Parkinson Patients' Trust in Avatars: Implications for Human-Computer Interaction and Neuroscience

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Parkinson's disease (PD) is a common chronic and progressive neurodegenerative disease with a median incidence of 14 per 100,000 increasing to 160 per 100,000 in the age group over 65 (Hirtz et al., 2007). These patients suffer from motor symptoms like bradykinesia, resting tremor, rigidity, and impaired postural reflexes (Hughes et al., 1992) and also non-motor symptoms are common, even in early stages of the disease (Aarsland et al., 2009). Cognitive disturbances include the domains of attention, memory and decision-making (Brand et al., 2004). Furthermore, several behavioral disturbances have been reported for PD, such as disturbances related to theory-of-mind (e.g. Yu & Wu, 2013), face recognition (e.g. Dujardin et al., 2004), risk-taking and trust (Javor et al., 2013a).

Patients in general use the computer and the internet for private and disease specific information search and communication (Hartzband & Groopman, 2010). According to a Norwegian study nearly 80% of computer users with Parkinson's Disease report to have significant, severe or highly severe difficulties using a computer (Begnum, 2010). Interacting with computers can lead to a perception of complexity, uncertainty, and stress (e.g., Riedl, 2013), and therefore the question of how to design computer interfaces for patient populations is a major topic in Human-Computer Interaction (HCI) (Biswas & Robinson, 2008). While the effects of PD patients' motor symptoms on their interaction with computers is on the research agenda of HCI scholars (e.g. Keates & Trewin, 2005), behavioral symptoms have hardly been made the subject of discussion in the past.

Avatars are user-created digital representations symbolizing the user's presence in a virtual environment (Bailenson et al., 2005). Several studies have demonstrated that avatars are perceived as social agents, thereby having potential social influence on humans (e.g. Bailenson et al., 2005; Pertaub et al., 2001). Hence, humans interacting with avatars have an experience of being with another person (Bailenson et al., 2005). In line with this research one study showed that avatars are trusted to a similar extent as humans by healthy subjects (Riedl et al., 2014). For these reasons, avatars often occur in the online world to help overcome the above-mentioned perception of uncertainty by imitating face-to-face interaction (Donath, 2007).

There have been first studies to investigate how patients suffering from psychiatric diseases interact with avatars, e.g. in schizophrenia (Park et al., 2009; Castelnovo et al., 2012) and bipolar disorder (Kim et al., 2009), and psychiatry has already started to adopt these findings in order to advance basic and clinical research. However, how neurological patients in general, and PD patients in particular, interact with avatars has, to the best of our knowledge, not yet been studied. This is surprising considering the fact that PD patients frequently encounter avatars in virtual environments in their private lives, but also in diagnostic environments used to examine and evaluate PD patients (Arias et al., 2012), in assistive technologies (Cunningham et al., 2009), and in neurorehabilitation systems (Yu et al., 2011). Furthermore, in the light of the above mentioned deficiencies of PD patients in face-to-face social interaction one might speculate if and how these impairments influence human-avatar interaction. To derive our hypotheses, we argue from a neuroscientific perspective as follows:

(1) PD patients have lower trust in simulated face-to-face interactions compared to healthy controls (Javor et al., 2013a). Because trust is mainly related to activity in three brain regions, namely the limbic system, the basal ganglia and theory-of-mind-regions of the frontal cortex (Riedl & Javor, 2012), and all of these regions are affected by PD, there are several candidates that could be responsible for the trust deficit in face-to-face interaction.
(2) There is evidence that theory-of-mind regions are more active in the evaluation of the trustworthiness of human faces compared to avatars (Riedl et al., 2014). Furthermore, avatars, if compared to humans, elicit less activation in the limbic system (Moser et al., 2007).
(3) Based on consideration of the facts in (1) and (2) we hypothesize that PD patients have less or no trust deficit when interacting with avatars, because some of the brain regions that are affected by PD and which are important for trust regulation are less active in human interaction with avatars.

To test our hypothesis we designed an experiment, where participants played a one-shot trust game against 16 avatars and 16 real faces in the role of the trustor (i.e., investor). We recruited 20 PD patients and 20 healthy controls (matched for gender, age, income and education). While PD patients have lower trust in human faces compared to healthy controls, this study shows no significant difference between PD patients' and healthy controls' trust in avatars. Furthermore, PD patients show higher trust in avatars if compared to their trust in human faces.

A major implication of our study is that avatars could be used in information systems and human-computer interfaces used by PD patients in order to increase their trust. We see the following important application domains: (1) assistive and rehabilitation technologies, (2) specific public health messages for PD patients in social media, and (3) telemedicine. Our study has also implications for e-commerce and suggests that online shops frequently used by PD patients could increase trust by using avatar salespersons. However, Javor et al. (2013b) argued that marketing research involving patients or disabled persons should be strictly evaluated from an ethical point of view.

Human-avatar interaction elicits a brain response that differs from human-human interaction, especially in the amygdala and theory-of-mind regions (Moser et al., 2007; Riedl et al., 2014). Our data shows that there is no difference in trust behavior between PD patients' and healthy controls' interaction with avatars, while there is a trust deficit in PD patients' interaction with humans. This could lead to the hypothesis that the trust deficit of PD patients in face-to-face-interaction could be a consequence of impaired limbic (face recognition) and frontal (theory-of-mind) functions. We advocate for further research using functional brain imaging to gain insights into the pathophysiology of trust in PD patients' interaction with humans and avatars.

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