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Hypersensitivity to contingent behavior in paranoia: a new virtual reality paradigm

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Full title: Hypersensitivity to contingent behavior in paranoia: a new virtual reality paradigm

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Abstract:

Contingency in interpersonal relationships is associated with the development of secure attachment and trust, whereas paranoia arises from the over-attribution of negative intentions. We used a new virtual reality paradigm to experimentally investigate the impact of contingent behavior on trust along the paranoia continuum. Sixty-one healthy participants were randomly allocated to have a social interaction with a pleasant virtual human (avatar) programmed to be highly responsive or not (high/ low contingency). Perceived trustworthiness and trusting behavior were assessed alongside control variables attachment and anxiety. Higher paranoia and dismissive attachment were associated with larger interpersonal distances. Unexpectedly, extremely paranoid individuals experienced the highly contingent avatar as more trustworthy than his low contingency counterpart. Higher dismissive attachment was also associated with more subjective trust in both conditions. Extreme paranoia is associated with hypersensitivity to non-contingent behavior, which might explain experiences of mistrust when others are not highly responsive in everyday social situations.

Keywords:

Attachment; trust; paranoia; contingency; social environment; virtual reality

1. Introduction

Contingency in interpersonal relationships plays an important role in early life, with parental responsiveness shown to be a predictor of secure attachment (Dunst et al, 2008). In recent years, insecure attachment has been considered in pathways to persecutory delusions (Berry et al, 2006; MacBeth et al, 2008). The caregiver's accurate attribution of mental states facilitates the development of the infant's mentalising capacity (Fonagy et al, 2007) but 'over-mentalising'(Versmissen et al, 2008) can lead to paranoia via external attributions (Bentall et al, 2001). Accordingly, perceiving intentionality when there is none has been reported in people with persecutory delusions (Blakemore et al, 2003).

Paranoia has also been associated with safety behaviors, attempts to minimise perceived threat (Freeman et al, 2007). We propose that interpersonal boundaries are a type of safety behavior that can be conceptualised as self-regulatory (Mikulincer et al, 2007), aiming to 'deactivate' the attachment system and protect from interpersonal threat. Increased interpersonal boundaries are indeed reported in psychosis (Park et al, 2009) and are crucially associated with an external locus of control (Duke et al, 1973). Accordingly, unfounded paranoia has been elicited in people with persecutory delusions, early psychosis, at risk mental state and high trait non-clinical paranoia in ambiguous virtual environments (Fornells-Ambrojo et al, 2008; Freeman et al, 2010; Lysaker et al, 2010; Valmaggia et al, 2007).

We know that interactional synchrony influences trust (Kendon, 1970) but to date no research has investigated the role of contingent behavior in people with paranoia. Virtual characters programmed to give contingent nonverbal feedback (e.g. nods) in response to participants' behavior elicit more rapport than non-contingent ones (Gratch et al, 2006). Mimicry also increases perceived likeability while it remains outside the perceiver's awareness (Bailenson et al, 2008). However, social anxiety reduces the impact of mimicry (Vrijsen et al, 2010) .

This novel virtual reality study investigates interpersonal processes in paranoia by manipulating the contingency of virtual human (avatar) behavior. Perceptions of trustworthiness and interpersonal distance are evaluated. We hypothesise that a) The impact of contingent behavior on subjective trustworthiness and interpersonal distance will depend on trait paranoia. An interaction is predicted whereby higher contingent behavior results in higher trustworthiness and reduced interpersonal distance in individuals with low paranoia, whereas high trait paranoia participants will be immune to the contingency manipulation; b) Insecure attachment will be associated with lower levels of trust and larger interpersonal distance

2. Method

2.1 Participants and procedure

Healthy male volunteers aged 18 and above were recruited from a London university. Exclusion criteria were a history of epilepsy or mental health problems, assessed with a question in the demographics section and a positive screen in the *Psychosis Screening Questionnaire* (PSQ) (Bebbington et al, 1995). Ethical approval was obtained from the Division of Psychology and Language Sciences. Potential participants first completed a series of online screening questionnaires. Eligible participants were then invited by email to attend the Virtual Reality Lab at the Department of Computer Science. Written informed consent was obtained. Participants completed a series of post-virtual reality measures and received £10.

Virtual reality apparatus and scenario: The VR environment was displayed in an immersive projection system. High-resolution images, were projected in real- time onto three back-projected wall screens (3m x 2.2m) and a floor screen (3m x 3m). Stereo presentation was delivered via Lightweight CrystalEyes shutter-glasses. An inertial/ultrasonic head-tracking device was mounted on the glasses. Spatialised audio was delivered via four corner speakers. Intersense IS900 was used for 6 degrees of freedom head-tracking. The virtual reality scenario represented a student flat and was designed to be non-anxiety provoking. The virtual tenant, 'Mark', was a young male. The scenario had three stages. 1) The virtual tenant introduced himself to the participant and asked the participant their name. 2) Following the avatar's cue that he was ready, participants asked the virtual flatmate set questions. 3) When participants asked their fourth and last question (What is the best thing about this flat?), Mark walked towards the window and invited the participant to see the terrace. The scenario lasted two and a half minutes.

- Please insert Figure 1 about here -

Contingency manipulation: Some of the virtual flatmate's non-verbal responses were programmed to have contingent/non-contingent relationship to participant's head movements. In the high contingency (HC) condition, the virtual flatmate tilted his head every time the participant moved the head from side to side, with a 1.5 second delay. When participants moved their head in any other way, the virtual flatmate swayed side to side. Additionally, the researcher triggered avatar nodding each time the participant spoke. In the low contingency (LC) condition, avatar responses were programmed to occur but with a 20 second delay.

Virtual reality procedure: Participants were divided into two groups based on a median split in paranoia scores and they were randomly allocated to the high or the low contingent (HC/LC) condition by

permutated blocks method. Participants were informed that the study aimed to understand how people respond to virtual environments. They were instructed to enter the scenario, and to interview the virtual tenant by asking him four pre-set questions in order (e.g. Q1:'*What do you like about flat sharing?*'). They were given a prompt sheet.

2.2. Measures

The *pre-virtual reality measures* were: (1) the *Paranoia Scale* (PS) (Fenigstein et al, 1992), (2) the '*Trait Anxiety Inventory* (STAI) (Spielberger, 1983), (3) the *Relationship Questionnaire* (RQ) (Bartholomew et al, 1991). *Virtual reality measures* included (4) *Interpersonal distance, a behavioral measure of trusting behavior was* proximity to the virtual tenant, measured as the mean distance kept by the participant from the tenant during the last scene. The distance automatically recorded (in metres) using horizontal Pythagorean distance. Baseline distance used as control was measured in the same way from the start of the scenario. *Post-virtual reality* measures were (5) Subjective avatar trustworthiness was assessed by asking participants to rate how trustworthy the virtual tenant had come across to them on a 7-point Likert scale and (6)the *Sense of presence questionnaire* (Slater et al, 1998).

2.3 Statistical analyses

Data was analysed using SPSS for Windows (v.21). Hierarchical regression analyses were conducted to predict the two dependent variables: trustworthiness and interpersonal distance. In step 1 individual key predictor variables (paranoia, contingency condition) and control variables (anxiety, avatar movement, attachment) were included using Enter Method. When mean interpersonal distance from the virtual tenant was the dependent variable, mean baseline distance was also entered as a covariate in step 1. In step 2, the interaction term (paranoia x contingency condition) was added also using Forward selection method. Step 1 was included to investigate the main effects of paranoia and the contingency condition on the dependent variables, since the inclusion of the interaction term in step 2 prevents interpretation of coefficients for these variables as they reflect conditional relationships (Jaccard et al, 1990). Regression residuals plots confirmed approximation to a normal distribution. The Johnson- Neymann technique was used to follow up significant interactions.

3. Results

Two hundred and eighty one potential participants accessed the online pre-virtual reality survey, 93 of which did not complete the survey, and 46 were excluded because of a history of mental illness. Of the 142 contacted to participate, 54 did not reply and 25 were not available to meet within the study time frame. Of the 63 participants who took part on the study, 2 were excluded due to unexpected technical

faults during the running of the virtual scenario. Sixty-one male participated. Their mean age was 25.3 (SD= 7.3), 47 (77%) were from a White ethnic background and 55 (90%) had student status. The mean paranoia score (PS) (Fenigstein et al, 1992) was 35.57 (*SD* = 10.96; range = 22-63), and trait anxiety (STAI) (Spielberger, 1983) had a mean of 38.08 (SD=8.91). PS and STAI were significantly correlated (Pearson's r= .48, *p*<.001). About half of the sample (n=30, 49%) had a secure attachment as indicated by the RQ (Bartholomew et al, 1991). Continuous scores for individual attachment categories were: secure (Mean = 4.87, *SD*= 1.56), insecure fearful (Mean = 3.16, *SD*= 1.82), insecure preoccupied (Mean = 2.72, *SD*= 1.85), insecure dismissive (Mean = 3.84, *SD*= 1.26). Paranoia was significantly associated with secure (Pearson's r= - .28, *p*= .029), insecure fearful (Pearson's r= .38, *p*= .002) and insecure preoccupied (Pearson's r= .38, *p*=.052) but not with dismissive attachment (Pearson's r= .12, *p*=.354).

Interpersonal distance between the participant and the avatar at the last stage of the virtual interaction (Figure 1d) had a mean of 1.43 metres (SD=0.26, range = 0.93-2.20), which compares to a mean baseline distance (Figure 1a) of 2.02 metres (SD=0.26, range = 1.37-2.60). These values are in line with implicit rules about social distance (Hall, 1966). Participants reported a mean level of subjective avatar trustworthiness of 4.87 (*SD*= 1.07, range =2-7). Subjective trust and interpersonal distance were not significantly associated (Pearson's r = - .03, p = .833). The HC (n= 30) and LC groups (n=31) did not differ on subjective trust (*t* =.76, df = 58, *p* = .452) or interpersonal distance (*F (1,58)* [1] = .67, *p* = .417). The mean total number of contingent avatar movements significantly differed between the high (M =23.1 (*SD* = 7.3) and low (M= 7.0 (*SD* = 1.1) contingency conditions (*t* =11.86, df = 59, *p* <.001). Participants felt as if they were in the virtual flat, as shown by a mean sense of presence (Slater et al, 1998) score of 25.47 (SD=6.52, range= 11-38).

3.1 Predictors of trusting behavior and subjective trustworthiness

Table 1 shows the results of a multiple regression predicting interpersonal distance from the virtual tenant. A greater distance from the avatar (less trusting behavior) was predicted by higher paranoia and dismissive attachment[2], as well as by greater distance at the start of the conversation and less avatar movements.

- Please insert Table 1 about here –

[1] Covarying for baseline distance

[2] Dismissive attachment was entered in step 1 out of the four attachment categories because of its association with the dependent variables: Dismissive attachment was found to be the only attachment type that was either significantly associated with subjective trust (r =.31, p= .016) or approached significance for interpersonal distance, r= .23, p = .083).

Greater trustworthiness was predicted by higher levels of dismissive attachment and by the interaction between paranoia and contingency (please see Table 1, Step 2). The Johnson- Neymann technique was used to characterise the interaction. The conditional effect of Contingency condition on Trust transitioned to significance at Paranoia score of 49.89, *b*= -1.24, *SE*= .15, *t*=, *p*= .05, 95% CIs [-2.49, 0.00] at the 90th percentile of the distribution in the sample (n=8), with the relation between Trust and Contingency condition being significant at Paranoia scores above this point. In sum, individuals with high trait paranoia reported significantly higher levels of trust towards a highly responsive avatar (HC) than to an avatar that was less responsive (LC).

4. Discussion

4.1. Self-regulatory attachment behavior

A novel virtual reality paradigm was used to investigate the impact of interpersonal contingency on trust. Trusting behavior, operationalised as the interpersonal distance, was predicted by higher paranoia, dismissive attachment, baseline interpersonal distance and avatar movement, but not by the degree of avatar contingent behavior. This is in line with evidence from experience data sampling in people with high paranoia who reported social threat irrespective of degree of familiarity (Collip et al, 2011) and failure to adjust behavior in response to evidence of another agent's trustworthy behavior in economic exchange paradigms (Fett et al, 2012).

High subjective trust was not reflected behaviorally in closer proximity with the avatar. Dismissive attachment was also associated with both higher subjective trust and larger interpersonal distances. Why would individuals who are experiencing another as trustworthy behave in a way that might signal mistrust? Anomalous trust behavior with discrepancies between observed trusting behavior in the presence of subjective trust, can be rooted in insecure attachment (Fonagy et al, 2007). Indeed, children with externalising behavior, who, like individuals with paranoia (Combs et al, 2007) have been found to have hostile attribution style (Orobio de Castro et al, 2005) are trusting of others, but appear less trustworthy. Experiencing another as trustworthy in the context of a history of disrupted attachments can be threatening and give rise to over-arousal (Horowitz et al, 1964). Distancing is therefore conceptualised as a 'deactivating strategy', a self-regulatory attachment behavior (Mikulincer et al, 2007).

4.2. Hypersensitivity to contingency in extreme paranoia?

Tasks used to investigate intentionality in paranoia (Blakemore et al, 2003) have been criticised for their third person perspective (Chan et al, 2011) and questionable generalizability (Montag et al, 2011). In contrast, the current paradigm manipulated used a first person perspective. Under these circumstances,

people with extreme non-clinical paranoia, against our predictions, showed a heightened perceptiveness to contingent behavior instead of over-attributing intentionality. Heightened sensitivity to threat could emerge from adverse childhood experiences (MacBeth et al, 2008). Indeed attachment-disrupting events, such as being brought up in an institution, have been implicated paranoia (Bentall et al, 2014) and, in at risk of psychosis populations, interpersonal sensitivity, an excessive awareness of the behavior of others, has been associated with paranoia (Masillo et al, 2012; Valmaggia et al, 2007).The current study suggests that particularly high levels of interpersonal contingency might be necessary for highly paranoid individuals to develop trust, and therefore the *absence* of high responsiveness from others is experienced as a sign of mistrust. As argued in Trower et al (1995)'s interpersonal theory of poor me paranoia, threats to the self can arise from the lack of objectifying other and the defence involves transforming indifference into persecution.

The findings should be interpreted with caution given the small sample size, with only 8 participants in the 90th percentile of high paranoia showing sensitivity to the contingency manipulation. However, data in the current study replicates continuum research with extreme subclinical paranoia such as (Combs et al, 2004) reports that those on the 85th percentile of paranoia, with paranoia scores of PS ≥ 53 (n=29) prefer larger interpersonal distances than people with low paranoia in an in vivo social task. Further research should focus on the role of paranoid beliefs characteristics such as *intentionality* to cause harm, that differ between those at the top and the bottom of the paranoia hierarchy (Freeman et al, 2005) as well as investigating contingency manipulations in more ambiguous scenarios that increase anxiety (Lysaker et al, 2010). The current findings also need to be replicated with clinical and non-clinical populations, including females. The analogue nature of the study is also a limitation, and further work could use naturalistic designs to capture the richness of real life social encounters. However, the use of virtual reality allowed us to control for confounds and focus on the aspects under investigation. Moreover, participants reported a of sense of presence , a subjective feeling of 'being' in the virtual scenario and their interpersonal behavior followed proxemics rules (Hall, 1966), supporting the validity to the paradigm.

Paranoia of the therapist has been linked to lack of progress in cognitive therapy for psychosis (Lawlor et al, 2014). The current study suggest that when working clinically with individuals with high trait paranoia, awareness of potential interpersonal sensitivity, and therapist own contingent behavior may be particularly important, as careful attunement to the client and contingent responsiveness might be crucial for the development of a trusting therapeutic relationship.

Disclosures: The authors declare no conflicts of interest.

References

Bailenson J, Yee N, Patel K & Beall AC (2008) Detecting digital chameleons. *Computers in Human Behavior* 24:66-87.

Bartholomew K & Horowitz LM (1991) Attachment styles among young adults: a test of a four-category model. *J Pers Soc Psychol* 61:226-44.

Bebbington P & Nayani T (1995) The Psychosis Screening Questionnaire. *International Journal of Methods in Psychiatric Research* 5:11-19.

Bentall RP, Corcoran R, Howard R, Blackwood N & Kinderman P (2001) Persecutory delusions: A review and theoretical integration. *Clinical Psychology Review*.21:1143-1192.

Bentall RP, de Sousa P, Varese F, Wickham S, Sitko K, Haarmans M & Read J (2014) From adversity to psychosis: pathways and mechanisms from specific adversities to specific symptoms. *Social psychiatry and psychiatric epidemiology* 49:1011-1022.

Berry K, Wearden A, Barrowclough C & Liversidge T (2006) Attachment styles, interpersonal relationships and psychotic phenomena in a non-clinical student sample. *Personality and Individual Differences* 41:707-718.

Blakemore S-J, Sarfati Y, Bazin N & Decety J (2003) The detection of intentional contingencies in simple animations in patients with delusions of persecution. *Psychological Medicine* 33:1433-1441.

Chan KK & Chen EY (2011) Theory of mind and paranoia in schizophrenia: A game theoretical investigation framework. *Cognitive neuropsychiatry* 16:505-529.

Collip D, Oorschot M, Thewissen V, Van Os J, Bentall RP & Myin-Germeys I (2011) Social world interactions: how company connects to paranoia. *Psychological Medicine* 41:911-921.

Combs DR & Penn DL (2004) The role of subclinical paranoia on social perception and behavior. *Schizophr Res* 69:93-104.

Combs DR, Penn DL, Wicher M & Waldheter E (2007) The Ambiguous Intentions Hostility Questionnaire (AIHQ): a new measure for evaluating hostile social-cognitive biases in paranoia. *Cognitive Neuropsychiatry* 12:128-143.

Duke MP & Mullens C (1973) Preferred interpersonal distance as a function of locus of control orientation in chronic schizophrenics, nonschizophrenic patients, and normals. *Journal of Consulting and Clinical Psychology* 41:230-234.

Dunst CJ & Kassow DZ (2008) Caregiver sensitivity, contingent social responsiveness, and secure infant attachment. *Journal of Early and Intensive Behavior Intervention* 5: 40-56.

Fenigstein A & Vanable PA (1992) Paranoia and self-consciousness. *Journal of Personality and Social Psychology* 62:129-138.

Fett A-KJ, Shergill SS, Joyce DW, Riedl A, Strobel M, Gromann PM & Krabbendam L (2012) To trust or not to trust: the dynamics of social interaction in psychosis. *Brain* 135:976-984.

Fonagy P, Gergely G & Target M (2007) The parent-infant dyad and the construction of the subjective self. *J Child Psychol Psychiatry* 48:288-328.

Fornells-Ambrojo M, Barker C, Swapp D, Slater M, Antley A & Freeman D (2008) Virtual reality and persecutory delusions: Safety and feasibility. *Schizophrenia Research* 104:228-236.

Freeman D, Garety PA, Bebbington PE, Smith B, Rollinson R, Fowler D, Kuipers E, Ray K & Dunn G (2005) Psychological investigation of the structure of paranoia in a non-clinical population. *The British Journal of Psychiatry* 186:427-435.

Freeman D, Garety PA, Kuipers E, Fowler D, Bebbington PE & Dunn G (2007) Acting on persecutory delusions: The importance of safety seeking. *Behavior Research and Therapy* 45:89-99.

Freeman D, Pugh K, Vorontsova N, Antley A & Slater M (2010) Testing the continuum of delusional beliefs: An experimental study using virtual reality. *Journal of Abnormal Psychology*.119:83-92.

Gratch J, Okhmatovskaia A, Lamothe F, Marsella S, Morales M, van der Werf RJ & Morency L-P (2006) Virtual Rapport. In J. Gratch, M. Young, R. Aylett et al (Eds), *Intelligent Virtual Agents*, Vol 4133, pp 14-27). Springer Berlin Heidelberg.

Hall ET (1966) The hidden dimension. Bantam Doubleday Dell Publishing Group

Horowitz MJ, Duff DF & Stratton LO (1964) Body-buffer zone;exploration of pesonal space. *Archives of general psychiatry* 11:651-656.

Jaccard J, Wan CK & Turrisi R (1990) The Detection and Interpretation of Interaction Effects Between Continuous Variables in Multiple Regression. *Multivariate Behavioral Research* 25:467-478.

Kendon A (1970) Movement coordination in social interaction: Some examples described. *Acta Psychologica* 32:101-125.

Lawlor C, Hall K & Ellett L (2014) Paranoia in the Therapeutic Relationship in Cognitive Behavioral Therapy for Psychosis. *Behavioral and cognitive psychotherapy*.

Lysaker PH, Salvatore G, Grant MLA, Procacci M, Olesek KL, Buck KD, Nicolo G & Dimaggio G (2010) Deficits in theory of mind and social anxiety as independent paths to paranoid features in schizophrenia. *Schizophrenia Research* 124:81-85.

MacBeth A, Schwannauer M & Gumley A (2008) The association between attachment style, social mentalities, and paranoid ideation: An analogue study. *Psychology and Psychotherapy-Theory Research and Practice* 81:79-93.

Masillo A, Day F, Laing J, Howes O, Fusar-Poli P, Byrne M, Bhattacharyya S, Fiori Nastro P, Girardi P, McGuire PK & Valmaggia LR (2012) Interpersonal sensitivity in the at-risk mental state for psychosis. *Psychological medicine* 42:1835-1845.

Mikulincer M & Shaver PR (2007) Attachment in adulthood. Structure, dynamics and change.). London: the Guildford Press.

Montag C, Dziobek I, Richter IS, Neuhaus K, Lehmann A, Sylla R, Heekeren HR, Heinz A & Gallinat J (2011) Different aspects of theory of mind in paranoid schizophrenia: Evidence from a video-based assessment. *Psychiatry research* 186:203-209.

Orobio de Castro B, Merk W, Koops W, Veerman JW & Bosch JD (2005) Emotions in social information processing and their relations with reactive and proactive aggression in referred aggressive boys. *Journal of Clinical Child and Adolescent Psychology* 34:105-116.

Park S-H, Ku J, Kim J-J, Jang HJ, Kim SY, Kim SH, Kim C-H, Lee H, Kim IY & Kim SI (2009) Increased personal space of patients with schizophrenia in a virtual social environment. *Psychiatry Research* 169:197-202.

Slater M, McCarthy J & Maringelli F (1998) The Influence of Body Movement on Subjective Presence in Virtual Environments. *Human Factors: The Journal of the Human Factors and Ergonomics Society* 40:469-477.

Spielberger C (1983) Manual for the State-Trait Anxiety Inventory STAI (Form Y).). Palo Alto, CA: Consulting Psychologists Press.

Trower P & Chadwick P (1995) Pathways to defense of the self: A theory of two types of paranoia. *Clinical psychology: Science and practice* 2:263-278.

Valmaggia LR, Freeman D, Green C, Garety P, Swapp D, Antley A, Prescott C, Fowler D, Kuipers E, Bebbington P, Slater M, Broome M & McGuire PK (2007) Virtual reality and paranoid ideations in people with an 'at-risk mental state' for psychosis. *British Journal of Psychiatry* 191:S63-S68.

Versmissen D, Janssen I, Myin-Germeys I, Mengelers R, Campo JA, van Os J & Krabbendam L (2008) Evidence for a relationship between mentalising deficits and paranoia over the psychosis continuum. *Schizophr Res* 99:103-10.

Vrijsen JN, Lange W-G, Dotsch R, Wigboldus DH & Rinck M (2010) How do socially anxious women evaluate mimicry? A virtual reality study. *Cognition and emotion* 24:840-847

Table 1

Table 1 Multiple regressions predicting interpersonal distance and avatar trustworthiness

Dependent variable:	***Interpersonal distance (at window in metres)***					***Avatar trustworthiness***				
	B	SE (B)	β	*t*	*p*	B	SE (B)	β	*t*	*p*
Step 1										
Baseline distance	**.31**	**.11**	**.32**	**2.81**	**.007***	-	-	-	-	-
Avatar movement	**-.02**	**.01**	**-.66**	**-3.15**	**.003***	-.02	.03	-.33	-.53	.583
Trait Anxiety	.00	.00	.11	.81	.419	-.02	.02	.15	- .96	.343
Dismissive attachment	**.04**	**.02**	**.26**	**2.27**	**.027***	**.20**	**.09**	**.30**	**2.24**	**.029***
Paranoia	**.01**	**.00**	**.33**	**2.55**	**.014***	.01	.01	.07	.48	.633
Contingency	-.19	.11	-.37	-1.72	.091	-.20	.52	-.09	-.38	.708
			F (6, 54) =4.89, p<.001** Adj R^2 = .28					F (5, 54) =1.47, p = .215, Adj R^2 = .038		
Step 2										
Avatar movement						-.02	.03	-.20	-.86	.392
Trait Anxiety						-.02	.02	.14	- .99	.325
Dismissive attachment						**.23**	**.08**	**.35**	**2.72**	**.009***
Paranoia						.03	.02	.35	2.04	.047[a]
Contingency						-.29	.49	-.14	-.59	.560[a]
Paranoia*Contingency						**-.07**	**.24**	**-.44**	**-2.75**	**.008***
						F (6, 53) =2.63, p = .026*, Adj R^2 = .142, ***ΔR2 = .110***				

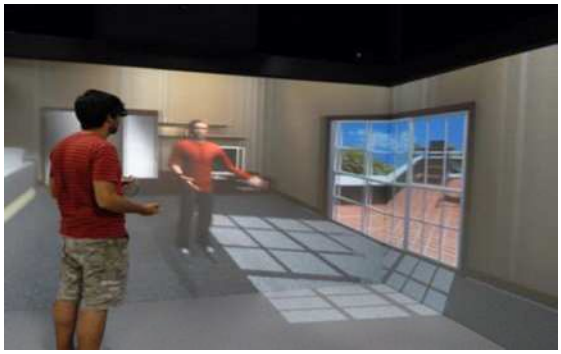
Note: * p< .05; ** p< .01, *** p< .001; Step 1 predictors (Method: Enter): Baseline distance in metres (for Interpersonal distance regressionnonly); Avatar movements; *Trait Anxiety Inventory* (STAI; Spielberger *et al.*, 1983); Dismissive attachment assed by the *Relationship Questionnaire* (RQ; Bartholomew & Horowitz, 1991); *Paranoia Scale* (PS; Fenigstein & Vanable, 1992); contingency condition variable coding: High contingency= 0; Low contingency =1. Step 2 predictor (Method: Forward selection): Paranoia x Contingency interaction.

[a] Values for Paranoia and Contingency entered in step 2 regression analyses are not interpretable because of the presence of the interaction term Paranoia x Contingency in the equation. For DV= *Interpersonal distance*, the interaction term paranoia x contingency condition was entered in step 2 using Forward selection but was not kept in as it did not significantly contribute to the model (*β* = .062, *t* =.423; p *=.674)* and would have resulted in a negligible increase in total variance explained (ΔR2 = .002).

Figure 1

Figure 1 Virtual reality images of interaction with virtual tenant: sequence of events

a) Initial greeting (stages 1 & 2)



b) Virtual tenant invites participant to look at the terrace "Come and have a look!" (stage 3)

c) Virtualt tenant and participant walk towards window (stage 3)

d) Virtual tenant and participant have moved across the room to look at the terrace (stage 3)