The effects of age of acquisition and semantic congruency on famous person category verification

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Abstract

The age of acquisition (AoA) effect, a processing advantage for items learnt earlier in life, affects naming and making familiarity decisions about famous people. However, its influence on semantic processing tasks involving celebrity stimuli is equivocal. In a category verification task designed to explore this issue further, mature adults were shown an area of fame, followed by a famous person's name. They were asked to indicate whether the area of fame and the celebrity matched. Stimulus congruency and AoA were manipulated orthogonally, with familiarity and facial distinctiveness being controlled. Faster and more accurate responses were produced when the area of fame and the celebrity matched. Faster and more accurate responses were made to early-acquired celebrities but the interaction fell short of significance but is consistent with that reported for lexical processing. With adequate control of extraneous variables and an extended distance between stimulus groups, AoA would seem to have an influence on the semantic processing of famous people and interacts near significance with congruency. The results are considered in the light of multiple loci theories of AoA.

Keywords: Age of acquisition; Semantic processing; Congruency effects; Name categorization

Introduction

People are faster and more accurate when processing words and objects that they have learnt earlier in life than those acquired later (e.g., Morrison & Ellis, 1995; Moore, Smith-Spark, & Valentine, 2004). This phenomenon, known as the age of acquisition (AoA) effect, has been reported across a range of different processing tasks (see e.g., Juhasz, 2005, for a review). Moreover, its influence has been shown to remain robust after controlling for other variables known to influence processing speed, most importantly word frequency (e.g., Cortese & Khanna, 2007; Peréz, 2007; Turner, Valentine, & Ellis, 1998). Whilst AoA effects on naming and familiarity decisions are also well documented in the people processing domain (e.g., Moore & Valentine, 1998, 1999), their influence on semantic processing tasks remains both underexplored and equivocal (e.g., Lewis, 1999a; Moore, 1998, 2003). Given this, the present paper sought to examine whether AoA effects could be obtained on a semantic processing task requiring responses to the names of famous people. Mature adults were presented with a category verification task in which they were required to indicate whether the name of a famous person was associated with a particular area of fame. Some interaction between AoA and semantic congruency has been suggested in the processing of words by Ghyselinck, Custers, and Brysbaert (2004). A natural consequence of the categorization task allowed congruency also to be explored to determine whether further (and stronger) evidence for this interaction would be found when processing famous names.

Age of acquisition effects have been found on a number of different types of semantic processing tasks in the lexical and object processing domains (e.g., Belke et al., 2005; Brysbaert, van Wijnendaele, & De Deyne, 2000; Ghyselinck et al., 2004; Johnston & Barry, 2005). These findings have been used to support a hypothesis that proposes that the effects of AoA originate, at least partly, from a semantic locus (e.g., Brysbaert et al., 2000).

The semantic hypothesis argues that the greater the level of involvement of semantic representations in task performance, the greater the effects of AoA are likely to be (e.g. Brysbaert et al., 2000). Other loci are not ruled out by this account, but the semantic processing system is posited to play a role in producing AoA effects. Brysbaert et al. argue that the order in which items are acquired plays a defining role in the way the semantic system is organized, with the meanings of later-acquired concepts depending on those of earlier-acquired items. The semantic hub network model of Steyvers and Tenenbaum (2005) is often cited in support of the semantic hypothesis (e.g., Ghyselinck et al., 2004). According to this model, it is the greater number of semantic connections to other nodes (or concepts) possessed by early-acquired items in their representational network that is responsible for AoA effects rather than the order in which nodes are acquired per se. Thus, semantic effects are argued to be superordinate to AoA effects under the semantic hub network account. The predictions of the Steyvers and Tenenbaum model should generalize from the

processing of words to the processing of famous people (see Smith-Spark, Moore, & Valentine, 2012, 2013). Moreover, the semantic hypothesis argues for AoA across different processing domains (e.g., Brysbaert et al., 2000).

There are several lines of evidence against the semantic hypothesis. Firstly, Izura and Ellis' (2004) investigation of second language (L2) learning indicated that AoA effects in L2 reflect the order in which words have been learnt in L2 rather than the age at which the corresponding words were learnt in the first language (L1). It is difficult for the semantic hypothesis to explain this result, as semantic representations should be shared between L1 and L2. Izura and Ellis argue that this finding indicates that AoA effects are not limited solely to the semantic level of representation. Secondly, Menenti and Burani (2007) compared participants' responses on a lexical decision to those on a semantic categorization task. In contrast to what would be predicted by the semantic hypothesis, the magnitude of the AoA effect was no greater on the semantic categorization task than on the lexical decision task. Thirdly, data from the processing of famous names argue against the pre-eminence of semantic connectedness over AoA proposed by Steyvers and Tenenbaum (2005). Smith-Spark et al. (2013) found a strong main effect of AoA in the absence of a main effect of a semantic variable (the amount of biographical information known about a celebrity) on a famous name familiarity decision task. However, there was a role for the semantic processing system in mediating the processing of late-acquired celebrities. Knowing more about a celebrity led to faster responses to late-acquired, but not early-acquired, stimuli. Moreover, Smith-Spark et al. (2012, 2013) have argued that AoA effects on semantic processing may become more salient on people processing tasks when the semantic processing system is involved to a greater extent.

Typically, the investigation of AoA effects in the people processing domain has used celebrities as stimuli. A similar processing advantage for early-acquired celebrities has been found when participants are asked to name the faces of celebrities (e.g., Moore & Valentine, 1998), read aloud their printed names (Moore & Valentine, 1999) and to make familiarity decisions about names or faces (e.g., Moore & Valentine, 1999; Smith-Spark, Moore, & Valentine, 2012, 2013). However, the contribution of the semantic processing system to the AoA effects reported in the people processing domain is less clear.

Lewis (1999a) proposed an instance-based model of AoA effects to account for the influence of AoA on recognition and naming tasks. This model explains the categorization speed of a stimulus as a function consisting of a negative power of the number of instances of a stimulus in memory (i.e. its frequency of encounter) and the time period over which the stimulus was encountered and a positive power of the time since last exposure to it (i.e., its recency). Lewis' demonstration of a cumulative frequency effect was based on a study in which the participants categorized faces as those of actors appearing in one of two very well-known British television soap operas. Whilst not explicitly tested within his model, Lewis argued that AoA was a significant predictor of RT on a semantic processing task.

However, Moore et al. (1999) identified a number of potential confounds that may have been present in Lewis' data (see Lewis, 1999b, for a response). Firstly, the measure of AoA was an estimate by the experimenter of the number of instances that should have been in the participants' memory (i.e., "familiarity", Moore & Valentine, 1998; or "frequency of encounter", Moore, 2003), and no subjective measures of AoA, familiarity, or facial distinctiveness were taken from the participants themselves. Such ratings have typically been taken when investigating both frequency (e.g., Valentine & Moore, 1995) and AoA effects in the processing of famous people (e.g., Moore & Valentine, 1998, 1999). In the lexical processing domain, it has been argued that obtaining subjective ratings from participants is superior to obtaining frequency measures from word corpora (e.g., Gernsbacher, 1984; although see Brysbaert & Cortese, 2011, for a dissenting view). There is no reason to assume that it should be different in the famous name processing domain and this has been argued elsewhere (e.g., Smith-Spark et al., 2012). The absence of subjective measures is compounded by a further assumption that actors were best known for their one soap-opera role. However, fame preceded the programme for some actors, whilst other celebrities had left the programmes to appear in contemporary top-rated British television series and plays. Furthermore, the stimuli represented close semantic associates, where response latencies could have been affected by semantic or associative priming (Bruce & Valentine, 1985). A raised level of semantic activation may have occurred due to the large number of celebrities derived from the same category (Sergent & Poncet, 1990). Reanalysis of the data by Moore (2003) suggested a more parsimonious interpretation of the results. Classification times were found to be significantly faster for pairs of soap actors who were from the same soap family than pairs who were not. Examination of the stimuli indicated that there were more familial pairs of early-acquired celebrities. As a result, a greater level of semantic priming may have occurred when responses were made to early-acquired famous people and may have led to Lewis' findings.

Moore (2003) did not obtain a processing advantage for early-acquired famous people on a number of semantic classification tasks, despite robust AoA effects being evident when the same celebrity stimuli were presented in naming and perceptual tasks (Moore & Valentine, 1998, 1999). Of Moore's experiments, six tasks revealed a non-significant processing advantage for early-acquired items and three revealed an advantage for late-acquired stimuli, of which only one difference was statistically significant (and even this was not replicated in a subsequent experiment). Moore suggested that the lack of an early-acquired advantage on these semantic tasks involving the faces or names of celebrities may have been due to only young adults aged 18 to 25 years being tested. In her 2003 studies, an early-acquired celebrity was rated as having been

acquired between six to 12 years of age and a late-acquired celebrity was rated as having been acquired after 18 years of age. The two stimulus groups were, thus, separated by a period of only six years. Moore argued that individual and familial interests will influence the extent to which children are exposed to certain celebrities (e.g., with, perhaps, a sporting, musical, or political bias). Such arbitrary influences would not present the same stimulus selection problem in object and lexical studies except with the most technical and domain-specific of stimuli. In other words, people's language experiences within the same culture are likely to be more similar than their interests and hobbies, which may diverge considerably and, therefore, lessen the chances of uncovering an AoA effect.

Given the concerns relating to both Lewis (1999a) and Moore (2003), it has yet to be demonstrated conclusively that AoA can influence semantic classifications on person processing tasks. Therefore, the current experiment was run in order to determine whether a semantic AoA effect on people processing could be found after removing the problems identified by Moore (2003; see also Lewis, 1999b). To this end, Moore's (2003) category verification task was used. Mature adult participants were requested to make Yes/No judgements as to whether there was a match between an area of fame (such as politics or film) and a subsequently presented celebrity (in the form of a photograph of his or her face). Equal numbers of congruent trials (in which the celebrity matched the preceding area of fame) and incongruent trials (in which the celebrity did not match the presented semantic category) were presented.

Two important alterations were made to Moore's experimental design. Firstly, a greater number of stimuli were used. Secondly, mature adults (aged 40+ years) were recruited as participants in order to permit a greater separation between early- and late-acquired items (resulting in a gap of 30 years rather than six years). Stimuli were selected based on ratings taken from a large group of mature adults who did not take part in the experiment (Smith-Spark et al., 2006).

A relationship between AoA and semantic congruency was expected on the basis of previous research. De Houwer (1998) found that faster responses were elicited when a participant's verbal response was congruent with the meaning of the stimulus and slower responses were produced when the response and the stimulus were incongruent. Ghyselinck et al. (2004) adapted De Houwer's task to investigate how AoA influenced semantic processing. Ghyselinck et al. matched stimuli for familiarity and manipulated AoA. Half their participants were instructed to say 'living' when presented with words in lower case and to say "non-living" to words presented in upper case. The remaining participants were asked to do the reverse. Half the words presented to participants belonged to living things and half to non-living. Ghyselinck et al. found significant effects of congruency (both by participants and by items) on RT and a significant effect of AoA by items. The magnitude of the congruency effect on early-acquired items was twice the size of that for late-acquired stimuli, but this congruency x AoA interaction fell short of statistical significance (p = .10). Ghyselinck et al. argued that this result suggested that the meanings of early-acquired words were activated faster than those of late-acquired words.

Consistent with previous research on people processing tasks (e.g., Moore & Valentine, 1998, 1999; Smith-Spark et al., 2012, 2013), it was predicted that an AoA effect would emerge after careful control of familiarity and facial distinctiveness. A congruency effect was also hypothesized, in accordance with previous findings of semantic congruency effects in different domains (words: e.g., De Houwer, 1998; faces: e.g., Barrett & Rugg, 1989). Faster RTs were expected on trials where there was a match between the area of fame and the subsequently presented celebrity. Whilst Ghyselinck et al.'s (2004) AoA x congruency interaction fell short of statistical significance, a similar pattern of results was expected with famous names.

Method

Participants

Twenty-four mature adults (14 female, 10 male; mean age = 68 years, SD = 9) received a small honorarium for participating. All 24 reported that they had been UK residents for their entire lives.

Materials

A PC running the E-Prime experiment generator software package (Psychology Software Tools, Inc., Sharpsburg, PA) was used to administer the experiment. Responses were made using a push-button response box.

Ninety-six famous face stimuli were selected from Smith-Spark et al.'s (2006) database of famous names. The stimuli were manipulated in such a way as to provide subgroups that were orthogonally different on measures of AoA but matched for familiarity and facial distinctiveness. Twenty-four stimuli were drawn from each of the four areas of fame (comedy, film, politics, and music).

Of these 96 stimuli, twenty-four early-acquired and 24 late-acquired celebrities were deployed in congruent trials, where there was a match between area of fame and the famous person. Another 48 celebrity stimuli were used in incongruent trials. There were, likewise, 24 early-acquired and 24 late-acquired famous names making up the incongruent trials. A one-way analysis of variance conducted on the a priori AoA ratings taken from Smith-Spark et al. (2006) database indicated a significant difference between early- and late-acquired celebrities ($F(3,92) = 117.04$, $p < .001$). Post hoc Bonferroni comparisons indicated that the significant differences in AoA were found between both early-acquired stimulus groupings and both incongruent stimulus groupings (all $p < .001$). No other differences were significant. The Smith-Spark et al. database was also used to match the stimulus groupings for the number of times their names had been generated (without recourse to reference works; indicating

the extent to which the celebrities were to the fore of participants' thoughts), the number of syllables in their names, their subjective familiarity, and their facial distinctiveness ($F \leq 1.30$, $p > .05$). Facial distinctiveness has been found to affect RTs even when names rather than faces are used as stimuli (Moore, 1998).

Design

Findings can be generalized over both participants (F1) and items (F2) by the use of multilevel modelling analysis (e.g., Brysbaert, 2007). Separate multilevel modelling analyses were performed on the reaction time (RT; ms) and accuracy (%) data with AoA (early-acquired vs. late-acquired) and stimulus congruency (congruent vs. incongruent) were entered as fixed factors, together with the AoA x stimulus congruency interaction. Participant number and stimulus number were entered into the analysis as random factors.

Text was presented in reverse video Courier New font. The famous names appeared in 12-point and the semantic categories in 24-point font.

Procedure

The participants gave their informed consent to take part in the experiment. They were told that on each trial they would be shown the name of one of four areas of fame (comedy, film, music, and politics), followed by the name of a famous person. The participants were asked to indicate as quickly and accurately as possible whether or not the famous name matched the preceding area of fame, by pressing the appropriate key on a response box (labelled 'Yes' for matching and 'No' for non-matching). At the start of each trial, an orienting asterisk appeared on the monitor screen for 700ms. The asterisk was replaced by a black screen and the presentation of a 2000 Hz tone (250ms in duration). One of the four areas of fame was then shown for 1500ms, followed by the famous name presented centrally on the screen. A Yes/No push-button response terminated the display and initiated the next trial. In order to familiarize participants with the task demands, a practice session of 15 trials preceded the experiment.

At the end of the task, the participants rated the congruent items[1] for familiarity, distinctiveness, and AoA as follows:

Familiarity: How often each celebrity had been encountered over time and across different media (from 1 = completely unknown through to 7 = very familiar).

Distinctiveness: How easy each famous person would be to spot on a crowded railway platform based on facial features alone (Valentine & Bruce, 1986). Ratings were made from 1, being a 'typical' face, hard to distinguish, to 7, being a highly distinctive face, easy to pick out in a crowd.

AoA: The participants rated when they first became aware of each celebrity on a 10-point scale (with a score of 1 indicating a famous person that the participant first became aware of before the age of five years, a score of 2 representing a celebrity first encountered before 10 years of age, a score of 3 reflecting a famous person acquired before age 15 years, and then rising in 10 year increments to 10, being a celebrity acquired before the age of 85).

Results

Responses more than 2.5 SD from the overall mean RT of each participant were removed from the data set prior to the analyses being performed. A total of 54 trials out of 2303 were removed (2.34%).

Following the data trimming, two stimuli were left out of the analysis, one due to low accuracy of response (Tom Jones = 58%) and one (Rod Stewart) due to participant ratings placing the stimulus in the late-acquired rather than the early-acquired grouping (mean AoA rating = 6.14).

All remaining items were responded to with accuracies in excess of 70% correct. The analyses which follow were based on this reduced data set.

Participant ratings

The participant ratings confirmed the validity of the a priori allocation of congruent stimuli to the early- and late-acquired groupings. The early-acquired congruent items were rated as having been acquired significantly earlier than the late-acquired congruent stimuli, $F(1, 45) = 131.59$, $MSE = .496$, $p < .001$, $\eta_p^2 = .745$. The congruent stimulus groups were well matched on ratings of familiarity, $F(1, 45) < 1$, $MSE = .364$, $p = .366$, and facial distinctiveness, $F(1, 45) < 1$, $MSE = .702$, $p = .913$.

Reaction time

Multilevel modelling analyses indicated that faster responses were made to early-acquired words (mean = 1561ms, $SD = 526$) than late-acquired words (mean = 1660ms, $SD = 540$). This effect of AoA on RT was found to be highly significant, $F(1, 2053) = 18.03$, $p < .001$.

Congruent stimuli (mean = 1528ms, $SD = 491$) were responded to more rapidly than incongruent stimuli (mean = 1697ms, $SD = 566$). The effect of congruency was also statistically highly significant, $F(1, 2053) = 52.64$, $p < .001$.

There was a trend towards a greater influence of congruency on early- than late-acquired stimuli (see Figure 1), but the AoA x stimulus congruency interaction fell short of statistical significance, $F(1, 2053) = 2.91$, $p = .088$.

Accuracy

Multilevel modelling analyses indicated that semantic categorization decisions were more accurate to the names of

[1] Participant ratings were not taken on the distractor items at the time of testing. The ratings were limited to congruent items in order to retain the goodwill of participants (who would otherwise have had to rate 96 stimuli on each of the three dimensions). Data collection was conducted some years ago, so it would not be possible to collect ratings even if the participants could be traced. However, given that the participant ratings for the congruent items showed strong positive correlations with the a priori ratings (familiarity, $r(48) = .761$, $p < .001$; distinctiveness, $r(48) = .838$, $p < .001$; AoA, $r(48) = .965$, $p < .001$), it is likely that a similar pattern would emerge with the incongruent items as they came from the same database.

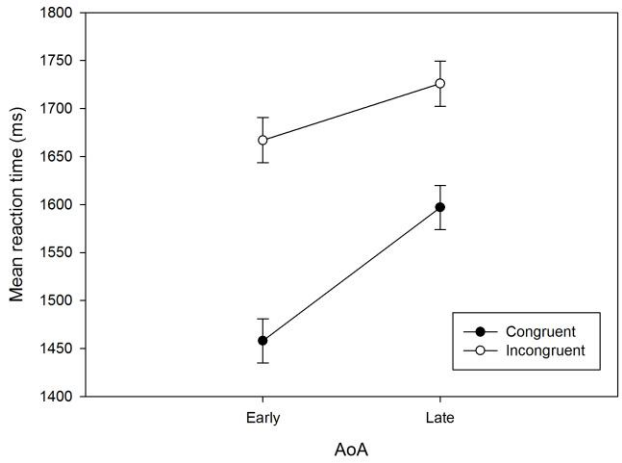

Figure 1: AoA x congruency interaction for RT.

early-acquired celebrities (mean = .93, *SD* =.25) than to the names of late-acquired famous people (mean = .89, *SD* =.31). The effect of AoA on accuracy was found to be very significant, $F(1, 2251) = 9.69$, $p = .002$.

Responses on congruent trials were also more accurate (mean = .93, *SD* = .26) than those on incongruent trials (mean = .89, *SD* = 0.31). Congruency also had a very significant influence on accuracy, $F(1, 2251) = 8.95$, $p = .003$.

There was no interaction between AoA and congruency, $F(1, 2251) < 1$, $p = .944$.

Discussion

In contrast to previous studies of semantic processing involving famous names (e.g., Moore, 2003), a significant effect of AoA was found, with the familiarity and distinctiveness of the stimuli being well-matched on both a priori and participant ratings. The participants were faster to semantically categorize early-acquired than late-acquired famous names. These findings are consistent with those of Lewis (1999a), who also found a significant effect of AoA on the semantic categorization of faces rather than names.

A congruency effect was also found in the current experiment. The participants were significantly faster and more accurate in responding to congruent items than they were when a mismatch occurred between the semantic category and the famous name. Age of acquisition and stimulus congruency were not found to interact significantly, although there was a trend towards faster responding to early-acquired than late-acquired congruent items. This is consistent with the pattern of data reported by Ghyselinck et al. (2004) on a lexical processing task. The findings thus extend their research on AoA and stimulus congruency from lexical processing to people processing.

It would appear that AoA confers a similar advantage on the semantic processing of the names of early-acquired famous people as it does on perceptual Yes-No familiarity decisions (e.g., Moore & Valentine, 1998). In previous studies (e.g., Moore, 2003), the range of AoA values over which stimuli could be selected was constrained by the relative youth of the participants. The use of a mature population in the present study allowed for a much wider separation between the early- and late-acquired AoA stimulus groupings. In combination with the selection of only the most familiar celebrities (based on scores from Smith-Spark et al., 2006, and validated by participant ratings) and a task drawing on greater levels of semantic processing (Smith-Spark et al., 2012, 2013), this has allowed semantic AoA effects on the processing of people's names to be captured. Regardless of whether a participant has a particular subjective interest in a given domain of fame or individual celebrity, it is hard to escape the mention of highly famous people in the media. Less stringent control in the matching of stimuli and the use of younger adult participants may thus explain the previous null results on tasks involving the semantic processing of famous names (Moore, 2003).

Stimulus congruency and AoA would seem to interact at around statistical significance across different processing domains. This finding adds further weight to Ghyselinck et al.'s argument that there is greater semantic activation for early-acquired stimuli. More generally, the results argue for multiple loci of AoA effects (in line with current AoA theories; e.g., Brysbaert et al., 2000; Ellis & Lambon Ralph, 2000; Moore & Valentine, 1999; Moore, 2003). These consider AoA to be a general property of learning which can be found across processing tasks and domains. The current findings extend the empirically reported effects of AoA on semantic processing from words and objects to people processing, suggesting that AoA influences semantic processing across a range of domains.

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