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Age of acquisition effects in vocabulary learning

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ABSTRACT

Two experiments examined whether the age of acquisition (AoA) of a concept influences the speed at which native English speakers are able to name pictures using a newly acquired second language (L2) vocabulary. In Experiment 1, participants were taught L2 words associated with pictures. In Experiment 2 a second group of participants were taught the same words associated with L1 translations. Following training both groups performed a picture naming task in which they were asked to name pictures using the newly acquired words. Significant AoA effects were observed only in Experiment 1, in that participants were faster at naming pictures representing early acquired relative to late acquired concepts. The results suggest that the AoA of a concept can exert influence over processing which is independent of the AoA of the word form. The results also indicate that different training methods may lead to qualitative differences in the nature of the links formed between words and concepts during the earliest stages of second language learning.

The age at which words are learned seems to have an enduring influence on how they are processed throughout life. Age of acquisition (AoA) effects have been observed in a variety of tasks including picture naming (e.g. Barry, Hirsh, Johnston, & Williams, 2001; Barry, Morrison, & Ellis, 1997; Carroll & White, 1973; Johnston & Barry, 2005), word naming (e.g. Brown & Watson, 1987; Gerhand & Barry, 1998; Havelka & Tomita, 2006; Morrison & Ellis, 1995; Morrison & Ellis, 2000) and lexical decision (e.g. Morrison & Ellis, 1995; Morrison & Ellis, 2000; Turner, Valentine, & Ellis, 1998). In all of these tasks early acquired words exhibit an advantage in that they tend to be processed faster than late acquired words. Furthermore, neuropsychological studies indicate that late acquired words are more susceptible to decay in aphasia and dementia (Cuentos, Aguado, Izura, & Ellis, 2002; Lambon Ralph, Graham, Ellis, & Hodges, 1998; Rodriguez-Ferreiro, Davies, Gonzalez-Nosti, Barbon, & Cuetos, 2009).

It seems therefore that AoA significantly determines the nature of the memory representation for a given item, with late acquired items never attaining equal status to those that are acquired earlier. Despite the large corpus of studies reporting AoA effects, at present it remains unclear as to exactly which aspects of lexical processing are affected by the AoA of an item. Over the years a number of different theories have been proposed locating AoA effects in either the phonological representations (e.g. Brown & Watson, 1987), the semantic representations (e.g. Brysbaert, Van Wijnendaele, & De Deyne, 2000), or in the mappings between different levels of representation (e.g. Ellis & Lambon Ralph, 2000). Part of the problem in distinguishing between these theories arises due to the difficulty in isolating lexical and conceptual contributions to the AoA effect. Words and concepts are so intimately bound that any task involving lexical processing will typically also involve automatic activation of conceptual information.

Some attempt has been made to isolate semantic contributions to the AoA effect using semantic categorisation tasks (e.g. Brysbaert et al., 2000; Johnston & Barry, 2005; Menenti & Burani, 2007; Morrison, Ellis, & Quinlan, 1992; Morrison & Gibbons, 2006) which do not require lexical access. However the results of these studies have not been consistent. For example, Morrison et al. (1992) found no AoA effects when participants were required to distinguish between pictures of natural and manmade items. Johnston and Barry (unpublished, cited in Johnston & Barry, 2005) also failed to find any AoA effects in a subsequent replication this study. In a later study Morrison and Gibbons (2006) found that AoA significantly predicted classification speed for living things, but not for nonliving things. In contrast, Johnston and Barry (2005) observed AoA effects when participants classified pictures of items (both living and nonliving) as "found inside or outside the house" (exp.1a) and "bigger or smaller than a loaf of bread" (exp.2a). Brysbaert et al. (2000) also observed significant AoA effects when participants classified words as "first names" or "words with definable meanings".

The emergence of AoA effects in semantic categorisation tasks seems therefore to be dependent upon the type of category judgement being made, although there is little agreement with respect to what constitute appropriate semantic categories for such tasks. Johnston and Barry argued that AoA effects might not observed when participants make a natural vs. manmade judgement because participants may be able to perform this task on the basis of visual characteristics alone (i.e. manmade objects tend

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to have more straight lines whereas natural objects are more curvaceous), thus reducing the need for participants to process items semantically. On the other hand Morrison and Gibbons (2006) commented that "first names" vs. "words with definable meanings" "may not constitute good semantic taxonomies" since there is no evidence in the neuropsychological literature that lexical abilities discriminate on this basis (Morrison & Gibbons, 2006, p951). A similar issue is present in the work by Johnston and Barry (2005), who comment themselves that the "found inside or outside the house" and "bigger or smaller than a loaf of bread" judgements do not correspond to categories that are thought to structure semantic memory (see also Bruce, Carson, Burton, & Ellis, 2000). The nature of the computations required to perform such decisions are therefore unclear.

An alternative approach was taken by Izura and Ellis (2002, 2004) who examined AoA effects in second language processing. In Izura and Ellis (2002) samples of late bilinguals (who had learned their second language after the age of 7) performed lexical decision tasks which incorporated words from both the participants' first (L1) and second (L2) languages. Since most models of bilingual memory assume that translation equivalents across languages both map onto the same conceptual representation (e.g. Kroll, & Stewart, 1994; Potter, So, Von Eckardt, & Feldman, 1984), Izura and Ellis (2002) reasoned that if AoA effects have a conceptual locus then lexical decision latencies in L2 should be linked to the order in which the L1 translations were acquired. In contrast however, it was observed that lexical decision latencies in L2 reflected the order in which the L2 words were acquired, and not that of the corresponding L1 translations.

Izura and Ellis argued that their results "rule out" some possible explanations about how and why AoA effects occur, concluding that AoA effects do not reside in the semantic representations. However, while the data reported by Izura and Ellis does indeed suggest that conceptual representations are unlikely to be the sole locus of AoA effects, it does not exclude the possibility that AoA effects operate at a conceptual level *in addition* to other levels of representation. It is possible that AoA effects in a second language are confounded by independent AoA effects operating at different levels of representation. If AoA effects have more than one locus, early conceptual influences may eventually be overridden by the order of acquisition of the L2 word forms. Furthermore, the lexical decision task used by Izura and Ellis does not necessarily *require* activation of conceptual information, and thus any conceptual influences on response latencies during this task are likely to be minimized.

The purpose of the present study was to isolate any potential AoA effects linked purely to conceptual representations by examining whether the AoA of a concept would influence the speed at which adults are able to name pictures when the AoA of the name is held constant.

1. Experiment 1

In Experiment 1, participants were taught new names associated with early or late acquired concepts, and subsequently performed a picture naming task using the new names that they had learned. Given that participants acquired all new names during a single learning session, any AoA effects observed during the picture naming task should reflect the AoA of the concept, independent of name.

1.1. Method

1.1.1. Participants

Thirty undergraduate students (10 male, 20 female) participated in this experiment in return for course credit. All were native English speakers with normal or corrected vision. Participant ages ranged from 18 to 39 years (mean age 20 years). As an incentive to motivate participants to learn as many new words as possible during the experiment, a £20 cash prize was available for the participant who recalled the most words in the final test.

1.1.2. Stimuli

The stimuli consisted of 30 pictures (all line drawings) selected from the International Picture Naming Project database (Szekely et al., 2004). Fifteen of these pictures represented concepts which are typically acquired at an early age (between 8 and 30 months), and fifteen represented late acquired concepts (not acquired in infancy >30 months). AoA ratings were also obtained from the International Picture Naming Project database, and are based on ratings from the MacArthur Communicative Development inventories (Fenson et al., 1994). The sets of early and late acquired pictures were matched for visual complexity, $t(28) = -0.124$, $p = 0.90$, and their corresponding English names were matched for frequency, $t(28) = -0.056$, $p = 0.96$, (frequency ratings obtained from CELEX Lexical Database, 1995) and length, $t(28) = -0.261$ $p = 0.80$.

Each picture was paired with a novel word form, some of which were selected from the ARC Nonword Database (Rastle, Harrington, & Coltheart, 2002). All novel word forms were orthographically and phonologically legal in English which meant that they could be easily pronounced by native English speakers. The new words assigned to pictures in the early and late acquired sets were matched for length (both in terms of number of letters, $t(28) = -0.130$, $p = 0.90$, and number of syllables, $t(28) = -0.287$, $p = 0.78$), and for initial phoneme. They were also matched on number of orthographic neighbours, $t(28) = -0.932$, $p = 0.36$).

1.1.3. Design and procedure

The experiment consisted of two parts; (1) a training session during which participants were required to learn the 30 new word–picture pairs, immediately followed by (2) a final test phase in which participants were required to name the 30 pictures using the new words. However, in order to facilitate learning, the training session also included a number of subtests. Data from the subtests and the final test phase were later analysed separately as "test 1" and "test 2" respectively. In both tests the independent variable was AoA (early vs. late acquired concepts) and the dependent measures were the naming latencies and error rates. Response times were measured from the time the picture appeared on the screen until the initiation of the oral response. Throughout the experiment stimuli were presented and responses recorded using DMDX display software (Forster & Forster, 2003). All participants were trained and tested individually in laboratory conditions.

On arrival participants were informed that they would be required to try and learn 30 new words which would be associated with pictures representing their meanings. Before the training session began participants viewed the 30 pictures along with their English names. Each picture appeared in the centre of the computer screen for 3 s with the English name presented above. This was the only time at which the English names were presented to participants during the experiment, and purpose was to avoid any potential ambiguity in relation to what the pictures were intended to represent.

1.1.4. Training and subtests (test 1)

In order to facilitate learning, the 30 picture–word pairs to be learned were split into five blocks of six for the training session. Three of the words appearing in each block represented early acquired concepts and three represented late acquired concepts. The order in which the five blocks were presented was counterbalanced between participants. During each block the six pictures were presented for 8 s each with the new word to be learned displayed directly above. As each picture–word pair was presented the participant was required to read the new word out loud and try to memorise it along with the picture representing its meaning. In the instance that the participant produced an incorrect pronunciation of the new word they would be corrected by the experimenter. Once the six picture–word pairs had been presented, the cycle was repeated twice more. The block was therefore presented a total three times, and each time the items would appear in a random order.