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ERP studies of visual and auditory processing of negated sentences

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\textbf{Introduction}

Previous research shows that negation is ignored in initial processing and the event-related potential (ERP) component N400 is insensitive to negation in the presence of semantic priming effects \cite{2-3, 5}. But other evidence has shown that negation can be readily integrated and incongruities in negated sentences can elicit an N400 \cite{6}. Most of this research has focused on negated forms such as not, no or any while little is known about prefificantly negated words (e.g. unauthorized, unintentional) despite their high frequency of occurrence in language use \cite{7}.

\textbf{Aim and research questions}

- Two ERP experiments in visual and auditory modalities to investigate affirmatives (authorized), prefificial negation (unauthorized) and sentential negation (not authorized) in sentential contexts such as example 1: 

  \begin{enumerate}
  \item The White House announced that the new Obama biography was authorized/unauthorized/not authorized and the details in the book were correct/wrong in fact.
  \item ERPs time-locked to the critical word (underlined), the congruency of which was determined by the adjective (bold) in the first part of the sentence. We asked the following questions:
  \end{enumerate}

\textbf{Visual study}:

\begin{itemize}
  \item Is there a delay in the integration of negated meanings?
  \item Is prefificial negation processed similar to the negated form or the affirmative form?
\end{itemize}

\textbf{Auditory study}:

\begin{itemize}
  \item Is auditory presentation of sentences more natural and easier than visual processing?
\end{itemize}

\textbf{Summary of findings}

\textbf{Visual:}

- **Affirmative: N400-P600:** successful detection of incongruities (N400) followed by re-evaluation of content to repair meaning (P600)
- **Sentential negation:** no N400, but a negativity with a longer latency than the typical N400: negation not entirely ignored in processing but meaning not fully present in memory either
- **Prefificial negation:** sustained anterior negativity: negated meaning needed to be retrieved from working memory, which was taxing

\textbf{Auditory:}

- **Affirmative: N400-P600:**
- **Sentential negation:** no N400 but a P600: re-evaluation of content
- **Prefificial negation:** late positivity (P600): re-evaluation of content

\textbf{Conclusions}

- Negated sentences were not ignored in early processing [ unlike 2-3, 5], nor were they processed the same way as affirmative sentences [ unlike 6].
- We found evidence for a more nuanced processing of negation suggesting that incongruities in negated sentences involved different processing mechanisms than those in affirmative sentences.
- Prefificial negation was the most difficult form to process in both studies, hence was not likely to be processed the same way as affirmative forms.
- Auditory processing of negated sentences was easier (clearer ERP effects) than word-by-word visual processing.

\textbf{Results}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
\textbf{Material} & 3 pseudo-randomized lists each including 108 (visual) and 102 (auditory) items \hline
\textbf{Procedure} & 
\begin{itemize}
  \item \textbf{Visual:} Counter-balanced, 9 and 11 ms after the adjective and critical words
  \item \textbf{Auditory:} Counter-balanced, 9 and 11 ms after the adjective and critical words
\end{itemize} \hline
\textbf{Presentation} & 
\begin{itemize}
  \item 229 words in total
  \item 229 words in total
\end{itemize} \hline
\textbf{Analysis} & 
\begin{itemize}
  \item EEG recording and processing
  \item 30 scalp, 2 mastoid and 4 facial electrodes
  \item Online referenced to left mastoid
\end{itemize} \hline
\textbf{References} & \begin{itemize}
\end{itemize} \hline
\end{tabular}
\caption{ERP studies of visual and auditory processing of negated sentences.}
\end{table}