

# **Age-of-acquisition and cumulative frequency have independent effects.**

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**Abstract**

Lewis (1999) argued that the effects of age of acquisition (AoA) are entirely attributable to cumulative frequency. He reported an instance-based model in which the number of instances of the stimulus stored in memory predicts reaction time. We note four aspects of the literature on AoA that cannot be explained by this instance-based approach. First, an effect of AoA has been observed in the absence of an effect of frequency. Second, an effect of AoA has been observed when cumulative frequency has been controlled. Third, the effect of AoA is dependent on task. Fourth, the effect of word frequency is dependent on stimulus modality. Lewis reported an experiment in which participants make a decision based on identity-specific semantic information to celebrity faces to demonstrate an effect of the number of instances in memory, which he interpreted as an effect of AoA. We note that effects of AoA have been found in lexical and perceptual tasks, but to date all attempts to demonstrate an advantage for early-acquired items in semantic classification tasks have failed. We conclude that the effects of AoA cannot be attributed solely to the effects of cumulative frequency.

*Keywords:* Age of acquisition, cumulative frequency, face and name processing.

## 1. Introduction

Lewis (1999) described an instance-based model in which the reaction time to a stimulus, in a task that requires retrieval from memory, is given by a function that includes a negative power of the number of instances in memory (NoI) and a positive power of the time since last exposure to the stimulus. He argued that this function can account for the effects of AoA in recognition and naming tasks to objects and familiar faces. According to Lewis the effects of AoA are entirely explicable as an effect of cumulative frequency on retrieval from memory and no other locus of AoA is required. This approach provides a challenge to researchers who have suggested that the locus of AoA is at the speech output lexicon. Lewis demonstrated an effect of NoI when participants classified actors according to which of two British TV 'soap operas' they appeared in. As naming was not required in this task, Lewis argued that the effect of AoA (his NoI) cannot be attributed to a locus at the speech output lexicon.

Moore and Valentine (1999; also see Moore, 1996; 1998) demonstrated an effect of AoA in a familiarity decision task to famous faces. Furthermore, Valentine, Hollis and Moore (1998) have demonstrated that the name is not automatically activated in this task. Therefore, the effect of AoA cannot in this case be attributed to automatic activation of phonology. In conclusion, we agree with Lewis and others (e.g. Yamazaki, Ellis, Morrison, & Lambon Ralph, 1997) that the speech output lexicon cannot be the sole locus for the effects of AoA.

Another point of agreement is that Lewis' data favours *order* of acquisition as an explanatory construct in preference to *age* of acquisition. We have argued elsewhere that the effect of AoA on face familiarity decision suggests that there is no critical age at which a stimulus must be encountered to benefit from being early-acquired, as might be assumed if the effect arises from language acquisition. Knowledge of celebrities is acquired after the rapid acquisition of language. (See Moore & Valentine, 1998; 1999 for discussion of this issue).

However, the proposal that AoA effects are entirely attributable to the effect of cumulative frequency does not stand up to scrutiny. We present four aspects of AoA effects reported in the literature that are contrary to the predictions of Lewis' interpretation.

## **2. An effect of AoA has been observed in the absence of an effect of frequency.**

Turner, Valentine and Ellis (1998) found that early-acquired words are recognised more quickly than late acquired words in an auditory lexical decision task (Experiment 2). However, no effect of word frequency was found in the same task (Experiment 1). It should be noted that the mean RT to high frequency words (576ms) was slightly longer than the mean RT of low frequency words (568ms). Therefore, the lack of an effect of word frequency cannot be attributed to a small advantage for high frequency words that fails to reach statistical significance due to low statistical power. Furthermore, Turner *et al.* used a matching procedure that included a number of improvements in comparison to earlier experiments. Lewis' model cannot account for an effect of AoA occurring in the absence of an effect of frequency. Indeed, frequency of occurrence is an essential predictor of RT in his model. Therefore, these data demonstrate that the mechanism that gives rise to the effect of AoA is not identical to that which gives rise to the effect of word frequency, contrary to Lewis' prediction.

## **3. An effect of AoA has been observed when cumulative frequency has been controlled.**

Moore and Valentine (1998) investigated the time taken to name celebrities' faces using multiple regression and factorial designs. Rated familiarity and AoA were the only significant predictors of naming speed. Moore and Valentine point out that the instructions used to collect rated 'familiarity' specified that the ratings should reflect the number of times a celebrity had been encountered in all media. Therefore, the 'familiarity' rating could equally well have been referred to as rated cumulative frequency. The factorial analysis is of most interest because it was found that early-acquired celebrities (acquired between 6 -12 years of age) were named faster than late-acquired celebrities (acquired after 12 years) who were matched on rated cumulative frequency. Therefore, cumulative

frequency cannot be used to account for an effect of AoA on naming latency of famous faces. Moore and Valentine also report a replication of this result.

#### **4. The effect of AoA is dependent on task**

The effects of AoA have been found to be task dependent. Moore (1996; 1998) found that early AoA facilitates face naming and familiarity decision tasks but does not facilitate semantic classification tasks (e.g. deciding the occupation of a celebrity). In both tasks early and late-acquired celebrities were matched on rated familiarity (cumulative frequency).<sup>1</sup> In light of Lewis' predictions, data from the semantic classification task and face familiarity decision task were combined for reanalysis. There was a main effect of Task in the analysis by participants ( $F_p(2,46)=18.21$ ,  $p<.0001$ ) and by items ( $F_i(3,96)=6.15$ ;  $p<.02$ ; mean familiarity decision RT = 662ms [s.d. = 81ms]; mean semantic classification RT = 898ms [s.d. = 261ms]) and no main effect of AoA. There was a significant interaction between Task and AoA by participants ( $F_p(2,46)=6.15$ ,  $p<.02$ ) and items ( $F_i(3,96)=6.35$ ;  $p<.02$ ). The significant interaction shows that the effect of AoA in familiar face processing is task dependent. Furthermore, we note that object naming shows an advantage for objects with early-acquired names but that a semantic classification (manufactured vs. natural) shows no such effect (Morrison, Ellis & Quinlan, 1992). Lewis does not offer any account of how the effect of AoA could be influenced by the specific processing task.

#### **5. The effect of frequency is dependent on stimulus modality.**

Turner *et al.* (1998) found that word frequency affects RT to make lexical decisions to words read from a computer screen (Experiment 3), however there was no effect of word frequency on RT to make lexical decisions on hearing the same words (Experiment 2). As shown above, the lack of an effect of word frequency in Experiment 2 cannot be attributed to lack of statistical power. Lewis' model provides no explanation of the modality-specific nature of the effect of word frequency on lexical decision.

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<sup>1</sup> Full details of the relevant experiments and data can be found in Moore (1998; Experiments 5 and 6).

## **6. Critique of Lewis' semantic classification task.**

A body of evidence exists to demonstrate that semantic classifications of objects (Morrison *et al.*, 1992), and famous faces and names (Moore, 1998) are not facilitated by early AoA. Why then did Lewis claim to have found that AoA affected RTs in his 'semantic classification task'? First we note that Lewis' measure of AoA was in fact the number of instances in memory (or cumulative frequency). Second, Lewis did not measure or control for AoA, familiarity or facial distinctiveness. Lewis assumes that the actors concerned are only known for their role in the soap opera. Indeed, some actors were famous prior to appearing in the soap (e.g. Mike Reid) others appear in current top-rated TV series (e.g. Sarah Lancashire). A further confound is that the stimuli presented in the experiment are close semantic associates. The RT would be affected by semantic (or associative) priming (Bruce & Valentine, 1985) and semantic activation that occurs as a result of presenting a large number of celebrities from the same category (Sergent & Poncet, 1990). In conclusion, Lewis' soap-opera classification task should not be confused with a familiarity decision task or an occupation decision task. Furthermore, Lewis' claim that the effects of AoA are entirely attributable to the effects of cumulative frequency is clearly at odds with the empirical evidence.

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