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Chapter 14

THE INFLUENCE OF USER'S PERSONALITY AND GENDER ON THE PROCESSING OF VIRTUAL AGENTS' MULTIMODAL BEHAVIOR

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ABSTRACT

Embodied Conversational Agents (ECAs) are virtual characters appearing in computer interfaces and interacting with users via speech, gestures and facial expressions. They are expected to enhance naturalness and intuitiveness of human-computer interaction, especially in assistance or e-learning contexts. Previous studies of multimedia educational appliances have shown that the behavioral strategy of the virtual tutor agent can influence the efficiency of the lesson: for example, if the agent's speech and gesture are redundant, learning increases. Likewise, users' personality may also influence the interaction with the agent and the processing of the lesson. The present chapter reports on a study about the effects of users' personality (Introversion / Extraversion) on the processing of the agent's behavior: are extraverts and introverts influenced to the same extent by the agent's communication strategy? We first review psychology literature about the behavioral and cognitive correlates of Introversion / Extraversion, as well as previous studies using ECAs for investigating similar topics. Since theoretical predictions appear inconsistent, we built our own experiment: 81 users (38 extraverts and 43 introverts) attended short presentations performed by ECAs and had to recall the content of presentations and to evaluate the agents. Our results show a subtle interaction between personality and gender: all users but female introverts were influenced by the virtual tutor's behavioral strategy. We discuss this result in terms of the influence of personality on learning cognitive processes. We also discuss the usefulness of ECA platforms as a research tool for conducting Psychology experiments and enriching existing models of human behavior.

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INTRODUCTION

Embodied Conversational Agents (ECAs) are virtual characters interacting with computer users via speech, gestures and facial expressions. Such multimodal interfaces are expected to enhance naturalness and intuitiveness of human-computer interaction, especially in assistance or e-learning contexts. However, accurate experimental user tests are useful all along the design process in order to anticipate and validate the actual cognitive effects of ECA interfaces: for example, to design ECAs' behaviors, developers need to know how these behaviors will be perceived by users, if they will influence or interfere with the task at hand, and if perception and performance are likely to vary across users. Besides, ECA platforms are also a powerful research tool: because they make it possible to build controlled and repeatable interaction situations much more easily than in classical Psychology experiments, they can provide an original way of conducting social and cognitive researches. In this respect, the present chapter describes a study involving introvert and extravert users and highlighting some differences in their processing of learning material. This study addresses the issue of optimizing verbal and non-verbal communication channels in educational appliances in order to increase the efficiency of the lesson. In a previous study (Buisine & Martin, 2007), we used ECAs to explore the effects of different types of communication strategies in a virtual tutor's behavior: speech-gesture redundancy (iconic or deictic gestures (McNeill, 1992) duplicate pieces of information conveyed by speech), complementarity (distribution of information across speech and gestures) and a control condition in which gesture did not convey semantic information. We investigated the influence of these strategies on the cognitive and social processes of tutees listening to the lesson: the main results of this study showed that redundant speech-gesture cooperation from the agent increased memorization from the tutees and increased agent's likeability. These results correspond to the downward relations represented on Figure 1: different ECAs' strategies result in different memorization scores and different likeability scores. The interaction between cognitive and social processes, which is represented by an intersection on Figure 1, is hypothesized from theories emphasizing the highly social nature of teaching and learning and the fact that interactions with teachers, peers, and instructional materials influence the cognitive processes of learners (Kim & Baylor, 2006). The present research, represented by the question mark on Fig.1, aims to enrich this model by investigating whether tutees' personality influences the way the educational material is processed. Here, ECAs' behavior being an integral part of the educational material, we chose to test the effects of the Introversion / Extraversion personality trait because it is notably related to one's verbal and nonverbal behavior and likely to influence the perception of others' behavior. Next section reviews previous research about the behavioral and perceptive correlates of Introversion / Extraversion as well as previous ECA research about Introversion / Extraversion (modeling ECAs' personality and/or considering the personality of the user interacting with the ECA).

RELATED WORK

The Behavior of Introverts and Extraverts

According to Eysenck and Eysenck (1968), extraverts tend to enjoy human interactions and to be enthusiastic, talkative, assertive, and gregarious. The typical extravert prefers being

in movement and action, and tends to be aggressive. Conversely, introverts tend to be quiet, low-key, deliberate, and relatively non-engaged in social situations. They control their feelings closely, and rarely behave aggressively.

Personality theories predict that extraversion should involve a higher level of expressive nonverbal behaviors (Eysenck & Eysenck, 1968). It was actually shown in experimental situations that extraversion is likely to increase emotional expressiveness assessed either by self reports or by objective behavioral measures (Riggio & Riggio, 2002). Extraversion correlates with the quantity of nonverbal behaviors during a competition (Gilbert & Reynolds, 1984) but it is also expressed in normal everyday situations: for example, Bruchon (1970) showed that the angle formed by the raised arms, the length of a step, the amplitude of free leg movement, the area covered in writing, and the area covered by a drawing are positively correlated with psychic extraversion. In dyadic interactions, the level of extraversion may influence the occurrence of some specific behaviors such as visual attention and body position, which increase the quality of social interaction with others (Berry & Sherman-Hansen, 2000). Extraverts also speak more (Campbell & Rushton, 1978), more rapidly, more loudly, with higher pitch and more pitch variation than introverts (Smith *et al.*, 1975; Woodall & Burgoon, 1983; Pittam, 1994). However, although these examples of results seem to constitute a consistent corpus of evidence, La France et al. (2004) underline that a meta-analysis of the literature still casts doubt about a reliable nonverbal profile of extraversion.

Introversion / Extraversion and Decoding other's Behavior

The previous studies were related to behavioral expressiveness of extravert and introvert people. Regarding behavioral decoding, i.e. the influence of personality on the attention to and perception of others' behaviors, several theoretical approaches are competing. Personality theories predict that extraversion should correlate with social skills and with a better ability to decode nonverbal behavior. This ability may be due to extraverts' superior attentive / perceptual skills, to superior interpretive / attributional skills, or both (Akert & Panter, 1988). However, other models suggest that the ability to encode and the ability to decode nonverbal emotional messages are negatively related and involve separate motivational bases of spontaneous expressivity and social vigilance, respectively (Cunningham, 1977). Accordingly, extraversion should be more related to encoding ability than to decoding skills and extraverts should process other's behavior less attentively and less accurately.

Experimental data also show mixed results: when nonverbal decoding is tested as a primary task, most studies fail to find a correlation between extraversion and nonverbal decoding (Lieberman & Rosenthal, 2001). Likewise, when the primary task consists in judging strangers' personality, some results suggest that neither gender nor extraversion impact the accuracy of judgment (Lippa & Dietz, 2000). Yet we must consider that in everyday life, nonverbal decoding is rarely a primary task but rather a secondary task within a multitasking context: reproducing such a situation in the laboratory, Lieberman and Rosenthal (2001) showed that introverts actually exhibit a nonverbal decoding deficit relative to extraverts.

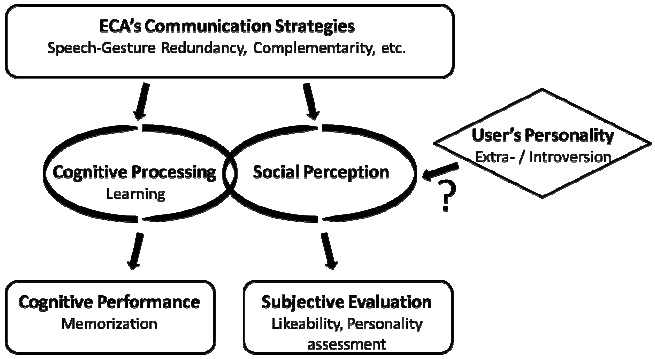

Figure 1. Our current model of the influence of ECAs' communication strategies.

Introversion / Extraversion and ECAs

Extraversion is frequently accounted for in the personality models implemented into ECAs. In this respect, the OCEAN (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) personality model (Wiggins, 1996) is one of the most popular (see e.g. André *et al.*, 1999a). Researchers simulate extraversion in ECAs by manipulating either their verbal (communication style, lexicon), paralinguistic (voice pitch, pitch range, volume, speech rate) or nonverbal (gestures, posture) behavior. For example Nass and Lee (2000) manipulated only the paralinguistic cues of a synthetic voice, keeping the content of speech constant in all conditions. They created extravert and introvert voices and submitted them to extravert and introvert users. This procedure showed that people preferred listening to a synthetic voice matching their personality, trusted it more and were more influenced by it (in selling context) than by a voice mismatching their own personality. Such a finding is consistent with the hypothesis that individuals are attracted to others similar to themselves and suggests that the same social phenomenon applies with humans and with ECAs (Reeves & Nass, 1996).

However, another hypothesis opposite to similarity-attraction also exists in the psychological literature, namely the complementarity principle: the latter holds that people will tend to behave in complementary ways in their interpersonal interactions and will seek out others who elicit complementary behavior from them (Nass *et al.*, 2000). Indeed, some other experimental results in the field of ECAs support the complementary principle and not similarity-attraction. Isbister and Nass (2000) created introvert and extravert static characters by manipulating both their verbal and nonverbal behaviors: extravert verbal behavior was specified with strong, friendly language and confident assertions, while introvert had weaker phrasing expressed by questions and suggestions. Extraverts showed poses with limbs spread wide from the body and postures closer to the user, whereas introverts had their limbs closer to the body and did not approach the user. It was then studied how introvert and extravert users perceive these agents, and users proved to prefer a complementary rather than a similar agent (they found more likable the ECA with a personality opposite to their own one). All the agents were also more likable, more fun and more useful when their verbal and nonverbal behaviors were consistent (extravert verbal behavior with extravert nonverbal behavior and introvert verbal behavior with introvert nonverbal behavior).

Some main effects of ECA's extraversion (irrespective of users' personality) were also observed. For example, Lee and Nass (2003) showed that a synthetic extravert voice (as defined by its paralinguistic features) induces a stronger sense of presence than an introvert voice, whatever the listener's personality (introvert or extravert). In an educative context, Darves and Oviatt (2004) showed that children engage more (ask significantly more questions related to the lesson) when the virtual tutor has an extravert voice (higher volume and pitch, wider pitch range). In this experiment children's personality was not collected. However, other studies failed to show any effect of ECA's personality on the performance to the target task: for example in a task involving a collaboration between a user (extravert or introvert) and a web tutorial (with an extravert or introvert verbal personality), the performance did not vary with any condition (Sayles & Novick, 2004).

Finally, ECA platforms can also enable researchers to investigate per se the social and/or cognitive effects of users' personality. For example an ECA experiment from Bickmore and Cassell (2001) suggested that extraverts and introverts use different interaction criteria to build social trust: in a real-estate negotiation, the use of small talks by the ECA affected extraverts' ratings of trust but not introverts'.

The series of experiments presented in this section suggest that people decode ECAs' behavior the same way as they decode human behavior (Isbister & Nass, 2000) and tend to validate ECA platforms as a research tool for Psychology experiments. Of course the results of ECA experiments must be taken with caution but they nonetheless enable researchers to build preliminary models and progress in understanding human behavior (in a similar way as other researchers use animal models to discuss models of human behavior).

Conclusion

The state of the art does not lead to clear predictions about our research question. Regarding decoding skills of introverts and extraverts, we may hypothesize following Lieberman and Rosenthal (2001) that introverts will decode ECAs' behavior less accurately, as in our experiment decoding will not be the primary task. Indeed the processing of ECAs' behavior will not be directly evaluated but will be involved in the achievement of a cognitive task (learn a lesson).

From the studies conducted with ECAs we cannot predict either how introverts and extraverts will subjectively evaluate ECAs' behavioral strategies. These strategies (redundancy, complementarity, control: detailed later in the paper) were not designed to evoke introversion or extraversion but could happen to be differently perceived by users of different personalities. Anyway we do not know whether the similarity-attraction or the complementarity principle will apply in such a case. Therefore our experiment remains mainly exploratory.

METHOD

Participants

The initial experiment (Buisine & Martin, 2007) involved 108 students (54 men and 54 women, 24.9 years old on average) from the University of Paris 5. They were all submitted to

the EPI - Eysenck Personality Inventory (Eysenck & Eysenck, 1968), which indicated their level of Introversion / Extraversion. This questionnaire also includes a Lying scale meant to detect subjects' attempts to falsify their answers. For the present study, we excluded the participants who obtained a score of 5 or more on the Lying scale, i.e. 27 users (12 women and 15 men). Hence, the study of personality influences was run with 81 users.

The new sample of users was divided into two sub-groups: the mean extraversion score in French students being 11.2 (Eysenck & Eysenck, 1971), introverts were defined as users with a score lower than 11.2 and extraverts as users with a score higher than 11.2. The personality variable finally appeared to be distributed as follows: 38 extraverts (18 women and 20 men) and 43 introverts (24 women and 19 men).

Material

We used 2D cartoon-like Limsi Embodied Agents (Abrilian *et al.*, 2002). As we needed to control the parameters of their behavior fully, the agents were not interactive for this experiment – in this respect they can be called Presentation Agents as defined by André et al. (1999b). Their behavior was manually specified using a low-level XML language. The three types of speech-gesture cooperation were generated as follows:

- Redundancy: the agent described or referred to every button / menu item both by speech and arm gesture (see Figure 1 upper left window). In speech, absolute localization of items (e.g. "on the top left side") was used whenever possible; otherwise the agent used relative localization (e.g. "just below, you will find..."). The agent also verbalized shape, color and size of items whenever it was a discriminating feature. Regarding hand and arm gestures, the agent displayed shape and size via iconic gestures (McNeill, 1992) with both hands when possible. A deictic gesture (McNeill, 1992) was used for every object. Finger or palm hand shape was selected according to the precision required (size of the item to be designated). When necessary, preceding a deictic gesture, the agent moved closer to the target item. S/he also glanced at target items for 0.4 seconds at the beginning of every deictic gesture. Non-semantic gestures (i.e. not related to any object of the lesson) were inserted in order to obtain natural-looking animation: beat gestures (which have a syntactic rather than a semantic function), self-centered gestures, etc. In total, redundant scenarios included 14 semantic gestures and 23 non-semantic arm gestures. Strokes of all gestures were placed manually during agents' speech.
- Complementarity: half of the semantic gestures from redundant scenarios (deictic gestures towards the image or iconic gestures) were selected to create complementary scenarios. The information they conveyed (identification of items, shape, or size) was removed from speech. Non-verbal behavior of agents was completed by non-semantic gestures. We thus ensured that information conveyed by gesture was not duplicated in speech and information conveyed by speech was not duplicated in gesture (see Figure 1 middle window). The agent moved closer to the target item when necessary and glanced at it for 0.4 second at the beginning of every

deictic gesture. Complementary scenarios included 7 semantic gestures and 30 non-semantic gestures.

- Control condition: the speech content was the same as in redundant scenarios (describing localization, shape, color, size of items), and non-semantic gestures were used throughout the presentation (see Figure 1 lower right window).

The rate of semantic gestures (deictic or iconic) among arm/hand movements was maximal in redundant scenarios (14/37), intermediate in complementary scenarios (7/37), and non-existent in control scenarios (0/37), but the total number of gestures was the same in the three conditions. Animation features that were common to all scenarios included lip movements, periodic eye blinks, and eyebrow movements manually inserted for the animation to be perceived as natural. We used IBM ViaVoice for speech synthesis with voice intonation set to neutral. The experiment was conducted in French.

To enable a within-user design, the three types of cooperation (redundancy, complementarity, control condition) were given to agents of varying appearance and applied to the presentation of different objects.: one female agent and two male agents, namely Lea, Marco and Jules. They appeared in front of a whiteboard and made short technical presentations associated with an image displayed on the whiteboard (Figure 1). The objects presented by the agents were a video-editing software program, a remote control for video-projector and a photocopier interface.

The same scripts were used for the three appearances in order to ensure independence between ECAs' behavior and their appearance.

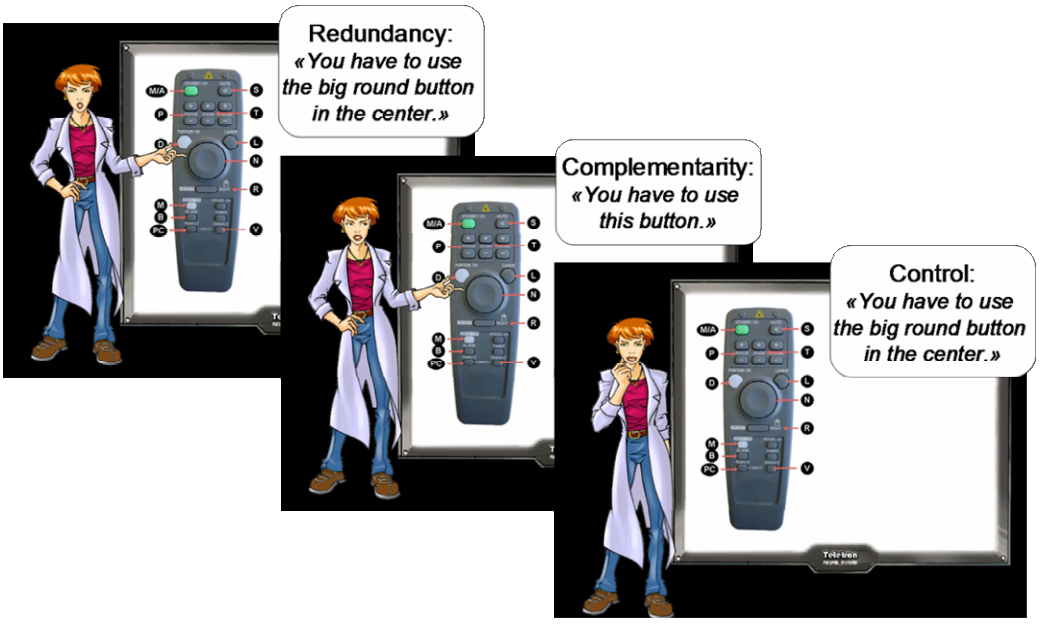

Figure 1. Each agent (the female agent Lea in this screenshot) was tested with the three types of speech-gesture cooperation: redundant (upper left window), complementary (middle window) and control (lower right window).

Design

Combinations between agents' appearance, speech-gesture cooperation and content of presentation were determined by means of a repeated-measurement Latin-square design (Myers, 1979): such a design enables the three variables to be investigated with less expenditure of time (each user saw 3 presentations, see Table 1) than complete factorial designs would involve (27 presentations). It also removes some sources of variance such as repetition effects. Individual differences (users' gender and personality) were randomly distributed across these combinations.

Table 1. The Latin-square design used for the experiment. Each user was allocated to a group (A to I) and followed the three experimental conditions of the corresponding row (in this order). The agent performing each condition is indicated in italics as column title (Lea, Marco, Jules); the speech-gesture cooperation and the object presented (in square brackets: RC for Remote Control, P for Photocopier, VS for Video Software) are indicated in each cell. Users' gender and personality were randomly distributed in all groups (A to I).

	Lea	*Marco*	*Jules*
A	Redundancy [RC]	Complementarity [VS]	Control [P]
B	Complementarity [P]	Control [RC]	Redundancy [VS]
C	Control [VS]	Redundancy [P]	Complementarity [RC]

	Marco	*Jules*	*Lea*
D	Redundancy [RC]	Complementarity [VS]	Control [P]
E	Complementarity [P]	Control [RC]	Redundancy [VS]
F	Control [VS]	Redundancy [P]	Complementarity [RC]

	Jules	*Lea*	*Marco*
G	Redundancy [RC]	Complementarity [VS]	Control [P]
H	Complementarity [P]	Control [RC]	Redundancy [VS]
I	Control [VS]	Redundancy [P]	Complementarity [RC]

Procedure and Data Collection

Users were instructed to watch three short multimedia presentations carefully and were informed that they would have to recall the content of the three presentations afterwards. The presentations were displayed on a 17'' computer screen, 1024*768 resolution, with loudspeakers for speech synthesis.

After the presentations, the data collection consisted of:

- Cued written recall: users were provided with the images used for the presentations and had to recall the lesson. The performance was expressed as a percentage of information recalled.

- A questionnaire in which users had to evaluate the likeability of agents and their expressiveness. In the questionnaire users had to rank the three agents according to these criteria. For the analyses the rankings were converted into scores (from 1 to 3; e.g. the first rank in likeability became a 3-point score in likeability). We also included in the questionnaire an open question about ECAs' personality in order to test whether speech-gesture cooperation influenced the perception of ECAs' personality. Words used to describe personality were then merely classified as positive (e.g. nice, competent, serious, open, enthusiastic, clever, cool, funny), negative (e.g. cold, inexpressive, strict, unconcerned) or neutral (e.g. standard, technical, discreet).

The numerical data (cued written recall, likeability of agents and expressiveness) were submitted to analysis of variance with user's Gender and Personality as the between-user factors and speech-gesture Cooperation as within-user factor. Fisher's LSD was used for post-hoc comparisons. The distribution of personality descriptors as a function of speech-gesture cooperation was studied using a Chi-square analysis. All the analyses were performed with SPSS software.

RESULTS

A significant main effect of speech-gesture Cooperation (on the whole user sample) appeared on the three dependent variables: recall ($F(2/154)=7.95$, $p=0.001$), likeability ratings ($F(2/154)=3.45$, $p=0.034$) and evaluation of expressiveness ($F(2/154)=4.72$, $p=0.01$): redundancy led to a better recall than the other strategies, and redundant agents were rated as more likeable and more expressive (Figure 2). The difference between complementarity and control condition was never significant.

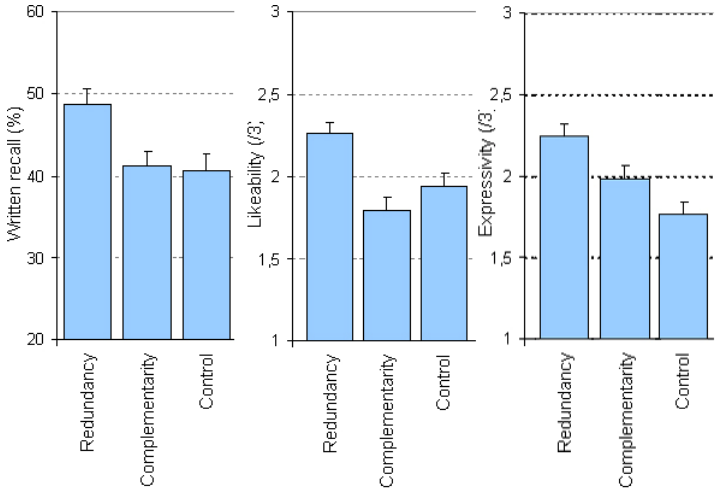

Figure 2. Percentage of information recalled (left panel), likeability scores of ECAs (middle panel) and expressivity scores of ECAs (right panel) as a function of ECAs' behavioral strategy (redundancy between speech and gestures, complementarity or control condition).

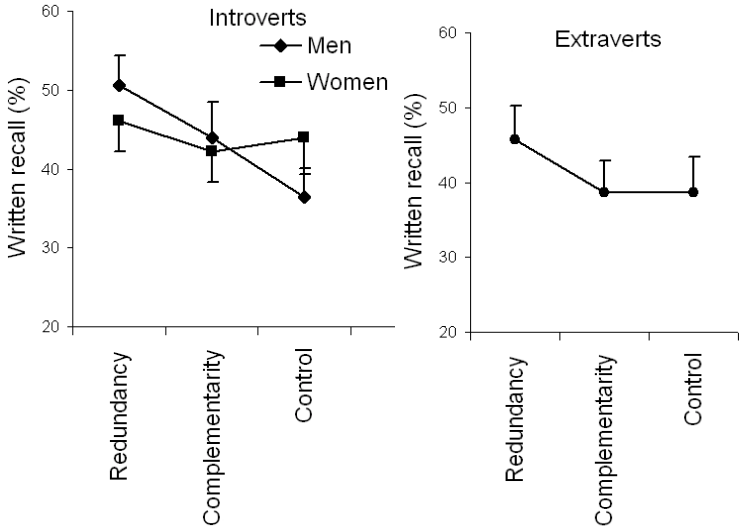

Figure 3. Percentage of information recalled as a function of ECAs' behavioral strategy (redundancy between speech and gestures, complementarity or control condition), by introvert users (left panel) and extravert users (right panel).

In introverts the interaction shows a Gender effect, the effect of ECAs' strategy being significant for men but not for women. The main effects of Gender and of Personality were not significant, but interaction effects between Personality, users' Gender and ECAs' multimodal Cooperation appeared on recall ($F(2/154)=3.12$, $p=0.047$) and on expressivity ($F(2/154)=3.19$, $p=0.044$).

The three-way interaction on the amount of information recalled can be described as follows:

- In introvert users there was an effect of gender ($F(2/82)=4.16$, $p=0.079$), as can be seen on Figure 3, left panel: the effect of ECAs' behavior was found in male introverts ($F(2/36)=13.46$, $p<0.001$) but not in female introverts ($F(2/46)=2.12$, NS).
- In extravert users there was no effect of gender ($F(2/72)=0.7$, NS): in this population the same effect of ECAs' behavior as in the whole sample was found (Figure 3 right panel).

The three-way interaction on the expressivity ratings showed the same pattern:

- In introvert users there was an effect of gender ($F(2/82)=2.48$, $p=0.09$), with the effect of ECAs' behavior found in male introverts ($F(2/36)=4.89$, $p=0.013$) but not in female introverts ($F(2/46)=1.38$, NS).
- In extravert users there was no effect of gender ($F(2/72)=0.96$, NS) and the global effect of ECAs' behavior was found.

There was no effect of Gender or Personality on likeability ratings.

Regarding users' perception of the agents' personality, 56.8% of descriptive words fell into the positive category, 30.9% into the negative category, and 8.6% into the neutral

category (3.7% of personality questions were not answered). Figure 4 presents the distribution of categories as a function of speech-gesture cooperation. Speech-gesture cooperation was proved to influence personality perception significantly ($\chi^2(6) = 9.3$; $p = .05$): Figure 4 shows that redundant agents were judged more positively than complementary and control agents. We compared the distribution of personality descriptors from introverts and extraverts and the analysis showed that there was no significant difference between the two personality subgroups ($\chi^2(8) = 12.1$; NS).

CONCLUSION

The analyses ran on the whole sample (merging introvert and extravert users) demonstrate the advantages of speech-gesture redundancy in the tutor's behavior: this strategy improved recall of the lesson as well as subjective evaluation from the tutees (likeability, expressiveness and personality of ECAs). Multimodal redundancy improved both the effectiveness of the system (higher performance from users) and the social perception of ECAs, since those with redundant behavior appeared more likeable and their personality more positive.

Regarding the effects of users' personality, we could summarize our results as follows: the benefits of redundancy were found on extraverts and male introverts, but female introverts were not influenced by ECAs' multimodal behavior. They performed as well irrespective of ECA's strategy. Even in interaction with users' gender, this result suggests an influence of introversion / extraversion on a cognitive task (processing of a lesson): such an effect is original in itself given the difficulties other authors experienced in relating extraversion to any cognitive component (Eysenck & Morley, 1994; Pytlik Zillig, 2001), reducing extraversion to only a behavioral and affective parameter.

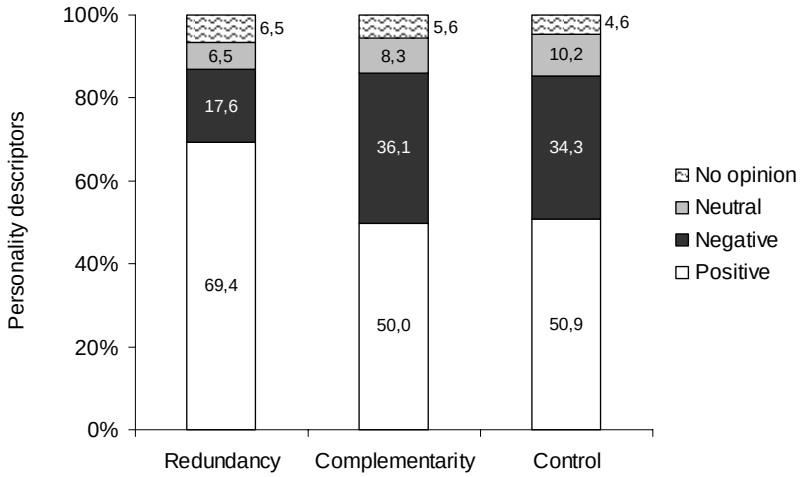

Figure 4. Percentage of positive, negative, neutral and missing personality descriptors as a function of ECAs' behavioral strategy (redundancy between speech and gestures, complementarity or control condition).

However, the lack of previous experimental results makes it difficult to interpret our data. Extraversion theories (Eysenck & Eysenck, 1968) suggest that because introverts are more inward-focused, they should perform better in vigilance tests and should persevere more in mental tasks. We could assume that our introvert users were more concentrated and did not need the help provided by multimodal redundancy. Indeed the semantic content of the lesson was the same in all strategies and redundancy was only a support for users' attention and information encoding. The differences between strategies could be compensated by an increased concentration. Therefore the first part of our hypothetical explanation is that introverts expended more internal cognitive strategies and were less influenced by external conditions (ECAs' behavior).

To explain the gender effect in the group of introverts, we could refer to gender differences in cognitive strategies, i.e. visual-spatial vs. auditory-verbal proneness for males and females respectively (Kimura, 1999). Internal strategies of male introverts being supposedly visual-spatial, it could explain why they went back to the vigilant processing of ECA's behavior. Conversely, female internal strategies are assumed to rely mainly on auditory-verbal cues.

To sum up, we formulate a two-step hypothesis to explain why female introverts were not affected by ECAs' behavioral strategy: their introversion level is assumed to have them deploy internal cognitive strategies and their femininity explains why these internal strategies did not focus on visual-spatial cues. This hypothesis remains mainly speculative and would obviously need further data to be substantiated.

Regarding users' subjective evaluation of ECAs, we observed a main effect of redundancy (on likeability ratings and on ECAs' personality assessment) and no interaction of users' personality on this result. We may conclude that none of the behavioral strategies we designed (redundancy, complementarity, control condition) evoked extraversion or introversion more than the others. Indeed, the number of gestures was kept constant in the three strategies. The only feature that could potentially be associated to introversion was that ECAs in the control condition did not move about from their standing place because they did not have to point to the image. Anyway introverts and extraverts evaluated ECAs the same way and neither similarity-attraction nor complementary principle applied here.

To conclude, we would like to emphasize that in the present experiment ECAs' behavior mainly consisted of multimodal spatial references to objects in the context of a learning activity and had limited or no emotional value. The results could have been very different with the processing of multimodal expression of emotions (Buisine *et al.*, 2006). In future work we could investigate this new issue: how do men and women, extraverts and introverts, perceive gestures that combine cognitive and emotional content?

REFERENCES

Abrilian, S., Buisine, S., Rendu, C. & Martin, J. C. (2002). Specifying cooperation between modalities in lifelike animated agents. PRICAI'2002 Workshop on Lifelike Animated Agents Tools, *Affective Functions, and Applications*, 3-8,

Akert, R. M. & Panter, A. T. (1988). Extraversion and the ability to decode nonverbal communication. *Personality and Individual Differences, 9*, 965-972.

André, E., Klesen, M., Gebhard, P., Allen, S. & Rist, T. (1999a). Integrating models of personality and emotions into lifelike characters. *i3 Workshop on Affect in Interactions "Towards a new Generation of Interfaces "*, 136-149,

André, E., Rist, T. & Müller, J. (1999b). Employing AI methods to control the behavior of animated interface agents. *Applied Artificial Intelligence*, *13*, 415-448.

Berry, D. S. & Sherman-Hansen, J. (2000). Personality, nonverbal behavior, and interaction quality in female dyads. *Personality and Social Psychology Bulletin*, *26*, 278-292.

Bickmore, T. & Cassell, J. (2001). Relational agents: A model and implementation of building user trust. CHI'01 *International Conference on Human Factors in Computong Systems*, 396-403, ACM Press.

Bruchon, M. (1970). Gestural amplitude and personality. *Bulletin de Psychologie*, *23*, 426-427.

Buisine, S., Abrilian, S., Niewiadomski, R., Martin, J.C., Devillers, L. & Pelachaud, C. (2006). Perception of blended emotions: From video corpus to expressive agent. *IVA'06 International Conference on Intelligent Virtual Agents*, 93-106, Lecture Notes in Computer Science, Springer.

Buisine, S. & Martin, J. C. (2007). The effects of speech-gesture cooperation in animated agents' behavior in multimedia presentations. *Interacting with Computers*, *19*, 484-493.

Campbell, A. & Rushton, J. P. (1978). Bodily communication and personality. *British Journal of Social and Clinical Psychology*, *17*, 31-36.

Cunningham, M. R. (1977). Personality and the structure of the nonverbal communication of emotion. *Journal of Personality*, *45*, 564-584.

Darves, C. & Oviatt, S. L. (2004). Talking to digital fish. In Z. Ruttkay, & C. Pelachaud (Eds.), *From brows to trust: Evaluating Embodied Conversational Agents*, 271-292: Kluwer Academic Publishers.

Eysenck, H. J. & Eysenck, S. B. G. (1968). *Manual for the Eysenck Personality Inventory*. San Diego, CA: Educational and Industrial Testing Service.

Eysenck, H. J. & Eysenck, S. B. G. (1971). *Manuel de l'Inventaire de Personnalité d'Eysenck*. Paris: Les Editions du Centre de Psychologie Appliquée.

Eysenck, M. W. & Morley, S. (1994). Neuroticism, extraversion, work locus of control, and work style. *Journal of the Indian Academy of Applied Psychology*, *20*, 111-115.

Gebhard, P. (2005). ALMA - A Layered Model of Affect. *AAMAS'05 International Conference on Autonomous Agents and Multiagent Systems*, 29-36,

Gilbert, D. G. & Reynolds, J. H. (1984). Type A personality: Correlations with personality variables and nonverbal emotional expressions during interpersonal competition. *Personality and Individual Differences*, *5*, 27-34.

Isbister, K. & Nass, C. (2000). Consistency of personality in interactive characters: Verbal cues, non-verbal cues, and user characteristics. *International Journal of Human-Computer Studies*, *53*, 251-267.

Kim, Y. & Baylor, A. L. (2006). A social-cognitive framework for pedagogical agents as learning companions. *Educational Technology Research & Development*, *54*, 569-590.

Kimura, D. (1999). *Sex and Cognition*. Cambridge: MIT Press.

La France, B. H., Heisel, A. D. & Beatty, M. J. (2004). Is there empirical evidence for a nonverbal profile of extraversion? A meta-analysis and critique of the literature. *Communication Monographs*, *71*, 28-48.

Lee, K. M. & Nass, C. (2003). Designing social presence of social actors in Human Computer Interaction. *CHI'03 International Conference on Human Factors in Computing Systems*, 289-296, ACM Press.

Lieberman, M. D. & Rosenthal, R. (2001). Why introverts can't always tell who likes them: Multitasking and nonverbal decoding. *Journal of Personality and Social Psychology*, *80*, 294-310.

Lippa, R. A. & Dietz, J. K. (2000). The relation of gender, personality, and intelligence to judges' accuracy in judging strangers' personality from brief video segments. *Journal of Nonverbal Behavior*, *24*, 25-43.

McNeill, D. (1992). *Hand and Mind*: University of Chigago Press.

Myers, J. L. (1979). *Fundamentals of Experimental Design -- 3rd Edition*. Boston: Allyn & Bacon, Inc.

Nass, C., Isbister, K. & Lee, E. J. (2000). Truth is beauty: Researching embodied conversational agents. In J. Cassell, J. Sullivan, S. Prevost, & E. Churchill (Eds.), *Embodied conversational agents*, 374-402. Cambridge: MIT Press.

Nass, C. & Lee, K. M. (2000). Does computer-generated speech manifest personality? An experimental test of similarity-attraction. CHI'2000 International Conference on Human Factors in Computing Systems, 329-336, ACM Press.

Pittam, J. (1994). *Voice in social interaction: An interdisciplinary approach*. Thousand Oaks: Sage.

Pytlik Zillig, L. M. (2001). Extraversion as a process: The effects of extraverted "states". *Dissertation Abstracts International: Section B Sciences and Engineering*, *62*, 591.

Reeves, B. & Nass, C. (1996). *The Media Equation. How people treat computers, television, and new media like real people and places*. New York: Cambridge University Press.

Riggio, H. R. & Riggio, R. E. (2002). Emotional expressiveness, extraversion, and neuroticism: A meta-analysis. *Journal of Nonverbal Behavior*, *26*, 195-218.

Sayles, K. & Novick, D. G. (2004). Assessing effectiveness of personality style in documentation. SIGDOC'04 International Conference on Design of Communication, 75-82, ACM Press.

Smith, B. L., Brown, B. L., Strong, W. J. & Rencher, A. C. (1975). Effects of speech rate on personality perceptions. *Language and Speech*, *18*, 145-152.

Wiggins, J. S. (1996). *The Five-Factor Model of Personality. Theoretical perspectives*: Guildford Press.

Woodall, W. G. & Burgoon, J. K. (1983). Talking fast and changing attitudes: A critique and clarification. *Journal of Nonverbal Behavior*, *8*, 126-142.