# EFFECT OF AGE ON LEXICAL DECISION SPEED WHEN SENTENCE CONTEXT IS ACOUSTICALLY DISTORTED

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## 1.    INTRODUCTION

Many factors affect a listener's ability to understand spoken language, including the availability and supportiveness of contextual information. In auditory lexical decision tasks, response times to target words are slowed when the preceding supportive context is acoustically distorted (Aydelott & Bates, 2004). In a previous study with normal-hearing younger adults, there was an effect of the amount of distortion, such that more acoustical distortion led to less facilitation by a congruent context (Pelletier, Goy, Coletta, Giroux, & Pichora-Fuller, 2010). Furthermore, distortion type affected lexical decision: when the sentence context was distorted by either time compression or low-pass filtering, congruent contexts facilitated lexical decision; however, incongruent contexts inhibited lexical decision only when the context was time-compressed.

Another factor that may affect a listener's ability to understand spoken language is age. Older listeners use congruent context in a compensatory fashion to offset age-related declines in auditory processing (Pichora-Fuller, 2008). However, when speech is time-compressed, older listeners may receive less information than younger listeners due to differences in auditory temporal processing or generalized slowing of cognitive processing speed (Pichora-Fuller & Souza, 2003).

In the current study, we tested older adults in two distortion conditions: low-pass filtering at 1750 Hz and 50% time compression. These conditions were the same as those selected in our earlier study of younger listeners because they resulted in similar reductions in word recognition for younger adults (Pelletier et al., 2010). It was predicted that, similar to younger adults, reaction times (RTs) would vary with the type of distortion, but that older adults would demonstrate more facilitation from context but a greater cost of distortion compared to younger adults.

## 2.    METHOD

### 2.1 Design

Participants heard sentences in which intact target words were preceded by intact or distorted sentence contexts. The sentence contexts could be semantically congruent, neutral or incongruent with the target word. Trials with real-word items were interspersed with trials with non-word items, and participants made a lexical decision about each target word as quickly and accurately as possible by pressing one of two buttons on a button box. Sentence contexts were distorted by either low-pass filtering at 1750 Hz or 50% time compression, and 36 older adults were tested in each distortion type condition. Participants were seated in a sound-attenuating booth, and stimuli were presented binaurally at 70 dB SPL through Sennheiser HD 265 headphones.

### 2.2 Participants

Listeners were native English speakers with a mean age of 71.6 ($SD = 4.3$) and 69.7 ($SD = 3.7$) years in the low-pass filtering and time compression conditions respectively. They had audiometric pure-tone thresholds $\leq 25$ dB HL from .25 to 3 kHz in the better ear. They provided informed consent and were paid $10/hr for their participation. Of the 86 participants recruited for the study, 14 participants were replaced because they failed to correctly answer at least 90% of test trials, leaving 36 in each group.

## 3.    RESULTS

### 3.1. Reaction times for lexical decision by older adults

Only reaction times (RTs) for correct responses to real word targets were analyzed. The median RT for each participant in each condition was calculated. RTs were faster when the context phrase preceding the target word was intact ($M=660$ ms, $SE=20$) compared to when it was distorted ($M=687$ ms, $SE=18$). RTs were also faster when the context was congruent ($M=497$ ms, $SE=19$) than when it was neutral ($M=762$ ms, $SE=18$) or incongruent ($M=762$ ms, $SE=23$), but RTs for neutral and incongruent contexts did not differ. Furthermore, RTs were faster when the context phrase preceding the target word was low-pass filtered ($M=616$ ms, $SE=26$) than when it was time-compressed ($M=731$ ms, $SE=26$). Thus, RTs were fastest when the context preceding the word was congruent and intact congruent, with RTs for intact contexts being similar to those for low-pass filtered contexts, but RTs for time-compressed contexts being slower than those for intact contexts.

These descriptions were confirmed by an ANOVA with Distortion Type (Time Compression, Low-Pass Filtering) as a between-subjects factor, and Distortion (Intact, Distorted) and Context (Congruent, Neutral, Incongruent) as within-subject factors. There were main effects of Distortion, $F(1,70) = 5.54$, $p < .05$, Context, $F(2,140) = 310.79$, $p < .001$, and Distortion Type, $F(1,70) = 9.85$, $p < .005$. There were interactions of Context × Distortion, $F(2,140) = 17.18$, $p < .001$, and Distortion Type × Distortion, $F(1,70) = 23.67$, $p < .001$.

### 3.2 Age differences in reaction time

The results for older adults in the present study were compared to those of the younger adults tested under

the same distortion conditions in our earlier study (Pelletier et al., 2010). An ANOVA was conducted on median RTs to real word targets, with between-subjects factors of Distortion Type (Low-Pass Filtering, Time Compression) and Age (Younger, Older), and within-subject factors of Distortion (Intact, Distorted) and Context (Congruent, Neutral, Incongruent).

RTs were faster for younger adults ($M$=660 ms, $SE$=20) than for older adults ($M$=687 ms, $SE$=18), $F(1,140)$ = 14.23, $p < .001$. Besides an overall age-related difference in RT, there were also age-related differences specific to context and the type of distortion.

## Facilitation by Context

Facilitation by congruent sentence context was calculated by subtracting the median RT for a participant's congruent trials from the median RT for the corresponding neutral trials to assess how much faster RTs were in the congruent condition compared to the neutral condition (see Fig 1).There was an Age × Context interaction, $F(2,280)$ = 5.65, $p < .005$, with older adults demonstrating more facilitation than younger adults (Fig. 1).
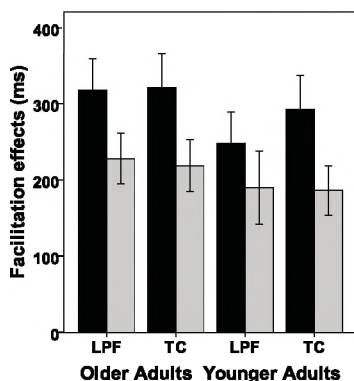


**Fig. 1. Facilitation effects by age, distortion (black: intact contexts; gray: altered contexts), and distortion type (LPF: low-pass filtering; TC: time compression). Standard error bars are shown.**

## Distortion

As shown in Fig 2, the effect of distortion on RT was greater for older adults than for younger adults, especially in the time compression condition. We calculated the cost of distorting congruent semantic contexts as the difference RTs between each participant's distorted and intact congruent trials. There was an Age × Distortion Type interaction, $F(1,140)$ = 7.81, $p < .01$.
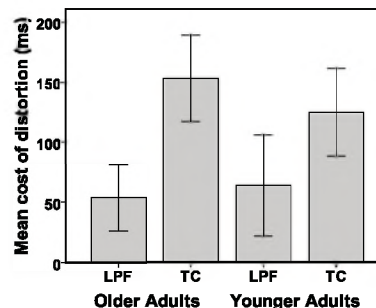


**Fig. 2. Cost of distortion by age and distortion type (LPF: low-pass filtering; TC: time compression). Standard error bars are shown.**

## 4.    DISCUSSION

When tested in intact conditions, contextual information facilitated (speeded) lexical decision more for older adults than younger adults. However, for older adults, the speed of lexical decision was affected by the type of distortion, with the cost of distortion being greater for time compression than from low-pass filtering. Although the amounts of distortion used in the present experiment were matched in difficulty for younger adults, it is possible that they were not well matched in difficulty for older adults, thus inflating differences between types of distortion. Preliminary results from an ongoing experiment indicate that, compared to younger adults, older adults found the 50% time compression condition to be more difficult and low-pass filtering at 1750 Hz to be relatively easier. Thus, RT differences between distortion types seem to be minimized when word recognition difficulty is matched between conditions, but matching must be age-specific.

In conclusion, there are age-related differences in the use of contextual information and the speed of processing contextual information when it is time-compressed, and reduced uptake of the sentence context leads to consequences for later word processing.

## REFERENCES

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