

Exposição por Realidade Virtual no Tratamento do Medo de Dirigir¹

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RESUMO - Um crescente número de pesquisas têm surgido sobre a aplicação da terapia de exposição por realidade virtual (VRET) para transtornos ansiosos. O objetivo deste estudo foi revisar algumas evidências que apoiam a eficácia da VRET para tratar fobia de dirigir. Os estudos foram identificados por meio de buscas computadorizadas (PubMed/Medline, Web of Science e Scielo databases) no período de 1984 a 2007. Alguns achados são promissores. Índices de ansiedade/evitação caíram entre o início e o fim do tratamento. VRET poderia ser um primeiro passo no tratamento da fobia de dirigir, uma vez que pode facilitar a exposição ao vivo, evitando-se os riscos e elevados custos dessa exposição. Entretanto, mais estudos clínicos randomizados/controlados são necessários para comprovar sua eficácia.

Palavras-chave: revisão; realidade virtual; fobia de dirigir.

Virtual Reality Exposure Therapy in the Treatment of Driving Phobia

ABSTRACT - A growing number of researches has appeared on virtual reality exposure therapy (VRET) to treat anxiety disorders. The purpose of this article was to review some evidences that support the VRET efficacy to treat driving phobia. The studies were identified through computerized search (PubMed/Medline, Web of Science, and Scielo databases) from 1984 to 2007. Some findings are promising. Anxiety/avoidance ratings declined from pre to post-treatment. VRET may be used as a first step in the treatment of driving phobia, as long as it may facilitate the *in vivo* exposure, thus reducing risks and high costs of such exposure. Notwithstanding, more randomized/controlled clinical trials are required to prove its efficacy.

Keywords: review; virtual reality; driving phobia.

Driving is a skill that frequently facilitates the maintenance of independence and mobility, and enables contact with a wide variety of important activities (Taylor, Deane & Podd, 2002). Driving phobia is a serious social and personal issue. This fear-related avoidance has serious consequences such as restriction of freedom, career impairments and social embarrassment (Ku, Jang, Lee, Lee, Kim & Kim, 2002).

Driving phobia is defined as a specific phobia, situational type, in the DSM-IV (APA, 1994). It is characterized by intense, persistent fear of driving, which increases as the individual anticipates, or is exposed to driving stimuli. People with driving phobia recognize that their fears are excessive or unreasonable. However, they are either unable to drive or tolerate driving with considerable distress (Wald & Taylor, 2000). Driving phobia does not typically decrease or becomes spontaneously asymptomatic without treatment and can become chronic (Mayou, Tyndel & Bryant, 1997; Taylor & Deane, 1999; Wald & Taylor, 2003). This specific phobia typically occurs in young to middle adult females (Ehlers, Hofmann, Herda & Roth, 1994; Taylor & Deane, 1999).

The majority of research points to post-traumatic stress disorder (typically related to motor-vehicle accident involvement), panic disorder, or agoraphobia as the psychiatric disorders most commonly associated with driving phobia (Taylor & Deane, 1999; Taylor & Deane, 2000). Ehlers et al. (1994) and Herda, Ehlers and Roth (1993) add social phobia as a contributing factor of fear of driving.

People with fear of driving often engage in maladaptive safety behaviors in an attempt to protect themselves from unpredicted dangers when driving (Antony, Craske & Barlow, 1995; Taylor, Deane & Podd, 2007). About one-fifth of accident survivors develop acute stress reaction; out of this subgroup, 10% go on to develop a mood disorder, 20% develop phobic travel anxiety, and 11% develop post-traumatic stress disorder (Mayou et al., 1997).

Driving Phobia

Some controversies lie upon categorizing fear of driving, and some diagnosis as panic disorder, agoraphobia, posttraumatic stress disorder and social phobia are considered to be part of the driving phobia (Lewis & Walshe, 2005). Although driving phobia is defined as a specific phobia in the DSM-IV (APA, 1994), Blanchard and Hickling (1997) point out some problems with classification: (a) anxiety may be better accounted for by another mental disorder; (b) anxiety may not invariably provoke an immediate anxiety response; (c)

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there may be times when driving does not evoke the particular triggers required for a phobic response; and (d) such response may not be regarded as fear as much as a situation that elicits anxiety and uncomfortable affect (Blanchard & Hickling, 1997; Taylor & Deane 2000).

Another point of conflict is whether or not fear of driving is considered a component of wider agoraphobic avoidance. Some authors show that situational panic attacks experienced by people with specific phobia are very similar to those experienced by people with agoraphobia (Taylor, Deane & Podd, 2000). Others indicate that driving phobias can also develop after the individual experiences an unexpected panic attack in the feared situation (Taylor et al., 2000). Curtis and Himle (citado por Taylor et al., 2000) distinguish specific phobias and agoraphobia in terms of focus of apprehension. Individuals with agoraphobia have avoidance behaviors because they fear panic and its consequences (anxiety expectancy), whereas people with specific phobia fear danger (danger expectancy) (Antony Brown & Barlow, 1997; Taylor et al., 2000).

The onset of driving-related fears is attributed to different variables. Most frequently, panic attacks are cited as the onset of driving fears (Taylor et al., 2000). Other circumstances correspond to traumatic experience (accidents, dangerous traffic situations, being assaulted while driving), seeing someone else experiencing a traumatic event when driving, being a generally anxious individual and being generally afraid of high speed (Munjack, 1984; Ehlers et al., 1994). Other psychological problems reported in road trauma include irritability, anger, insomnia, nightmares, and headaches (Blaszczynski, Gordon, Silove, Sloane, Hilman & Panasetis, 1998).

Interestingly, Taylor and Deane (2000) noticed that many non-motor vehicle accidents (MVA)-onset driving-fearful individuals have fears of similar severity as their MVA-onset driving-fearful counterparts. In their research, no significant differences were found between these groups on measures of physiological and cognitive symptoms, state anxiety, degree of interference in daily functioning, prior help from a mental health professional, and avoidance of obtaining a driver's license.

The most feared driving situation cited by driving phobics is MVA (Blanchard, Hickling, Taylor, Loos & Gerardi, 1994; Blanchard, Hickling, Taylor & Loos, 1995), but they also mention issues of control (losing control of the car, not being in control of the driving situation, being in control of a powerful vehicle), specific driving situations (driving at high speed, at night, in unfamiliar areas, over bridges, through tunnels, on steep roads, on open roads, merging, and changing lanes), and the skills required for driving (reaction time, judgment errors, weather conditions, road conditions) (Taylor & Deane, 2000; Taylor et al., 2000; Taylor et al., 2007b). Concerns about anxiety symptoms while driving may also be present (Wald & Taylor, 2003). Driving in the company of someone who criticizes one's driving was rated with the highest score of anxiety and avoidance in Taylor and Deane's study (2000), even though it was unclear whether the respondent rated a perceived or real criticism.

Cognitive errors are likely to increase feelings of vulnerability and maintain anxiety and fear reactions (Taylor et al.,

2007). It is suggested that cognitive errors of driving phobia may involve the tendency to overestimate the amount of fear that will be endured in a subjectively threatening situation (Rachman & Bichard, 1998). In addition, people with driving phobia underestimate their own skills and abilities and those of other drivers. As a result, they experience increased anticipatory anxiety before attempting to drive, as well as avoidance behavior (Koch & Taylor, 1995; Taylor & Deane, 2000). Avoidance behavior may range from an occasional reluctance to drive in particular situations (e.g. heavy traffic or bad weather) to a global avoidance of vehicular travel altogether. It can maintain phobia symptoms to the extent that it prevents exposure to the fear stimuli (Taylor et al., 2007).

Taylor et al. (2007b) used the Driving Cognitions Questionnaire (DCQ) to detect the most frequent cognitions of fearful participants while driving. The most rated items were reacting too slowly, being perceived as a bad driver, holding up traffic and making people angry. In the same study, social concerns were evident on the Fear Questionnaire (FQ). Taylor and Deane (2000) have already mentioned evidence of the influence of social factors in driving fear, emphasizing feelings of humiliation or embarrassment as a consequence of perceived negative performance evaluation by others.

Virtual Reality Exposure Therapy in the Treatment of Driving Phobia

According to the emotional processing theory, successful exposure therapy leads to new and more neutral memory structures that overrule the old anxiety-provoking ones (Foa & Kozak, 1986). If a virtual environment can elicit fear responses and activate the anxiety-provoking mechanism, it might be effective as an alternative technique to address exposure interventions. In this sense, Virtual Reality Exposure Therapy (VRET) can be a viable alternative to *in vivo* exposure therapy (Foa & Kozak, 1986).

Virtual reality exposure integrates real-time computer graphics, sounds and other sensory inputs to create a computer-generated world with which the individual can interact (Anderson, Jacobs & Rothbaum., 2004; Riva, 2002; Riva & Wiederhold, 2002; Rothbaum & Hodges, 1999; Wiederhold & Rizzo, 2005). A successful virtual experience provides users with a sense of presence, as though they were physically immersed in the virtual environment (Gregg & Tarrier, 2007; Krijn et al., 2004; Krijn, Emmelkamp, Olafsson & Biemond, 2004). This sensation is achieved by shutting out "real world" stimuli so that only computer-generated stimuli can be seen and heard. Some sensory virtual reality modalities also include tactile and olfactory sensory stimulation as elements of reality (Gregg & Tarrier, 2007; Krijn et al., 2004b). It has been observed that, for phobic subjects, an increase in the sense of presence consequently increases anxiety. On the other hand, it has also been noticed that increasing stress levels increase the sense of presence (Walshe, Lewis & Kim, 2004; Walshe, Lewis, O'Sullivan & Kim, 2005).

Little controlled treatment research on driving phobia has been found, although some case reports of accident and non-accident-related driving fear point out that desensiti-

zation can be an effective treatment, whereas other studies show that various combinations of *in vivo* and imaginary exposure were successful (Wald & Taylor, 2003; Taylor et al., 2007; Walshe et al., 2005). Results from recent studies using VRET suggest that this treatment might be appropriate for driving phobia (Wald & Taylor, 2000; Wald & Taylor, 2003).

VRET has some potential advantages over *in vivo* and imaginary exposure. According to Wald and Taylor (2000), individuals with intense driving fears may refuse to participate in *in vivo* exposure or drop out of treatment early. For these authors, *in vivo* exposure has a number of limitations and risks because exposure occurs on public roadways, whereas driving situations are often unpredictable, time limited, and difficult to control. The authors also assert that *in vivo* exposure raises special safety and ethical concerns because highly anxious patients may be at an increased risk of making driving errors and being involved in a MVA as a consequence of reduced attention and information processing capacities (Wald & Taylor, 2000). VRET, on the other hand, occurs in a clinician's office, so the consequences of driving errors or unsafe avoidance behaviors are minimized as well as the risk of a real motor vehicle accident. It also reduces potential embarrassment that can be associated with initial *in vivo* driving exposure. Other advantage is that feared driving situations are able to be controlled by the clinician, and adjusted, repeated, and prolonged according to the client's needs (Wald & Taylor, 2000).

Sometimes, in imaginary exposure, it is difficult for phobic subjects to imagine a feared stimulus, so it is harder to induce anxiety (Wald & Taylor, 2000). For most individuals, virtual reality stimuli are more concrete and realistic than imaginary exposure, reducing the possibility of avoidance behaviors. Thus, VRET is mentioned as an alternative treatment to be used before the *in vivo* exposure (Wald & Taylor, 2000).

Some limitations are presented in VRET. In some cases, similar difficulties as those experienced in imaginary exposure can arise in virtual environments. For some individuals, for example, it might not be sufficiently realistic, so it is more difficult to feel the sense of presence; as a result, the experience is not real enough to induce anxiety (Walshe et al., 2005). According to Wald and Taylor (2003), VRET has other limitations: it may not be cost-effective given the current cost of virtual reality technology, it is not widely accessible to therapists and clients, and sometimes it is not able to sufficiently target the client's idiosyncratic driving fears (Wald & Taylor, 2003).

Recently, the literature shows a considerable number of publications on various aspects of VRET, which has been applied to the treatment of anxiety disorders, especially phobias (Côté & Bouchard, 2005; Jang, Kim, Nam, Wiederhold, Wiederhold & Kim, 2002; Pull, 2005; Rothbaum & Hodges, 1999; Rothbaum, Hodges & Kooper, 1997; Rothbaum, Hodges & Smith, 1999; Wilhelm et al., 2005). The purpose of this article is to review, by means of a systematic methodology, the literature that supports the potential effectiveness of VRET in the treatment of driving phobia.

Method

A systematic on-line search was performed on the PubMed/Medline and Web of Science (ISI) databases. The keywords used in the search were: "virtual reality" and "fear of driving"; "virtual reality" and "driving phobia". We reviewed articles published between 1984 and 2007. Among the articles we selected those approaching virtual reality applied to driving phobia treatment and trials with VRET for anxiety disorders. Another search was made for the relevant references cited in these papers. We included papers in English, Portuguese, French, German and Spanish.

Results

Forty-seven articles were selected and reviewed, of which 34 dated from the last 10 years. Twenty-four studies citing VRET for the treatment of driving phobia were identified. Ten studies tested the sense of presence in the virtual environments or used virtual reality technologies for the treatment of this fear, with or without the development and validation of any instrument for driving fear evaluation. Ten literature reviews were included: two on VRET for driving phobia and eight on VRET for anxiety disorders. Unfortunately, there are few systematic studies published on the effectiveness of VRET in the treatment of driving phobia. In fact, only three papers represented systematic studies on VRET of driving phobia (one of them was a case study), and cause of that they were selected to be described here (see Table 1).

Jang et al. (2002) analyzed non-phobic participants' physiological reactions to driving and flying virtual environments. Eleven participants were exposed to each virtual environment for 15 min. Physiological measures consisted in heart rate, skin resistance, and skin temperature monitoring. After each exposure, participants were evaluated by means of the Presence & Realism Questionnaire (PRQ) and Simulator Sickness Questionnaire (SSQ). Results demonstrated that skin resistance and heart rate variability can be used to show arousal in participants exposed to virtual environments, and, therefore, can be used as objective measures in monitoring the reaction of non-phobic participants to these environments. The authors also concluded that heart rate variability could be useful for assessing emotional states.

One study by Wald and Taylor (2003) examined the efficacy of VRET for driving phobia with a multiple baseline across-subjects experimental design. This design included an intervention phase consisting of eight weekly treatment sessions and follow-up assessments. Seven adults with a specific phobia diagnosis were recruited from the community by means of media advertisements. Five participants completed the treatment with 1- and 3-month follow-up assessments. From those five participants, three showed a decrease in scores on many of the outcome measures (see Table 1), and hence, no longer met the criteria for driving phobia at post-treatment. Those three patients presented loss of treatment gains in the first and second follow-up assessments, and improvement in driving frequency in the last follow-up assessment. One patient showed marginal improvement and another one

Table 1. Studies on Virtual Reality Exposure Treatment (VRET) for the treatment of driving phobia.

Authors	Participants	Goals	Interventions	Number of sessions	Follow-up	Evaluation	Results
Jang et al. (2002).	11 non-phobics (0 F / 11 M)	To analyze non-phobic participants' physiological reactions to two virtual environments: driving and flying.	- VRET	1 session (15 min)	No follow-up	- Physiological response (heart rate, skin resistance and skin temperature) - Simulator Sickness Questionnaire (SSQ) - Presence & Realism Questionnaire – (PRQ) - Tellegen Absorption Scale (TAS) - Dissociative Experiences Scale (DES)	- Skin resistance and heart rate variability can be used to show arousal of participants exposed to the virtual environment experience
Wald and Taylor (2003).	5 with specific phobia diagnosis (5 F / 0 M)	To evaluate the efficacy of VRET for treating driving phobia.	- VRET	8 sessions	1-3-12-month	- Main Target Phobia and Global Phobia Items from the Fear Questionnaire - Driving Frequency - Clinical Structured Interview (SCID)	- Three patients showed improvement in driving anxiety and avoidance and at post-treatment no longer met criteria for driving phobia - One patient showed marginal improvement - One patient showed no treatment gain - Loss of treatment gains were detected at first and second follow-up assessments
Walshe et al. (2003).	11 with a specific phobia diagnosis that experienced immersion when exposed (9 F / 2 M)	To investigate the effectiveness of the combined use of computer generated environments involving driving games and a virtual reality driving environment in exposure therapy for the treatment of driving phobia following a motor vehicle accident program.	- VRET - Physiological feedback - Diaphragmatic breathing - Cognitive reappraisal	12 1-h sessions	No follow-up	- Physiological response (heart rate) - Subjective ratings of distress (SUDS) - Fear Of Driving Inventory (FDI) - Clinician Administered PTSD scale (CAPS) - Hamilton Depression Scale (HAM-D) Achievement of target behaviors	- Ten of 11 of the driving phobic subjects met the criteria for immersion/presence in the virtual driving environment. - Post-treatment reductions on all measures - Participants expanded their driving practice and started traveling by vehicle with less anxiety

showed no treatment gains. According to the authors, these results suggest that VRET is a promising treatment for driving phobia, although it may not be sufficient for some patients.

Walshe, Lewis, Kim, O'Sullivan and Wiederhold (2003) investigated the effectiveness of the combined use of computer generated environments involving driving games and a virtual reality driving environment as an exposure therapy for the treatment of driving phobia following a motor vehicle accident program. Seven subjects, who met the DSM-IV criteria for Simple Phobia/Accident Phobia, experienced immersion when exposed to a virtual driving environment and computer driving games, and they were selected to participate in a cognitive behavioral treatment. After treatment, significant reductions were found in measures of subjective distress, driving anxiety, post-traumatic stress disorder rating, heart rate rise, and depression ratings. The Fear of Driving Inventory (FDI) findings were consistent with clinical reports in which participants were expanding their driving practices and traveling by vehicle with less anxiety. According to the authors, for some phobic drivers, computer game reality induced a strong sense of presence sometimes to the point of inducing panic.

Only one case study using virtual reality applications for driving phobia has been reported. Wald and Taylor (2000) described a case of a patient who completed three sessions of VRET (one hour each). The peak of anxiety decreased within and across sessions. In the post-treatment assessment, her phobic symptoms had diminished and she no longer met the diagnostic criteria for driving phobia. Also, the clinical improvement was maintained at 1-, 3-, and 7-month follow-up. Evaluation was made by the Structured Clinical Interview (First, Spitzer, Gibbon & Williams., 1996), the Driving Anxiety Test (an *in vivo* behavioral measure), and a driving diary (minutes of driving per day). This case study reported substantial results. VRET was successful in reducing fear of driving. Ratings of anxiety and avoidance declined from pre-treatment to post-treatment. Phobia-related interference in daily functioning similarly decreased. However, more case studies are necessary to corroborate these findings.

Discussion

It was observed that the number of sessions of treatment and follow up, and the number of sessions spent on VRET interventions differed immensely among the described studies. Components of the treatment protocols also varied among studies. As a consequence, comparing research results was impossible.

Comorbidities were not mentioned in any study. Comorbidities are important confounding factors in the evaluation of treatment plans and their results. Besides, the studies did not specify the number of subjects on medication or that had previously attempted any treatment. The assessment of specific driving variables (e.g., number of accidents, years of driving) has been rarely reported in the literature, despite the obvious clinical relevance of this information for conducting a comprehensive assessment and planning appropriate intervention targets. For example, the treatment for someone whose driving fear developed subsequently to the onset of

panic disorder and agoraphobia is likely to be different from the treatment for someone who has always had a specific phobia of driving. Relevant variables of interest here may relate to the individual's history as a driver, such as circumstances surrounding learning to drive, obtaining a driver's license, and accident history. The individual's experience in these and other areas creates a complex set of conditions that need to be considered in developing an intervention that is tailored to each client (Taylor et al., 2007).

Although the data are promising, they suggest that VRET alone may not be sufficient in the treatment of driving phobia for some individuals. VRET may be used as a first step in the treatment for reducing driving fear to a degree appropriate for a subsequent *in vivo* exposure therapy.

Fear or anxiety symptoms can be assessed by objective measures: heart rate, peripheral skin temperature, skin resistance (Jang et al., 2002), body posture, respiration rate, brain wave activity (Krijn et al., 2004b; Wiederhold & Wiederhold, 1999), or subjective measures, usually the Subjective Units of Discomfort Scale (SUDS) (Krijn et al., 2004b; Wiederhold & Wiederhold, 1999). Generally, VRET researchers administer a wide range of questionnaires to evaluate the sense of presence (Jang et al., 2002) or driving cognitions (Ehlers et al., 2007). Both forms of evaluation were found in these studies, not necessarily administered together.

Roth (2005) demonstrated that the anxiety of patients with situational phobias is accompanied by autonomic, respiratory, and hormonal changes in the feared *in vivo* situation. According to Roth (2005) and Alpers, Wilhelm and Roth (2005), phobics differed from controls both in terms of physiologically and self-report measures before, during, and after *in vivo* exposure. The physiological scores were highly congruent with self-report measures of anxiety and decreased over sessions in phobics, what is in accordance with the expected therapeutic effects of repeated exposure, although the exposures were too few to result in complete remission. These authors showed substantial respiratory disturbances along with the expected elevations in heart rate and in the frequency of non-specific skin conductance fluctuations (a variable controlled by the sympathetic system). In addition, a measure of respiratory variability was higher, with hyperventilation. In the study of Alpers et al., salivary cortisol before and after driving was greater than that of control levels, particularly in the first exposure session. Also, multiple physiological measures of phobic participants and controls contributed with no redundant information, thus making it possible an accurate classification of 95% of phobic and control participants.

The data mentioned above illustrate the importance of physiological monitoring. However, none of the studies used multiple physiological measures with phobics. Respiratory variation or salivary cortisol level were not considered in the analysis of the efficacy of VRET in Jang et al. (2002), nevertheless they are effective physiological measures to assess anxiety and sense of presence in standard exposure. No electroencephalographic or neuroimaging data were found in fear of driving VRET studies.

Final Considerations

Driving phobia is a serious personal and social problem with several consequences, including career repercussions, social embarrassment and restrictions. In the treatment of this disorder, there are some evidences of the advantages of VRET before applying *in vivo* exposure therapy because it can function as an alternative way to induce exposure. This idea is supported by some studies in which physiological measures were used to assess the effectiveness of the sense of presence (Alpers et al., 2005; Jang et al., 2002; Walshe et al., 2003). In those studies, the post-treatment showed reductions in such measures, thus suggesting that VRET has a direct effect of habituation.

Virtual reality offers many possibilities for psychology, including assessment, treatment, and research. In the clinical psychology field, virtual reality is a safe, inexpensive, accepted, and probably soon a widespread tool used in exposure treatments of phobic disorders. However, more randomized clinical trials, in which VRET could be compared to standard exposure, with more objective measures, are required. We suggest that further studies should be made, using effective physiological measures and *in vivo* exposure to evaluate the efficacy of the VRET and the sense of presence.

References

- Alpers, G. W., Wilhelm, F. H., & Roth, W. T. (2005). Psychophysiological assessment during exposure in driving phobic patients. *Journal of Abnormal Psychology, 114*, 126-139.
- American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Association.
- Anderson, P., Jacobs, C., & Rothbaum, B. O. (2004). Computer-supported cognitive behavioral treatment of anxiety disorders. *Journal of Clinical Psychology, 60*, 253-267.
- Antony, M. M., Brown, T. A., & Barlow, D. H. (1997). Heterogeneity among specific phobia types in DSM-IV. *Behaviour Research and Therapy, 35*, 1089-1100.
- Antony, M. M., Craske, M. G., & Barlow, D.H. (1995). *Mastery of your specific phobia*. San Antonio, TX: The Psychological Corporation.
- Blanchard, E. B., & Hickling, E. J. (1997). *After the crash: Assessment and treatment of motor vehicle accident survivors*. Washington, DC: American Psychological Association.
- Blanchard, E. B., Hickling, E. J., Taylor, A. E., & Loos, W. (1995). Psychiatric morbidity associated with motor vehicle accidents. *Journal of Nervous and Mental Disease, 183*, 495-504.
- Blanchard, E. B., Hickling, E. J., Taylor, A. E., Loos, W., & Gerardi, R. J. (1994). Psychological morbidity associated with motor vehicle accidents. *Behaviour Research and Therapy, 32*, 283-290.
- Blaszczynski, A., Gordon, K., Silove, D., Sloane, D., Hilman, K., & Panasetis, P. (1998). Psychiatric morbidity following motor vehicle accidents: A review of methodological issues. *Comprehensive Psychiatry, 39*, 111-121.
- Côté, S., & Bouchard, S. (2005). Documenting the efficacy of virtual reality exposure with psychophysiological and information processing measures. *Applied Psychophysiology and Biofeedback, 30*, 217-232.
- Ehlers, A., Hofmann, S. G., Herda, C. A., & Roth, W. T. (1994). Clinical characteristics of driving phobia. *Journal of Anxiety Disorders, 8*, 323-339.
- Ehlers, A., Taylor, J. E., Ehring, T., Hoffman, S. G., Deane, F. P., Roth, W. T., & Podd, J. V. (2007). The driving cognitions questionnaire: Development and preliminary psychometric properties. *Journal of Anxiety Disorders, 21*, 493-509.
- First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1996). *Structured clinical interview for Axis I DSM-IV disorders - Patient edition (Version 2.0)*. New York: Biometrics Research Department, New York State Psychiatric Institute.
- Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99*, 20-35.
- Gregg, L., & Tarrrier, N. (2007). Virtual reality in mental health: A review of the literature. *Social Psychiatry and Psychiatric Epidemiology, 42*, 343-54.
- Herda, C. A., Ehlers, A., & Roth, W. T. (1993). Diagnostic classification of driving phobia. *Anxiety Disorders Practice Journal, 1*, 9-16.
- Jang, D. P., Kim, I. Y., Nam, S. W., Wiederhold, B. K., Wiederhold, M. D., & Kim, S. I. (2002). Analysis of physiological response to two virtual environments: Driving and flying simulation. *Cyberpsychology and Behavior, 5*, 11-18.
- Koch, W. J., & Taylor, S. (1995). Assessment and treatment of motor vehicle accident victims. *Cognitive and Behavioral Practice, 2*, 327-342.
- Krijn, M., Emmelkamp, P. M. G., Biemond, R., de Ligny, C. W., Schuemie, M. J., & van der Mast, C. A. P. G. (2004a). Treatment of acrophobia in virtual reality: The role of immersion and presence. *Behaviour Research and Therapy, 42*, 229-239.
- Krijn, M., Emmelkamp, P. M. G., Olafsson, R. P., & Biemond, R. (2004b). Virtual reality exposure therapy of anxiety disorders: A review. *Clinical Psychology Review, 24*, 259-281.
- Ku, J. H., Jang, D. P., Lee, B. S., Lee, J. H., Kim, I. Y., & Kim, S. I. (2002). Development and validation of virtual driving simulator for the spinal injury patient. *Cyberpsychology and Behavior, 5*, 151-156.
- Lewis, E. J., & Walshe, D. G. (2005). Is video homework of benefit when patients don't respond to virtual reality therapy for driving phobia? *Cyberpsychology and Behavior, 8*, 342-342.
- Mayou, R., Tyndel, S., & Bryant, B. (1997). Long-term outcome of motor vehicle accident injury. *Psychosomatic Medicine, 59*, 578-584.
- Munjack, D. J., (1984). The onset of driving phobias. *Journal of Behavior Therapy and Experimental Psychiatry, 15*, 305-308.
- Pull, C. B. (2005). Current status of virtual reality exposure therapy in anxiety disorders: Editorial review. *Current Opinion in Psychiatry, 18*, 7-14.
- Rachman, S., & Bichard, S. (1998). The overprediction of fear. *Clinical Psychology Review, 8*, 303-312.
- Riva, G. (2002). Virtual reality for health care: The status of research. *Cyberpsychology and Behavior, 5*, 219-225.
- Riva, G., & Wiederhold, B. K. (2002). Guest editorial: Introduction to the special issue on virtual reality environments in behavioral sciences. *IEEE TITB, 6*, 193-197.
- Roth, W. T. (2005). Physiological markers for anxiety: Panic disorder and phobias. *International Journal of Psychophysiology, 58*, 190-198.

Rothbaum, B. O., & Hodges, L. F. (1999). The use of virtual reality exposure in the treatment of anxiety disorders. *Behavior Modification, 23*, 507-525.

Rothbaum, B. O., Hodges, L. F., & Kooper, R. (1997). Virtual reality exposure therapy. *Journal of Psychotherapy Practice and Research, 6*, 291-296.

Rothbaum, B. O., Hodges, L., & Smith, S. (1999). Virtual reality exposure therapy abbreviated treatment manual: Fear of flying application. *Cognitive and Behavioral Practice, 6*, 234-244.

Taylor, J. E., & Deane, F. P. (1999). Acquisition and severity of driving-related fears. *Behaviour Research and Therapy, 37*, 435-449.

Taylor, J. E., & Deane, F. P. (2000). Comparison and characteristics of motor vehicle accident (MVA) and non-MVA driving fears. *Journal of Anxiety Disorders, 3*, 287-298.

Taylor, J. E., Deane, F. P., & Podd, J. V. (2000). Determining the focus of driving fears. *Journal of Anxiety Disorders, 14*, 453-470.

Taylor, J., Deane, F. & Podd, J. (2002). Driving-related fear: A review. *Clinical Psychology Review, 22*, 631-645.

Taylor, J. E., Deane, F. P., & Podd, J. V. (2007a). Driving fear and driving skills: Comparison between fearful and control samples using standardized on-road assessment. *Behaviour Research and Therapy, 45*, 805-818.

Taylor, J. E., Deane, F. P., & Podd, J. (2007b). Diagnostic features, symptom severity, and help-seeking in a media-recruited sample of women with driving fear. *Journal of Psychopathology and Behavioral Assessment, 29*, 81-91.

Wald, J., & Taylor, S. (2000). Efficacy of virtual reality exposure therapy to treat driving phobia: A case report. *Journal of Behavior Therapy and Experimental Psychiatry, 31*, 249-257.

Wald, J., & Taylor, S. (2003). Preliminary research on the efficacy of virtual reality exposure therapy to treat driving phobia. *Cyberpsychology and Behavior, 6*, 459-465.

Walshe, D. G., Lewis, E. J., & Kim, S. I. (2004). Can MVA victims with driving phobia immerse in computer simulated driving environments? *Cyberpsychology and Behavior, 7*, 317-318.

Walshe, D. G., Lewis, E. J., Kim, S. I., O'Sullivan, K., & Wiederhold, B. K. (2003). Exploring the use of computer games and virtual reality exposure therapy for fear of driving following a motor vehicle accident. *CyberPsychology and Behavior, 6*, 329-334.

Walshe, D., Lewis, E., O'Sullivan, K., & Kim, S. I. (2005). Virtually driving: Are the driving environments "real enough" for exposure therapy with accident victims? An explorative study. *Cyberpsychology and Behavior, 8*, 532-537.

Wiederhold, B. K., & Rizzo, A. S. (2005). Virtual reality and applied psychophysiology. *Applied Psychophysiology and Biofeedback, 30*, 183-185.

Wiederhold, B. K., & Wiederhold, M. D. (1999). Clinical observations during virtual reality therapy for specific phobias. *Cyberpsychology and Behavior, 2*, 161-168.

Wilhelm, F. H., Pfaltz, M. C., Gross, J. J., Mauss, I. B., Kim, S. I., & Wiederhold, B. K. (2005). Mechanisms of virtual reality exposure therapy: The role of the behavioral activation and behavioral inhibition systems. *Applied Psychophysiology and Biofeedback, 30*, 271-284.

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