Cognitive Mechanisms Underlying Virtual Reality Exposure's Efficacy in the Treatment of Arachnophobia

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Introduction

- Most of the currently available studies suggest that VR exposure is at least as effective as in vivo exposure. However, few studies have been done on treatment mechanism.
- On what dimensions is VR exposure effective ? Is this technique suggestive enough to elicit fear when the participant knows the stimuli are not real ? Does exposure affect cognitive processes in the brain ?
- Many measures, such as questionnaires, are available, but they remain very subjective. This is where objective outcome measures become interesting.

Goal

- The goal of this presentation is to contrast the predictive value of psychological mechanisms involved in the exposure treatment of phobias when delivered in virtual reality.

Hypotheses

H1. General improvement (on the FSQ) will be significantly predicted by changes in process variables such as self-efficacy (on the PSETSQ), beliefs (on the SBQ) and information processing (emotional Stroop Task).

H2. Changes in information processing will better predict changes in anxiety (cardiac response) during the behavioral avoidance test.

H3. Changes in self-efficacy will better predict changes in avoidance behavior (distance from the spider) during the behavioral avoidance test.

Participants

- 28 arachnophobics, aged between 21 and 53 years old (mean = 34, s.d. = 10,3)
- 27 women, 1 man
- Exclusion criteria: major comorbid disorders, epilepsy, major heart or vestibular problems.

Materials

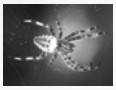
- Pentium III
- Wireless mouse
- I-Glass SVGA head mounted display
- Intertrax^2 motion tracker from Intersense
- VR environments were created by adapting a 3D game (Max Payne).

Methods

- Session 1 : global evaluation (SCID-IV) for specific phobia.
- Session 2 : CBT rationale and practice with VR equipment in a neutral environment (apartments without spiders).
- Following 5 sessions : gradual exposure therapy using virtual reality.
- Pre and post : questionnaires (spider phobia, anxiety, perceived self-efficacy and immersive tendency), Pictorial Stroop test and behavioral avoidance test (BAT) with psychophysiological measures (heart rate variability).

Pictorial Stroop task

- Practice trials (20) : stimuli were pieces of furniture; feedback was given
- Experimental trials (128) : spiders (threat), cows (neutral) and rabbits (positive) and a blank screen with only the coloured filters (baseline).
- Response time was recorded; participants answered manually on an keypad with coloured keys.

Behavioural avoidance test

- Feared stimuli : a live tarantula in a vivarium placed on a platform 173 cms away from the participants, first hidden under a cardboard box.
- BAT steps :
  - 0 : Look at the box
  - 1 : Box lifted
  - 2 : Lid removed
  - 3 to 9 : move platform by pressing a button
  - 10 : Place face over opening for one minute
- At all times, participants could stop the platform, but had to keep looking at the tarantula for one additional minute.

Treatment outcome

	Pre-treatment	Post-treatment	*F* (1, 27)
BAT	4.25	8.39	66.4***
FSQ	99.71	48.8	67.39***
SBQ – beliefs	98.79	62.93	57.61***
SBQ - behavior	74.54	47.21	60.68***
PSETSQ	34.16	72.13	70.8***
STAI - trait	34.11	32.18	4.38*
Stroop - threat	883.84	760.15	4.76*
ASL for IBI	-935.96	1286.87	16.94*

Note. * $p < .05$, *** $p < .001$

Regression predicting general outcome with beliefs, self-efficacy and information processing

The regression was significant [$F_{(3,26)} = 18.23$, $p < .001$]

$R = .84$, $R^2 = .70$, Adj $R^2 = .67$

Predictors	t	B	Part sr^2
Δ Beliefs	4.36***	.60	.49
Δ Self-efficacy	-2.37*	-.33	-.27
Δ Info processing	.19	.02	.02

* $p < .05$, *** $p < .001$

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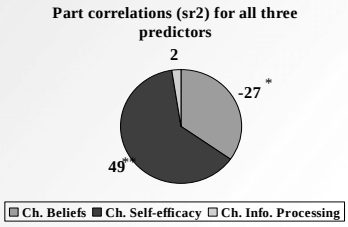


Hierarchical regressions comparing the relative contribution of the two significant predictors of general outcome

Steps	R	R^2	R^2 change	F change
1. Δ Beliefs	.48	.23	.23	7.66**
2. Δ Self-eff.	.65	.42	.19	8.31***
Reverse order				
1. Δ Self-eff.	.62	.39	.39	16.56***
2. Δ Beliefs	.65	.42	.03	1.34

* $p < .05$, *** $p < .001$

Regression predicting avoidance with beliefs, self-efficacy and information processing

The regression was significant [$F_{(3,27)} = 7.45$, $p < .001$]
Only self-efficacy contributed significantly ($p < .05$)
But beliefs and information processing were close to significance with p of .08 and .09, respectively.

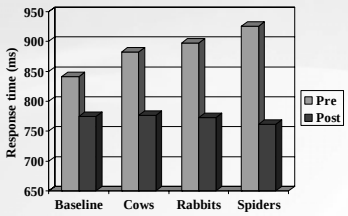
Std regressions with only two predictors	R	R^2	R^2 change	F change
Self-efficacy	.55	.30	.30	11.27**
Beliefs	.64	.42	.11	4.86*
Info. processing	.55	.30	.30	11.27**
Self-efficacy	.64	.41	.11	4.62*

* $p < .05$, ** $p < .01$

Regression predicting cardiac response with beliefs, self-efficacy and information processing

All correlations between the cardiac response (Inter-Beat-Intervals) and the predictive variables were low and the regression model was far from significant [$F_{(3,26)} = .14$, *ns*].

Results : Stroop



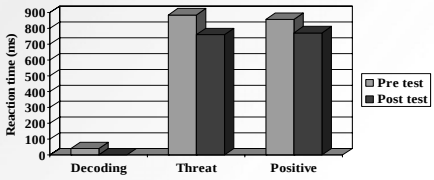
- Non parametric analyses were made on interference data (Stimuli – Baseline) at pre-test because the interference scores were not normally distributed.
- Friedman: $p < .05$.

Results : Stroop (continued)

- A pure *Emotional interference effect*, was calculated with :
  - **a)Decoding effect** : Neutral – Baseline
  - **b)Emotional interference effects** :
    - Threat – Decoding effect
    - Positive – Decoding effect
- ANOVAs used interference presumably created only by emotions and reactions to emotions;
- Controls habituation;
- But provides information about only two stimuli (positive and threat).

Results : Stroop (continued)

- **<u>Emotional interference effect</u>**
  - Decoding effect* (F = 8,06, p < 0,008)
  - Threat interference* (F = 4,76, p < 0,038)
  - Positive interference n.s. (F = 2,96, p < 0,097)



Discussion

- VRE does provoke significant clinical and statistical therapeutic change for people suffering from arachnophobia;
- This information may be applied to both traditional *in vivo* and virtual reality exposure;
- Though some results are still puzzling, they are very interesting first steps towards a better understanding of the cognitive mechanisms underlying VRE's efficacy.

Discussion (continued)

- Perceived self-efficacy was found to be an important predictor for general outcome and avoidance behaviours; consistent with Williams and colleagues (1989);
- Beliefs also played a significant role for general outcome, but had lesser predictive power than perceived self-efficacy. It also seems to be an interesting predictor for avoidance, but it still has to be confirmed;
- Information processing seems to present an interesting predictive value for avoidance, but it still has to be confirmed.