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The Effect of Embodying the Elderly on Time Perception

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Abstract

The present study investigated the perception of stimulus durations represented by elderly faces or by young faces. In a temporal bisection task, participants classified intermediate durations as more similar to a short or a long reference duration. The results showed that the durations represented by elderly faces were less often classified as “long” than the durations represented by young faces. According to internal clock models of time perception, this shortening effect is due to a slowing down of the speed of the internal clock during the perception of elderly faces. Analyses also revealed an interaction between sex of face and sex of participant such that this shortening effect occurred only when the participants share the same sex than the stimulus faces. As discussed, this finding is quite consistent with embodied cognition approaches to information processing, but alternatives accounts are also considered.

Keywords : Time perception, Embodiment, Elderly stereotype

When individuals judge the passage of time, their judgments can be biased in a number of ways. For example, the presentation of a face on a computer screen is perceived to last longer when the face expresses anger than when it expresses a neutral emotion (Droit-Volet, Brunot, & Niedenthal, 2004; Gil, Niedenthal, & Droit-Volet, in press). This extending effect has been interpreted in the theoretical framework of internal clock models (Gibbon, 1977; Gibbon, Church & Meck, 1984). Specifically, the perception of anger increases arousal and this in turn increases the number of pulses emitted by the internal clock. Given that the pulses compose the raw material for time perception, an increase in the number of pulses yields to an increase in the perceived duration of the angry face. Recently, Effron, Niedenthal, Gil, and Droit-Volet (2006) further demonstrated that for the perception of an emotional expression to influence temporal perception at all, imitation of the expression must occur. In their study, participants in whom imitation of the expressions was prevented were not influenced in their temporal judgment by the facial expressions of anger or happiness presented on a computer screen. Such an effect was interpreted in terms of embodiment theories of cognition. These theories hold that the encoding of incoming emotional information involves an internal simulation of the perceived entity (e.g., imitation of a facial expression), with all of its physiological implications, such as a matching of emotional state (e.g., Adolphs, 2002; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Thus participants in the study by Effron and colleagues who could imitate the facial expression, but not those who were prevented from imitating the expressions, experienced changes in arousal that affected their temporal perception.

Embodied cognition accounts are general models of information processing, and the simulation of "being there" with perceived entities is assumed to occur quite broadly and to include systems that underlie perception in all of the sense modalities, as well as the motor systems that support responding and introspective systems that support conscious experience (Barsalou, 1999, 2003; Barsalou & Wiemer-Hastings, 2005; Blakemore & Decety, 2001; Gallese, 2003). The present research was designed to test the prediction that durations represented by exemplars from the category of elderly people are perceived shorter than durations represented by exemplars from the category of young people. This effect should occur if perceivers produce internal simulations of the (slow) motor behavior of the elderly, as suggested in recent work by Bargh and colleagues for other types of behavior (e.g., Bargh, Chen, & Burrows, 1996), because one effect of such an embodiment is a decrease in arousal.

Embodying Temporal Perception

Temporal processing is assumed to rely on a central mechanism – usually referred as the *internal clock* – that produces pulses with a given rate thereby providing a temporal basis both for motor sequences (e.g., finger tapping, walking) and for temporal judgments (Ivry & Hazeltine, 1995; Keele, Pokorny, Corcos, & Ivry, 1985; Treisman, 1963). According to the internal-clock model of time processing (Gibbon, 1977; Gibbon, Church & Meck, 1984), the raw material for subjective time comes from the number of pulses emitted by a pacemaker and accumulated in a timer during the event to be judged. Subjective time thus depends on the number of pulses accumulated during the duration to be judged: The more pulses accumulated, the longer the duration is judged to be (for a review, see Meck, 2003). In studies of temporal perception, there is now ample evidence that subjective time varies as a function of the speeding up or the slowing down of the pacemaker in certain circumstances, when, for example the participants are under stress (Meck, 1983), receive arousal drugs such as methamphetamine (Drew, Fairhurst, Malapani, Horvitz & Balsam, 2003; Maricq, Roberts & Church, 1981; Rammsayer, 1997, 1999), or are exposed to rhythmical stimuli (Droit-Volet & Wearden, 2002; Penton-Voak, Edwards, Percival, & Wearden, 1996). As noted, the pacemaker is also accelerated during the perception of highly arousing emotional expressions (Angrelli, Cherubini, Pavese, Manfredini, 1997; Chambon, Gil, Niedenthal, & Droit-Volet, 2005; Droit-Volet et al., 2004).

When combined with predictions from embodied cognition models, temporal processing models predict that representing duration with exemplars of the category “elderly people” will bias judgments of duration. In particular, if perceivers reproduce the sensory-motor states of “being there” with elderly people, arousal should decrease (Jennings & van der Molen, 2002). This should slow the speed of the pacemaker, fewer pulses should accumulate, and time should appear shorter rather than longer.

Constraints on Embodiment

An embodiment account would also make another prediction. Studies of the imitation and internal simulation of others’ gestures and expressions have demonstrated that the behavior of all perceived individuals is not inevitably and automatically reproduced. For example, individuals are more likely to imitate behaviors of in-group members, suggesting that people tend to imitate the gestures of people with whom they are identified or wish to empathize (e.g., Elfenbein & Ambady, 2002; LaFrance & Ickes, 1981; Mondillon, Niedenthal, Gil, & Droit-Volet, in press; Zajonc, Adelmann, Murphy, & Niedenthal, 1987). The implication of these past demonstrations is that processes of identification and motivation to empathize impose limits on the extent to which the behaviors of other people are embodied (Decety & Jackson, 2004; Jackson & Decety, 2004). Futhermore, as noted by Blakemore and Decety (2001), the perception and simulation of human movement is influenced by a perceiver’s knowledge of and experience with his or her own movement constraints (Viviani, 2002). This reasoning suggests a refinement of the present prediction regarding the perception of duration represented by the elderly. Specifically, a same-sex effect could be expected to occur because the participants may not be sufficiently identified with the elderly of the opposite sex to internally simulate their motor behavior.

Present Experiment

In the present experiment we employed the temporal bisection task, a frequently used task developed to test the predictions of the clock-based models (e.g., Allan & Gibbon, 1991; Droit-Volet, Meck, & Penney, 2007; Wearden, 1991). In the bisection task, participants are presented with two standard durations, one short and one long, in an initial training phase. In a test phase, they are presented with comparison stimulus durations (i.e., intermediate duration values and standard values). The task is to classify each comparison duration as more similar to either the short or to the long standard duration. In the present version of the task the comparison stimulus durations in the test phase were represented by pictures of faces of elderly and younger males and females (expressing neutral emotion). If individuals simulate the motor behavior of the elderly when exposed to exemplars of the category, this should have the effect of slowing down the pacemaker rate and, subsequently lead them to less often classify the comparison duration as similar to the long standard duration than when exposed to young faces. This should largely be true for same-sex faces, with which the perceivers are likely to be more identified.

Method

Participants. Sixty-six first-year undergraduates (33 females) from Blaise Pascal University participated in the experiment.

Apparatus. The participants were tested individually in a quiet laboratory room. The procedure was controlled by a computer program supported by PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993), which presented the stimuli and recorded the participants' responses. Participants made their responses by pressing the "*d*" and "*k*" keys on the computer keyboard. The stimuli to be timed were presented in the center of the computer screen. Pink ovals were used to represent standard durations in the training phase, and photos of the faces of women or men, with a neutral facial expression, in the testing phase. The stimulus set consisted of 24 photographs of faces[1] (12 elderly and 12 young people) with women and men being equally represented in the two age categories. The faces had been selected from a larger set of 58 faces on the basis of a pretest. Eighteen additional undergraduates (9 female, 9 male) participated in the pretest and rated each face on perceived age and emotional expression (anger, sadness, and happiness). Faces perceived to express a marked emotional expression were not selected for use in the main experiment. The mean perceived age was 23.2 years (SD = 1.1) for the resulting young faces sample, and 72.3 years (SD = 5.1) for the elderly one. For the two samples, the mean perceived age of women and men faces sub-samples did not differ significantly (ps > .10).

The faces in the elderly sample were perceived as significantly more sad and more happy than the faces in the young one, $t(22)$ = 2.96 and 2.22, respectively, ps < .01. Because, as noted, the duration (from 400 to 1600 ms) of the presentation duration of faces with an emotional expression (angry, happy, and sad faces) are typically perceived longer than the presentation duration of neutral ones (Droit et al., 2004; Effron et al., 2006), the presence of slight emotional expression should serve to work against the current hypothesis.

Procedure. The standard durations used in the bisection task was 400 ms for the short standard and 1600 ms for the long standard, and the comparison durations 400, 600, 800, 1000, 1200, 1400 and 1600 ms. In the training phase, participants were shown the short and the long standard stimulus durations, presented in the form of a neutral stimulus (a pink oval). Each standard was presented five times in a random order. Next, they completed eight trials with the neutral stimulus in order to learn to press one key after the short and the other key after the long standard. The key-response match was counterbalanced across participants.

In the testing phase, the participants were presented with the young and elderly faces that now represented the seven comparison durations. Their task was to judge whether the duration of each presented face was closer to the short or to the long standard duration. There were six blocks of 28 trials, 14 for the faces of elderly people (7 women and 7 men) and 14 for the faces of young people (7 women and 7 men), 7 for the 7 comparison durations. There was thus a total of 168 trials. The face was randomly chosen on each trial from the panel of different faces. The trials were presented in a random order within each bock, and the inter-trial interval randomly chosen between 1 and 3 s.

Results

Figure 1 shows the mean proportion of "long" responses plotted against the comparison durations for the elderly and young women's faces as well as for the elderly and young men's faces in the two groups of participants, i.e., male (top panel) and female participants (bottom panel). Inspection of Figure 1 shows that the psychophysical functions for the elderly faces were shifted to the right compared to those for the young faces. Due to a lesser proportion of "long" responses, this rightward shift indicates that the presentation durations of elderly faces were perceived as shorter than those of young faces. However, as expected, the rightward shift of the psychophysical functions is mainly observed when the sex face and the sex participant are the same.

To explore the magnitude of the differences in temporal perception between the elderly and the young faces, the proportions of "long" responses for each participant were transformed to z-scores. Then, an index of difference (*d'*) was calculated by substracting the *z*-score for the young faces from the *z*-score for the elderly faces (Macmillan & Creelman, 1991). For the seven stimulus durations and two sexes (men's and women's faces) this yielded 14 *d'* scores for each participant. These *d'* values are positive if the temporal stimulus was judged to match the longer standard more often when elderly faces were seen compared to young faces. Positive *d'* values thus indicate that stimulus duration was perceived as longer when represented by elderly faces than by young faces. Conversely, *d'* values are negative if the temporal stimulus was judged to match the longer standard less often when elderly faces were seen compared to young faces. Negative *d'* values thus indicate that stimulus duration was perceived as shorter when represented by elderly faces than by young faces. Figure 2 shows the *d'* for each stimulus duration and sex of face for the male and female participants separately. Inspection of Figure 2 provides support for our prediction that the relative shortening of perceived durations represented by elderly faces would occur only for same-sex faces. For each sex of face, we averaged the *d'* scores across duration, and tested whether this average *d'* was greater than 0. This was the case when females compared the duration of women's faces to the standard durations ($M = -0.23$), $t(15) = -4.41$, $p < .01$, and when males compared the duration of men's faces, ($M = -0.28$), $t(17) = - 6.61$, $p < .01$, but not for opposite-sex judgments, i.e., when females judged men's faces ($M = 0.03$), $t(15) = 0.94$, $p = .36$, and when males judged women's faces ($M = -0.02$), $t(17) = -0.59$, $p = .57$.

In a second analysis, we conducted an overall analysis of variance (ANOVA) on the *d'* scores with one between-subjects factor (participant sex) and two within-subject factors (comparison duration, and sex of face). The ANOVA revealed a significant interaction between participant sex and face sex, $F(1, 32) = 59.47$, $p < .01$. Consistent with the findings reported above, relative to the young faces, the durations of elderly faces were perceived as shorter by females when duration was represented by women's faces $t(32) = 3.20$, $p < .01$, and inversely, by males when duration was represented by men's faces, $t(32) = 5.54$, $p < .01$. Furthermore, in each group of participants, the difference in temporal judgment of the faces of the different sexes reached significance both for the female participants, $t(15) = 4.80$, $p < .01$, and for the male participants, $t(17) = 6.29$, $p < .01$.

The ANOVA also revealed a significant effect of stimulus duration, $F(6, 192) = 3.24$, $p < .01$, as well as a three-way interaction between stimulus duration, sex of face and sex of participant, $F(6, 192) = 3.06$, $p < .01$. Analysis of the *d'* scores in each condition taken separately showed no effect of stimulus duration when opposite sex faces were compared to the standard durations. However, and consistent with the arousal hypothesis, the effect of stimulus duration reached significance both when females judged duration represented by women's faces, $F(6, 90) = 2.79$, $p < .05$, and when males judged duration represented by men's faces, $F(6, 102) = 5.14$, $p < .01$. The interpretation of the changes in perceived duration as due to changes in arousal is supported by this interaction because effects of arousal increase at longer durations (for a discussion, see Burle & Casini, 2001). These findings provide further evidence that a decrease in arousal is responsible for the biased temporal perception observed here.

Discussion

The present experiment showed that female participants classified stimulus durations as "long" less often when the durations were represented by an elderly woman's face than by a young woman's face. This effect was not observed when durations were represented by men's faces. In addition, male participants classified stimulus durations as "long" less often when the durations were represented by an elderly man's face than by a young man's face. This effect was not observed when durations were represented by women's faces. According to internal-clock models of time processing, and specifics of our pattern of results, this effect suggests a decrease in arousal when faces of same sex elderly people are perceived. The present interpretation holds social perception involves embodiment of the perceived persons (particularly when the perceiver is motivated to do so; e.g., Mondillon et al., in press). This embodiment reoccurs on perception of a member of the category. In the case of "elderly people," because elderly individuals tend to produce slower motor movements, one aspect of embodying the elderly is a decrease in arousal. A decrease in arousal is known to introduce a bias in temporal perception, and that is just the effect observed here. The bias itself could be seen as counter-intuitive because if elderly people are typically slow, one might expect that the duration of an image of an elderly face on a computer screen would be perceived by young adults as longer than it is. That is, the slowness of crossing the street or performing any motor behavior might be metaphorically transferred to (longer) duration.

The advantage of the present method is that it allows us to test an embodiment hypothesis in a task that is sensitive to automatic changes in arousal as a function of embodiment, but that is not likely to be influenced by conscious considerations or self-presentation concerns. In addition, since thoughts about the elderly are sometimes associated with feelings of sadness, or are considered as threatening reminders of our own inevitable mortality which, in turn, may induce feelings of intense anxiety (Martens, Goldenberg, & Greenberg, 2005), influences of the concept of the elderly on temporal perception could be mediated by changes in emotional state. Little is known about the effect of anxiety on the judgment of a stimulus duration, but other findings suggest that death anxiety does not impact on time perception (Joubert, 1983). Moreover, Droit-Volet and colleagues (2004) showed that the duration of sad faces was perceived as slightly longer than the duration of neutral faces. For these reasons, we believe that the present finding is not due to emotional processes. In fact, the obtained effect appeared strong enough to overcome the opposing influences of possible feelings of sadness.

An important consideration is the relationship between the present findings and other demonstrations held to be effects of the activation of the elderly stereotype on behavior. As cited in the introduction, related research has demonstrated that the presentation of elderly-stereotypic traits elderly causes individuals to automatically produce stereotype-consistent behavior (e.g., reduced motor speed). Bargh and colleagues (1996), for example, showed that university students primed with the elderly category walked more slowly when leaving the laboratory than non primed students. The interpretation of the behavioral effects of category activation on motor behavior developed by Bargh and his colleagues relies both on semantic network models of memory and on the principles of ideomotor action offered by James (1890). Thus, these automatic behavior effects have largely been interpreted as indicating that the priming task activated the stereotypical traits of the category (e.g., slow) which, in turn, activated behavioral representations associated with each trait (e.g., walking slowly) and thereby increased the tendency to perform these behaviors (see also Dijksterhuis & Bargh, 2001; Kawakami, Young, & Dovidio, 2002).

The embodied cognition account of the present findings can also be used to interpret these previous findings. The difference is not in the precise predictions so much as in the assumptions about the underlying process. Most semantic models assume that traits and stereotypes are represented by amodal symbols that are not linked to the perceptual (input) or motor (output) systems (Niedenthal et al., 2005). They further assume that these abstract symbols are the core of the traits and stereotypes, and that embodiment is a *consequence* of the activation of the core construct. In an embodiment account, the core knowledge or the content of the stereotype is the multimodal simulation itself. As the core knowledge, the simulation is what is activated upon presentation of word (e.g., stereotypic traits) or images (e.g., pictures of faces) that are used as primes to the stereotype knowledge. As Barsalou, Niedenthal, Barbey, and Ruppert (2003) have written, “Consider the trait of *slow movement* in the *elderly* stereotype. On the embodied view, *slow movement* is not represented by an amodal redescription which in turn implements associated movements in the motor system. Instead, knowledge of slow movement resides in simulations of seeing and executing slow movement [of elderly people]…” (p. 73).

In fact, it is unclear exactly how the traits contained in an amodal representation of the elderly would affect temporal perception upon its activation by the presentation of images of elderly people. As we suggested earlier, one possibility is that the stereotypic trait “slow” would function as a framework guiding that colors the interpretation of the stimulus to be estimated (Higgins, 1996). This influence on information processing during time estimation could result in a judgmental assimilation, time being judged as slower when represented by exemplars of the elderly category. Thus, the slow movement part of the elderly stereotype would be used to judge a duration as long just because the elderly are slow (i.e., take a long time). Yet we found a quite different pattern of results: an opposite effect when durations were represented by same-sex elderly faces and no effect in the case of opposite-sex elderly faces. We do not interpret this as a contrast effect. Contrast effects have been found to be elicited by extreme and well-known primed exemplars (e.g., Dijksterhuis, Spears, Postmes, Stapel, Koomen, van Knippenberg, & Scheepers, 1998), characteristics the exemplars used in the present experiment did not possess.

Another possibility is that there is a stereotypic belief that the elderly perceive time with a particular bias and that this bias is used in estimating durations that are represented by faces of the elderly. We are not aware that the elderly are held to perceive time in a particular way and research on the content of elderly stereotype does not mention any characteristic related to time perception (Hummert, Garstka, Shaner, & Strahm, 1994; Schmidt & Boland, 1986). Additionally, research on aging has shown that the elderly do not show biases relative to younger individuals in their performance on the bisection task, even if the elderly are more variable in their responses (McCormack, Brown, & Maylor, 1999; Wearden, Wearden, & Rabbitt, 1997).

Therefore, in our view, the observed effect of the elderly on temporal perception as well as the other demonstrations of the influence of words and pictures representing the elderly on motor behavior may all be demonstrations of a single underlying process. In each case, the incoming prime selects a specific embodied simulation that is used as the means of encoding the information. The embodied simulation has the effect of temporarily influencing cognition, such as temporal perception, and behavior such as walking. The embodiment account also has the advantage of developing the ability to predict limitations of embodiment in information processing. Both motivational and task concerns will predict whether incoming information is embodied or not (e.g., Mondillon, Niedenthal, Winkielman, & Vermeulen, 2006; Solomon & Barsalou, 2004). In the present case we expected and observed that younger women would be more likely to embody a same-sex older person than an opposite-sex older person for both reasons of increased motivation and identification with the former. We did not predict that we would also observe any change in the perceived duration of same-sex younger faces because those younger faces were the same age as the participants. Embodying the younger person would thus yield the same state as their resting state, not an increase in arousal. On the other hand, one might predict an increase in arousal and the attendant increase in the perceived duration if the stimulus faces of young individuals were those of children rather than young adults. This prediction would make sense if it were independently shown that children typically produce speedier behaviors than young adults.

This point raises a limitation of the present study, namely the absence of neutral stimuli providing baseline data against which elderly faces and young faces effects could be respectively compared. Such a condition would have been useful, but we still feel confident interpreting our results to mean that embodying the same-sex elderly individuals decreased arousal rather than that embodying all of the other types of individuals increased arousal. It would indeed be difficult to explain why elderly faces of opposite sex prompted the same level of arousal as young faces of both sexes. In future studies an associated direct measure of the arousal level would serve also to provide further evidence of the role of arousal in the obtained effects.

In conclusion, the present findings add to the growing body of evidence that knowledge is constituted by the reenactment of the bodily states that are activated in interaction with entities in the world. Knowledge so define can be predicted to have fascinating and unexpected effects on basic processes of perception, such as the perception of time, especially in the context of social interaction.

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Footnotes

1. Concerning the young faces, the stimuli set was a sample of the MacBrain Face Stimulus Set. Development of the MacBrain Face Stimulus Set was overseen by Nim Tottenham and supported by the John D. and Catherine T. MacArthur Fondation Research Network on Early Experience and Brain Development. Please contact Nim Tottenham at tott0006@tc.umn.edu for more information concerning the stimulus set. Concerning the elderly faces, we are indebted to Leslie Zebrowitz for providing with additional photographs.

Figure Captions

Figure 1. Proportion of long responses plotted against stimulus duration for the different types of face (elderly women, young women, elderly men, young men) and for female and male participants.

Figure 2. Values for *d'* as a function of the gender of face (WF: women's faces; MF: men's faces) and the gender of participant. Higher values reflect a greater tendency to match the stimulus to the long standard for older faces than for young faces.

Figure 1

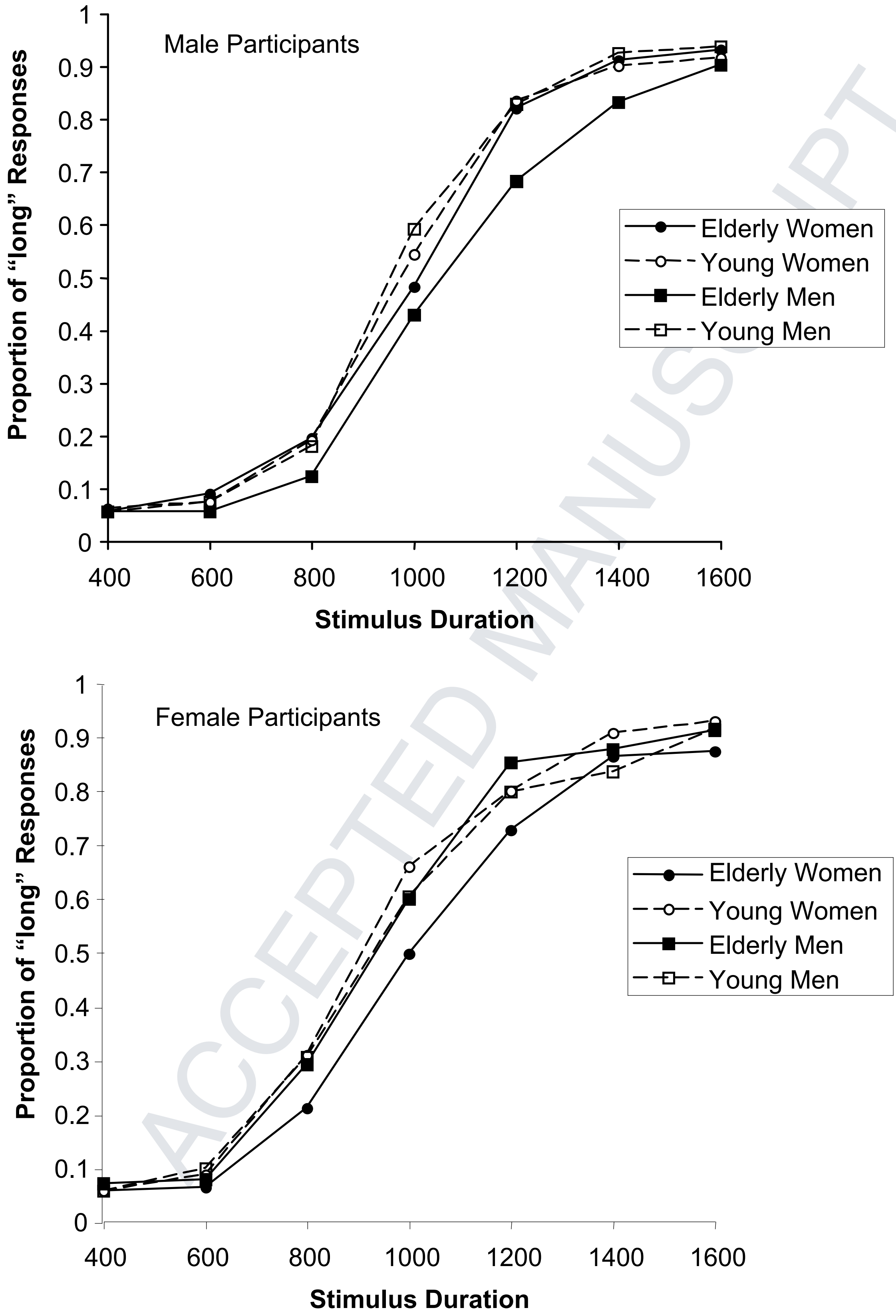
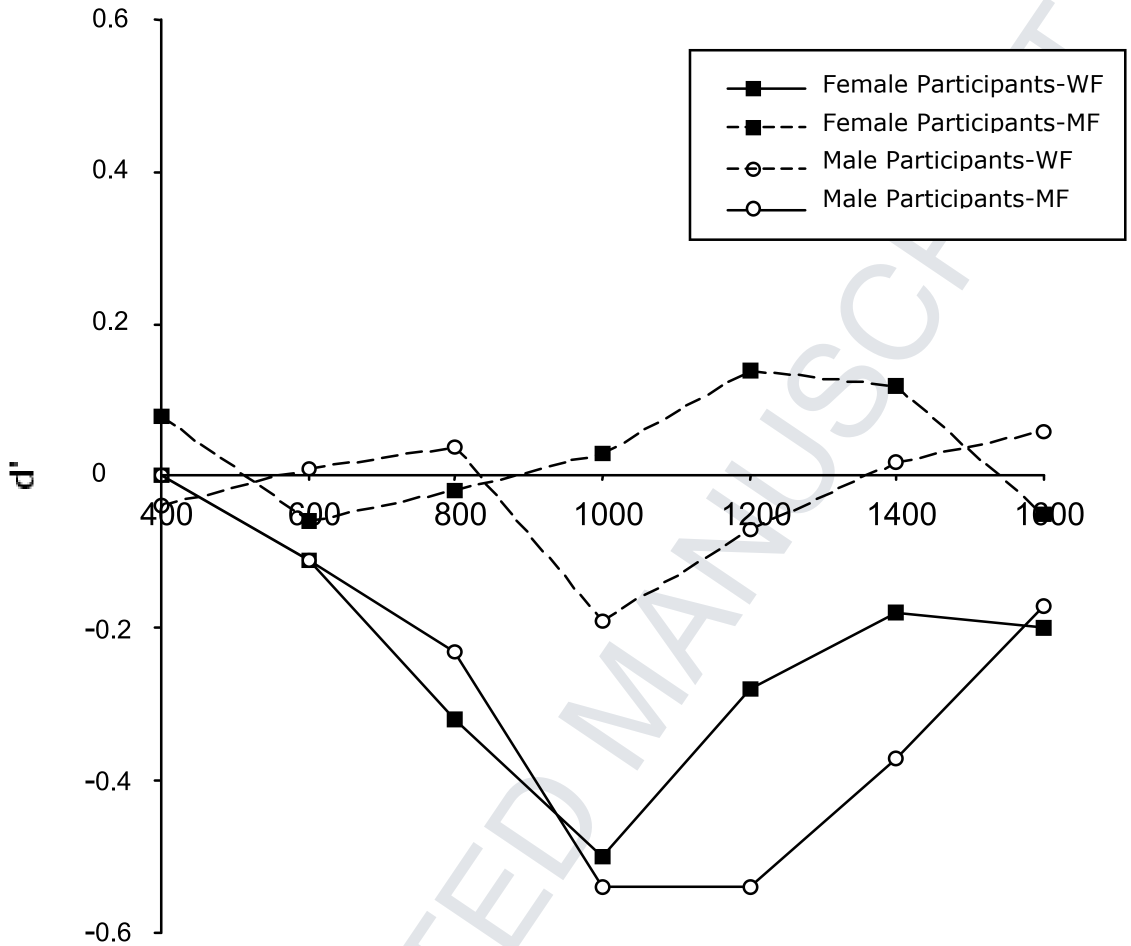

Male Participants
Proportion of "long" Responses
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
400
600
800
1000
1200
1400
1600
Stimulus Duration
Elderly Women
Young Women
Elderly Men
Young Men
Female Participants
Proportion of "long" Responses
Stimulus Duration
Elderly Women
Young Women
Elderly Men
Young Men

Figure 2


0.6
0.4
0.2
0
-0.2
-0.4
-0.6
d'
400
600
800
1000
1200
1400
1600
Female Participants-WF
Female Participants-MF
Male Participants-WF
Male Participants-MF