that the equipment registered as a selecting gesture. When an object was selected, it moved from the shelf and affixed itself to the participant's virtual hand. Participants 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.

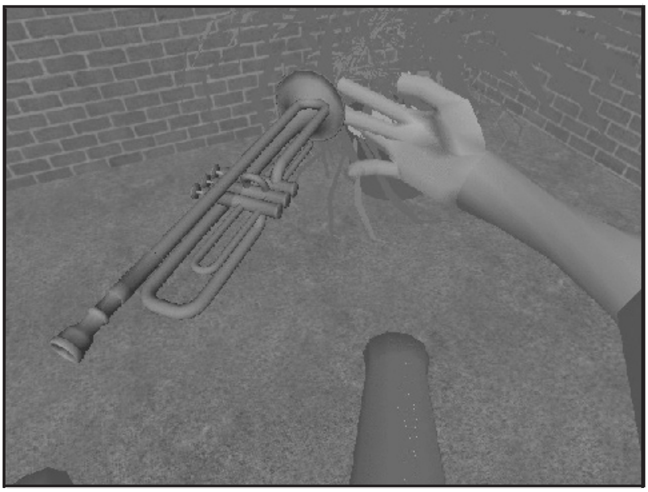

Figure 1. An example of one of the virtual objects (a trumpet) as it appears to a participant in the telepathy immersive virtual environment.

Computer Equipment and Setup

The experimental setup 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 an Ubuntu Linux operating system. 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 custom-built application implemented by the authors for this project. 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 connection. This received instructions from the sender's computer/software. Real-time actions by participants in the virtual world were displayed on computer monitors in each room, 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 call rand() [http://www.cplusplus.com/reference/clibrary/cstdlib/rand.html], which returns an integer selected from a pseudorandom sequence which was initialized by "seeding" it with the current system time (in milliseconds) at which the software was started. Thus, for every run of the software, a different sequence of pseudorandom numbers was used.

The second computer in each participant room was a standard office PC running Windows XP. This computer hosted the Skype Voice-Over-Internet Protocol (VOIP) 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. 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 on the virtual shelf).

Target Pools and Objects

In order to familiarize participants with the experimental procedure and the procedures for selecting and deselecting objects, the sender and receiver first used a demonstration set comprised of four doors with different colours and different knocking or bell-ring sounds. The target pool was comprised of four sets and a total of 16 objects with associated sounds. The objects were: football, telephone, toaster, and toilet (Set 1); trumpet, ping pong bat; rubber stamp, and maracas, (Set 2); balloons, cleaver, electric drill, and tambourine (Set 3); electric hair dryer, plunger, teapot, and coil spring (Set 4).

Measure of Presence

One common measure of presence in immersive virtual reality is a Presence Questionnaire. Whereas "immersion" refers to the objective factors of a virtual system such as field of view, display resolution, and degree of interactivity possible, "presence" refers to the psychological and behavioural response to these factors (Slater & Wilbur, 1997).

Slater and colleagues (Usoh, Catena, Arman, & Slater, 2000) argue that Presence is comprised of three aspects: a sense of being in the virtual environment (VE), the degree to which the VE becomes the dominant reality for participants, and the extent to which participants view the VE as a "place" they visited rather than simply images they saw. The questionnaire used in the present study (adapted from Usoh et al., 2000, with "virtual environment" replacing "office space") consists of six items, scored from 1–7. In the present study this gives a possible range of 6–42, where higher scores are taken to indicate a higher sense of presence. Example items are: "Please rate *your sense of being in the* virtual environment, on the following scale from 1 to 7, where 7 represents your *normal experience of being in a place"* and "To what extent were there times during the experience when the virtual environment was the reality for you?"

Procedure

Upon arrival, participants were greeted by the researchers and given a short tour of the study rooms where the experiment took place and 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.)

Next, participants received a set of verbal, standardized instructions about what they were asked to do in this part of the experiment. Both the sender and receiver were then fitted with a head-mounted display and instrumented glove. In each room, the sender and receiver 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 and the 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. Trial 1 then formally began.

The sender's computer selected one of the four object sets randomly from the target pool and presented four objects on the virtual shelf in each of the virtual environments. In the sender's environment, they saw one object that was randomly selected as the target from the object set, and three fixed square opaque panels. The placement of the target object on the shelf in each trial was randomized and was in the same position for both the sender and receiver. In the receiver's environment, they initially saw four square opaque panels. These panels hid the objects from view. The sender was restricted to seeing and exploring the target object but 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. The sounds for each object were related in a logical manner. For instance, when handling the telephone, participants would hear it ring; when handling the hairdryer, they heard a recording of one switched on; and when handling the trumpet or maracas, participants heard the sounds such instruments would usually make. These sounds would be heard in a loop while the object was being handled. The sender was then free to interact with the object, turning it around and 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 his or her mouth. When the sender was finished with the object, he or she was able to perform a gesture (making a fist) that 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.

Throughout the trial period, 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 the pair was performing.

At the end of the first trial (which lasted 7 min) Experimenter 1 (with the receiver) signaled to Experimenter 2 that they were stopping the trial by using the text "chat" function of Skype. Experimenter 2 then switched off the speakers in the sender's room and quit the Telepathy Immersive Virtual Environment (TIVE). 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 senders were then free to remove their HMD and to complete a questionnaire that assessed their degree of Presence in the TIVE during the trial. Once the Presence questionnaire was completed, they then signed a sheet to confirm what the target object was. The receivers kept their HMD on while 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 he or she felt that there were any items which were definitely not the target (they could choose from 0 to 3 of the items). The receivers were 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 to give a different numerical rating for each object, which the experimenter wrote onto the judging sheet. These confidence ratings were then used to derive ranks for each object.

Once the judging procedure was complete, the receiver removed his or her HMD and completed the first Presence questionnaire. The experimenter with the receiver then confirmed with the receiver what his or her first choice was and 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 the receiver. Next, the sender and receiver reversed roles and performed Trial 2. This 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.

Results

Randomness and Response Bias Checks

Each participant pair was exposed to two of four available sets. Each object set would be expected to appear 50 times over 200 trials, 25 times in each of the two sender-receiver trials that comprised the present study. An object set was chosen from a second pool of objects (to be used in a later study) by 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 two trials. No significant results were found for either Trial 1, χ^2 (3, N = 100) = 2.96, $p > .2$, two-tailed, or Trial 2, χ^2(3, N = 100) = 2.54, $p > .2$, two-tailed, or for Trials 1 and 2 combined, χ^2(3, N = 200) = 1.70, $p > .2$, two-tailed.

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 (3, N = 100) = 4.24, $p > .2$, two-tailed, or Trial 2, χ^2 (3, N = 100) = 7.76, $p > .05$, two-tailed, or for Trials 1 and 2 combined, χ^2 (3, N = 200) = 6.48, $p > .05$, two-tailed.

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 four sets of objects. There was a significant result for Object Set 11 in Trial 1, χ^2 (3, N = 31) = 21.26, $p < .001$, two-tailed, and Trial 2, χ^2 (3, N = 20) = 14.80, $p < .01$, two-tailed, and when both trials were combined, χ^2(3, N = 51) = 32.22, $p < .001$, two-tailed. Object Set 11 contained the following objects: football, telephone, toaster, and toilet. 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 in either Trial 1 or 2 or Trials 1 and 2 combined.

Level of Participant Presence

Both senders (M = 22.32, SD = 7.69) and receivers (M = 23.17, SD = 7.55) reported similar levels of Presence while immersed in the virtual environment.

Direct Hit Results and Post Hoc Analyses

Two hundred trials were conducted in which a mean chance hit rate of 50 (25%) was expected. Forty-eight hits (24%) were scored (equally spread in both trials); this was tested using a binomial test of significance and found to be nonsignificant, p = .81, z = -0.24, Cohen's d = -0.44. The percentage ratings given by participants to targets and nontargets were converted into z scores for later correlational analyses. A one-sample t test for directional scoring found no significant effect, $t(199)$ = -.245, p = .807. These findings are not surprising given the results of the planned analysis.

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, whereas 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.

Post hoc analyses (binomial tests of significance) found no experimenter pairings produced any significant results (32 trials for DW and CM: p = .57, binomial test of significance, z = 0, Cohen's d = -0.21; 20 trials for DW and CS: p = .38, binomial test of significance, z = 0.24, Cohen's d = -0.19; 138 trials for DW and FC: p = .35, binomial test of significance, z = -0.39, Cohen's d = -0.41).

Discussion

Within this paper we have reported the findings of a telepathy study using TIVE, 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, in which the outcomes were no different from what would be expected by chance. 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.

Although our results could be used to argue for the nonexistence of psi, there are alternative explanations. First, if telepathy is possible it may be that the current theoretical understanding of how telepathy works is not sufficiently developed in order to suitably identify and produce the conditions necessary for its reliable occurrence under experimental conditions. Although our approach here has been to stimulate and engage the senses of participants, it may be that additional sensory stimulation is not helpful, and could even be disadvantageous, for telepathic communication. Additionally, researchers familiar with the literature on the experimenter effect in psi research may question whether the intention of the experimenters was psi-conducive (see, for example, Smith, 2003), although it is difficult to establish this apart from looking at different patterns of findings between experimenters.

Although the above issues are worthy of consideration, we reserve more in-depth discussion regarding the limitations of the present study to the selective manner in which our experimental design drew upon previous ganzfeld work, in particular on those studies that incorporated computers in both the sender and receiver environments, to provide the theoretical underpinnings for much of our rationale as to why immersive virtual reality may optimize the conditions expected to be conducive to observing telepathy in the laboratory. However, although there are a number of technical similarities between these ganzfeld studies and our IVR system, arguably our work has more resemblance to forced-choice experiments using real objects. Our work therefore differs in other, perhaps more crucial, ways from ganzfeld work. Indeed, just as Bem et al. (2001) pointed to the diluting effect that the inclusion of nonstandard studies made to the results of meta-analyses of ganzfeld work, it might be that it is the departure of the present study from a standard ganzfeld "recipe" which has produced similarly nonsignificant outcomes.

Whereas the "standard ganzfeld" places the participant in a relaxed hypnogogic state that is designed to facilitate spontaneous internally generated imagery, our own IVR system places the participant in an increased state of arousal and sensory alertness and is based on external, stimulus-influenced imagery. This relaxation period during the ganzfeld has been proposed by some researchers to be in part responsible for when a significant effect is found in such studies (e.g., Parker, 2000). During this period, the participant typically first generates response content freely for a time and then that material is later used (typically by means of a review) when making a final choice or ranking several possible targets. In contrast, the IVR is not free-response but a forced-choice design.

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 would obtain better hit rates than student samples (e.g., Dalton 1997; Parker, 2000). However, with this study we are at a similar stage to early ganzfeld work that took a similar approach. With the development of computerized ganzfeld systems, it is possible for researchers to reap the benefits of the extensive time and work that have been involved in developing those systems and focus their own efforts on select populations. Similarly, a considerable portion of our own time has been given to developing the TIVE, which can now be exploited in further work with samples hypothesized to excel at such tasks.

A third criticism may be that—again unlike the ganzfeld, in which trials frequently last as long as 2 hr—our own trials lasted 7 min 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 may be that in the present study participants took the role of 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 multisensory and may have a psychological impact on the receiver (Delanoy, 1989). We envisaged that IVR would provide a much more dynamic and multisensory rendition of target stimuli than has been achieved in previous research, such as those ganzfeld studies involving static or moving images as stimuli, and therefore provide an increased opportunity for the correct identification of the target by the receiver. However, it may be that more personally meaningful or emotive targets might improve the potential psi-conducive nature of this type of study. 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, whereas Dalkvist and Westerlund (1998) found a negative relationship between target emotionality and psi-hitting in a forced-choice design.

Although the findings regarding target-emotionality and psi-hitting are unclear, it is conceivable that the relationship of participants to the stimuli is important in the likelihood that a correct identification will be obtained. For instance, one extension of the present work that 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.

There is a further issue related to whether the potential benefits of IVR technology were adequately utilized in this study. The tendency for participants to score at the mid-point of the Presence scale may be used to argue that the TIVE was not as engaging as intended, and modifications which could lead to elevated levels of Presence might also lead to greater "hit" rates. For instance, the virtual environment itself could be modified further to include increasingly realistic objects that allow for more participant interaction. A qualitative analysis of how participants interact with the objects used in the TIVE has found that certain objects that 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, Simmonds-Moore, Fox, & Howard, 2006). Rather than placing all objects within a set for the receiver, it would be possible to construct four 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 a hairdresser's, a pub, an office, etc.).

Future analysis and research dissemination will explore correlates of psi performance within the same study reported here. 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.

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Abstracts in Other Languages

Spanish

RESUMEN: En este artículo informamos sobre el uso de Realidad Virtual Sumergible (RVS) como un ambiente experimental y una forma de estudiar la telepatía. Proponemos que la RVS tiene un número de ventajas sobre el ganzfeld que usa estímulos estáticos o dinámicos, al igual que sobre estudios de telepatía que usan objetos físicos. Nuestro Ambiente de Telepatía Virtual Sumergible (ATVS) usa tecnología gráfica computarizada tri-dimensional para generar ambientes artificiales que permiten interacciones en tiempo real en conjunto con pantallas montadas en la cabeza, sonidos, y guantes que permiten a los participantes tener interacciones con objetos virtuales. Informamos los resultados de una prueba de comunicación telepática usando ATVS. Un total de 200 participantes (88 hombres, 112 mujeres, M edad = 28.9, rango 16–64 años, SD = 9.13) fueron estudiadas en pares, una vez como emisores y otra vez como receptores. Este estudio no encontró evidencia a favor de la hipótesis psi en término de aciertos direccionales y en un análisis de magnitud post hoc, en el cual los resultados no fueron diferentes de lo esperado al azar. Se presentan sugerencias para explicar estos resultados y para trabajos futuros.

German

ZUSAMMENFASSUNG: In dieser Arbeit stellen wir die Verwendung einer ‚immersive virtual reality' (IVR) (‚eingetauchten virtuellen Realität') in Form einer experimentellen Umgebung und als Mittel zur Untersuchung von Telepathie vor. Wir sind der Meinung, dass die IVR eine Anzahl von Vorzügen im Vergleich zur Ganzfeldtechnik aufweist, bei der statisches oder dynamisches Stimulusmaterial verwendet wird, wie auch bei Telepathiestudien mit physikalischen Objekten. Unser eigenes‚Telepathy Immersive Virtual Environment' (TIVE) verwendet eine dreidimensionale Computergraphiktechnologie, um künstliche Umgebungen zu erzeugen, die eine Interaktion und Erkundung in Echtzeit gestatten in Verbindung mit am Kopf angebrachten Displays, Ton sowie mit Instrumenten ausgestatteten Datenhandschuhen, die es den Teilnehmern ermöglichen, mit virtuellen Objekten zu hantieren. Hier werden die Ergebnisse eines Tests der telepathischen Kommunikation unter Verwendung der TIVE vorgestellt. Zusammen wurden 200 Teilnehmer (88 Männer, 112 Frauen, Altersdurchschnitt = 28.9, Streuung = 16–64 Jahre, SD = 9.13) in Paaren getestet, einmal als Sender, einmal als Empfänger. Die Psi-Hypothese liess sich nicht bestätigen, weder in Form einer richtungsabhängigen Trefferleistung noch in Form einer post hoc vorgenommen Größenabschätzung, die ergab, dass die Ergebnisse sich nicht von dem unterschieden, was unter Zufallsbedingung zu erwarten war. Deutungsmöglichkeiten für dieses Ergebnis werden diskutiert zusammen mit Vorschlägen für künftige Arbeiten.

French

RESUME: Dans cet article, nous présentons l'utilisation d'une réalité virtuelle immersive (IVR) en tant qu'environnement expérimental et moyen d'étude de la télépathie. Nous pensons que l'IVR a plusieurs avantages par rapport au dispositif Ganzfeld et aux études télépathiques avec des objets physiques. L'environnement virtuel immersif télépathique (TIVE) que nous avons développé utilise une technologie graphique en trois dimensions pour générer un environnement artificiel qui permet une interaction en temps réel, et une exploration en conjonction avec un dispositif placé sur la tête (HMDs), du son, et des gants informatisés qui permettent aux participants d'interagir avec des objets virtuels. Nous décrivons dans cet article les résultats d'un test de communication télépathique utilisant le TIVE. Un total de 200 participants (88 hommes, 112 femmes, âge moyen = 28,9, de 16 à 64 ans, SD = 9,13) ont été testés par paire, avec un émetteur et un récepteur à chaque essai. Les résultats ne soutiennent pas l'hypothèse psi, ni dans le sens prévu, ni dans une analyse post hoc de la magnitude, dans laquelle les résultats ne sont pas différents de ce que l'on pourrait attendre par le simple fait du hasard. Des suggestions pour expliquer ces résultats sont discutées, ainsi que des propositions pour de futures études.