

Psychological responses to simulated displays of mismatched emotional expressions

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Abstract

Embodied agents are often designed with the ability to simulate human emotion. This paper investigates the psychological impact of simulated emotional expressions on computer users with a particular emphasis on how mismatched facial and audio expressions are perceived (e.g. a happy face with a concerned voice). In a within-subjects repeated measures experiment ($N = 68$), mismatched animations were perceived as more engaging, warm, concerned and happy when a happy or warm face was in the animation (as opposed to a neutral or concerned face) and when a happy or warm voice was in the animation (as opposed to a neutral or concerned voice). The results appear to follow cognitive dissonance theory as subjects attempted to make mismatched expressions consistent on both the visual and audio dimensions of animations, resulting in *confused* perceptions of the emotional expressions. Design implications for affective embodied agents are discussed and future research areas identified.

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1. Introduction

Embodied agents have generated a large amount of interest from research groups around the world over recent years. Initial work in this space tended to concentrate on the use of these agents to help with work-based tasks such as autonomously managing email or providing news items of interest to users (Maes, 1994). This research led to the development of agents such as Microsoft's infamous "Office Paperclip" which often frustrated and infuriated computer users by making irrelevant and unhelpful suggestions at inappropriate times. Many researchers have since moved away from developing embodied agents for such purposes and are now investigating their potential in other areas. In particular, recent research has concentrated on their use in situations where relationships are important in human-human interaction. For example, teaching (Burlison and Picard, 2004; Maldonado et al., 2005), exercise

and nutritional advisors (Bickmore and Picard, 2005; Creed, 2006; Mazzotta and De Rosis, 2006), and therapy (Grolleman et al., 2006). Embodied agents have also been used in computer games for a number of years and are now widely used in Massive Multiplayer Online Games (MMOGs) like *Second Life* (Second Life, 2007) and *There.com* (There.Com, 2007). Recent research has suggested that the social norms and rules we live by in the physical world also seem to apply to MMOGs and virtual worlds (Yee et al., 2006). Studies such as these highlight the social and emotional nature of these environments – despite them being virtual, we still have social interactions with others that appear to mirror those in the real world.

Emotional expression plays a vital role in human-human interactions - therefore, the persistence of social norms and rules in virtual worlds strongly suggests that emotion may also be of importance in human-computer interaction (HCI). Numerous studies have investigated the role of emotion in HCI – for example, a number of researchers have found that we can recognise and distinguish between simulated affective displays (i.e. emotion expressed by an

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embodied agent) with similar accuracy to that of human emotional expressions (e.g. Bartneck, 2001). Additionally, various recent studies have suggested that we respond to simulated displays of emotion in a similar way to human emotion and that it can enhance users' perceptions of an agent (e.g. Brave et al., 2005). However, very few studies have explicitly tested an emotionally expressive agent against an unemotional one, and as a result, we still have a limited understanding of how users actually perceive simulated emotions and what influence they have on user attitudes and behaviour.

One area that we understand very little about is the importance of consistency in simulated emotional expression. Two of the primary ways in which we express emotion are through our facial expressions (Ekman, 1972) and our voices (Murray and Arnott, 1993). However, it is unclear how important it is for these to be consistent when conveying emotion – both the psychological and HCI literature suggest that we favour consistency over inconsistency, but does this apply to emotional expressions made by embodied agents? For example, what do users perceive if they observe a happy face with a concerned voice? Do users base their perceptions of the emotion on one channel more than another? That is, does either the visual or audio channel dominate in perceptions of the emotional expression, or are they both essential? Additionally, what impact does mismatching emotional expressions have on users' perceptions of the expression? Inconsistencies in our lives can often irritate and annoy us – does the same apply in virtual spaces and interactions? With the increased growth and usage of embodied agents in virtual environments, it is essential that we develop a deeper understanding of the answers to these types of questions.

This paper will explore these issues in further detail – we start by discussing the importance of emotion in social interactions and highlight research which has examined the role of emotion in HCI. We then talk of the importance of consistency in our everyday lives and detail relevant research that has already investigated this space. Following this, we provide the results of an experiment we conducted that investigated our perceptions of mismatched emotional expressions with an embodied agent we have developed. A discussion of the results is then provided and followed by suggestions for important future studies.

2. Related work

2.1. Affective embodied agents

Emotions have been shown to influence a number of cognitive processes including attention (Evans, 2001), memory (Christianson and Loftus, 1991), judgement and decision making (Baron, 1987), learning (Goleman, 2004) and problem solving (Isen et al., 1987). Much of the work on emotion in HCI stems from Picard's (1997) seminal book on "Affective Computing" and there are now numer-

ous research groups around the world attempting to build emotionally intelligent systems. A wide variety of embodied agents that exhibit human-like emotion have been developed over recent years including Cosmo (Lester et al., 1997) and Herman the Bug (Lester et al., 1999), Gandalf (Thorisson, 1999), Steve (Rickel and Johnson, 1999), PPP Persona (Van Mulken et al., 1998), MACK (Cassell et al., 2002), REA (Bickmore and Cassell, 2001), Olga (Beskow and Mcglashan, 1997) and Laura (Bickmore, 2003). Such agents are used in a wide range of domains including educational applications (Maldonado et al., 2005; Johnson et al., 2000), military simulations (Marsella et al., 2004), behaviour change systems (De Rosi et al., 2004; Ruttkay et al., 2006), computer games (Isbister, 2006), presenting (Prendinger et al., 2004; Bos et al., 2006), as companions whilst browsing the web (Hook, 2004), and as information providers (Pelachaud et al., 2002).

Recent research has suggested that we respond to simulated emotion in a similar way to human emotion. For example, Brave et al. (2005) examined how users respond to both self-oriented and other-oriented empathic emotion. Results of this study found that subjects perceived embodied agents (i.e. static photographs of humans with speech bubbles containing textual content) that were empathetic toward them (whilst playing Poker) as more likeable, trustworthy, supportive and caring than agents which were not empathetic towards them. Similarly, Bickmore and Picard (2005) found that an embodied exercise advisor was perceived to be more likeable and caring when it made use of relational strategies that humans often use to build and maintain relationships (e.g. empathic and polite communication, talking about the relationship and humour). However, like many of the studies in this area, the exclusion and inclusion of emotional capabilities were not explicitly compared, so the influence of emotion has to be inferred from the reported results. Nevertheless, studies such as these are helping to develop an understanding of how emotionally expressive agents can influence our attitudes and behaviour, but it is still unclear how we respond to more ambiguous emotional expressions.

2.2. Perceptions of emotion from face and voice

Two of the primary ways in which we express emotion are through facial expressions (Ekman, 1972) and speech (Murray and Arnott, 1993). The majority of studies that have investigated our perceptions of emotional expressions tend to focus on either one of these, as opposed to the combination of both. Investigating our perceptions of emotional expressions through the combination of visual and audio channels gives rise to some important questions. For instance, does either channel dominate our perceptions of emotional expression? How does the channel through which an emotional expression is processed influence how it is perceived? Does combining visual and audio elements of emotional expressions result in enhanced recognition of the emotion?

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