# **Audio-visual identification of place of articulation and voicing in white and babble nois[ea\)](#page-0-0)**

<span id="page-0-1"></span><span id="page-0-0"></span>Magnus Al[m](#page-0-1) and Dawn M. Behne *Department of Psychology, Norwegian University of Science and Technology, N-7491 Trondheim Norway Department of Linguistics, Simon France, Simon France, Simon France, Canada S5 Canada V56 Canada V5 Department of Psychology, Norwegian University of Science and Technology, N-7491 Trondheim Norway*  $($   $\mathbb{R}$   $\mathbb{R}$  00  $\mathbb{R}$  1 Ap<sub>1</sub> 00  $\mathbb{R}$  o 1 Ap<sub>1</sub> 00  $\mathbb{R}$ 

 $S_{\rm{c}}$  including conditions greatly favor the auditory favor the auditory of auditory favor the auditory of auditory  $S_{\rm{c}}$  $f^*$  due  $A^{\prime\prime}$ , visible  $A^{\prime\prime}$  and  $A^{\prime\prime}$  responses are more likely  $t^{2}$  occur in noisy environments entirely in  $t^{2}$  ,  $t^{$  $B_4$ <sub>2</sub>, 1982 Ross *et al.*[, 2007](#page-10-0). However, whereas and incorresponds in a proportional shift to  $\mathcal{L}_A$  and  $\mathcal{L}_B$  in a proportional shift toward  $\mathcal{L}_B$  $\sum_{k=1}^{\infty} \frac{1}{k} \cos^2(\pi x, \xi) = \frac{1}{k} \int_{\mathbb{R}^n} \frac{1}{k} \cos^2(\xi) \frac{1}{k} \sin^2(\xi) \frac{1}{k} \sin^2(\xi) \frac{1}{k} \sin^2(\xi)$  $A'$ -fusions is not linear e.g.,  $\binom{n}{k}$  ,  $\binom{n}{k}$  or  $\binom{n}{k}$  . 2007 [Sommers](#page-10-1)  $\binom{n}{k}$  $\frac{1}{2}$ ,  $\frac{1}{2}$ [, 2005](#page-10-1). Previous research e.g.,  $\frac{1}{2}$  e.g.,  $\frac{1}{2}$  e.g.,  $\frac{1}{2}$ and  $\mathbf{F}_{\mathbf{a}}(k,1)$  for  $\mathbf{F}_{\mathbf{a}}(k,1)$  for  $\mathbf{F}_{\mathbf{a}}(k,1)$ that moderate white noise facilitates AV-fusion responses,  $\mathcal{E} = \mathcal{E} = \frac{1}{2} \int_{0}^{\infty} \mathcal{E} \left( \frac{\partial}{\partial x} \mathcal{E} \right) \mathcal{E} \left( \frac{\partial}{\partial y} \mathcal{E} \right)$  $\therefore$   $\frac{1}{2}$   $\frac{1$  $M \times C_{\mathcal{A}}$  studies  $M$  studies  $C_{\mathcal{B}}$  in non-text referred to above used to above used to above used to above used to  $\mu$ , density,  $\mu$ ,  $\$  $m = \frac{m}{2}$ meaning  $m = \frac{m}{2}$  intensity levels across frequencies in a given containing  $m = \frac{m}{2}$ band, while babble noise is a fluctuating signal with a low $f_{\text{max}}$  frequency dominated spectral shape. The same spectral shape. The same spectral shape same same same same spectral shape.  $e^{\frac{1}{2}x}$ energy, which noise covers a wider range of frequencies than  $\frac{1}{2}$  $\mathbf{b}_{\mathbf{a}}$  noise at any given time. The masking effect of noise  $\mathbf{b}_{\mathbf{a}}$  $\frac{1}{2}$ is partly determined by the frequency of the frequency of the frequency of the frequency of tar- $\frac{d}{dx}$  stimulus and frequency and the size and frequency of universal the size and frequency of universal strict  $\frac{d}{dx}$  $t_{\text{eff}} = \frac{1}{2} \int_0^1 \frac{1}{2} \cos \theta \, d\theta$  in the integral integration of the integration  $\theta$  $\frac{1}{\sqrt{2\pi}}$  signal in notation in  $\left( \frac{1}{\sqrt{2\pi}} \right)$  is  $\frac{1}{\sqrt{2\pi}}$  i.e.,  $\frac{1}{\sqrt{2\pi}}$  i.e.,  $\frac{1}{\sqrt{2\pi}}$  $\frac{1}{\mu}$  .  $\frac{1}{2}$  .  $\frac{1}{\mu}$  .  $\frac{1}{\mu}$  .  $\frac{1}{\mu}$  .  $\frac{1}{\mu}$  .  $\frac{1}{\mu}$  .  $\frac{1}{\mu}$ 

 $\mathbf{X}'$  ,  $\mathbf{Y}'$  ,  $\mathbf{Z}'$  , contribution to  $A$ <sup>S</sup>P depends on the characteristics of th  $\infty$  signal e.g.,  $\frac{1}{2}$ ,  $\frac{1}{2}$  $\infty$  s,  $0$  and  $\infty$  attributes such as  $\mathbf{A}$  and  $\mathbf{B}$  and  $\mathbf{B}$  $\frac{\partial^2}{\partial x^2}$  is to  $\frac{\partial^2}{\partial x^2}$  if  $\frac{\partial^2}{\partial x^2}$  $M_{\rm e} = \frac{1}{2} \frac{1}{\sqrt{2}} \frac{1}{\sqrt{2}} \left[ \frac{1}{2} \frac{1}{\sqrt{2}} \frac{1}{\$  $\mathcal{A} = \mathcal{A} \mathcal{A} \mathcal{A}$  is identification of  $\mathcal{A} = \mathcal{A} \mathcal{A} \mathcal{A}$  $\nabla_{\mathbf{w}}$  is robust at  $\mathbf{w}$  in  $\mathbf{w}$  is robust at  $\mathbf{w}$   $\mathbf{w}$   $\mathbf{w}$   $\mathbf{w}$   $\mathbf{w}$   $\mathbf{w}$   $\mathbf{w}$  $\mathbf{z} \in \mathbb{R}$  in  $\mathbb{R}^n$  in  $\mathbb{R}^n$ , who found that  $\mathbb{R}^n$  $\mathcal{L}^{\mathcal{P}}$  voice chance  $\mathcal{L}^{\mathcal{P}}$  is a SNR of a  $-\frac{1}{2}$  dB. For  $\frac{1}{2}$  dB. For stop stop constants the acoustical curve in portants the acoustical curve inportant curve in  $\frac{1}{2}$  $f_{\alpha} = \sum_{i=1}^{n} \frac{1}{2} \sum_{i=1}^{n}$ cation that the formation is deep the most important the most important the most important the most important o  $\frac{1}{\epsilon}$  (et  $\frac{1}{\epsilon}$  cue delated by  $\frac{1}{\epsilon}$  )  $\frac{1}{\epsilon}$  by  $\frac{1}{\epsilon}$  stevens  $\frac{1}{\epsilon}$  $\frac{1}{2}$  and  $\frac{1}{2}$  a  $\mathcal{L} = \left( \begin{array}{cc} 1 & 0 \\ 0 & 0 \end{array} \right)$  is considered the most important the most important the most important terms of  $\mathcal{L}$  $c_n = \left(\begin{array}{cc} 0 & \sqrt{2} & \sqrt{2} \\ \sqrt{2} & \sqrt{2} & \sqrt{2} \\ \sqrt{2} & \sqrt{2} & \sqrt{2} \end{array}\right), \quad \left(\begin{array}{cc} 1 & \sqrt{2} \\ \sqrt{2} & \sqrt{2} \\ \sqrt{2} & \sqrt{2} \end{array}\right)$  $\frac{1}{2}$  the formal transition involves subtle acoustic variation involves subtle acoustic variations of  $\frac{1}{2}$ with a wide range of  $\mathbb{R}$  with a wide range of  $\mathbb{R}$  is associated of frequencies, whereas VOT is associated with a set of  $\mathbb{R}$ ated with the time interval between  $\frac{1}{2}$  and the time interval between  $\frac{1}{2}$  and the time interval between  $\frac{1}{2}$  $c^2$  construction release and voice  $\frac{1}{2}$  and  $\$  $\begin{bmatrix} \n\text{Re} & \text{Re} & \text{Re} & \text{Re} & \text{Re} & \text{Im} & \text$  $f(x) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \frac{dx}{(x-x)^2} dx$  intensity distribution across  $f(x) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \frac{dx}{(x-x)^2} dx$  $\int_{\mathcal{A}}\alpha\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x}|^{2}}\int_{\mathcal{A}}\mathbf{x}^{2}dx=\frac{1}{2}\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x}|^{2}}\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x}|^{2}}\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x}|^{2}}\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x}|^{2}}\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x}|^{2}}\int_{\mathcal{A}}\frac{d\mathbf{x}}{|\mathbf{x$  $\frac{1}{2}$  ,  $\frac{1$ portally distinct than the subtle action of  $\frac{1}{2}$  $g_{\mu\nu}$ guishing different formant transitions and may contribute to the matrix  $\mu$ voicing in the contraction being less susceptible to noise that  $\tilde{f} = \frac{1}{2}$  $P(A, B)$  Polynomia  $P(A, B)$  is greatly robustness in  $P(A, B)$  $s_n$  sately salient visual curve  $\frac{1}{2}$  is, see that is, see in the face of the face o  $\sigma$  speaker greatly aids perceivers in identifying  $\sigma$  in  $\sigma$  $e_{\mathbf{r}}$ ,  $e_{\math$ voicing identification e.g., Behne *et al.*[, 2006](#page-9-9) [Binnie](#page-9-4) *et al.*,  $1^{n+1}$ <sup>1</sup>  $\rightarrow$   $\rightarrow$   $\rightarrow$   $\rightarrow$   $(00^{n})$   $\rightarrow$   $\rightarrow$   $\rightarrow$   $(00^{n})$   $\rightarrow$   $\rightarrow$   $(00^{n})$   $\rightarrow$   $\rightarrow$   $(00^{n})$   $\rightarrow$   $\rightarrow$   $(00^{n})$ 

ent  $A'$  syllables that varied in terms of voicing  $A'$  varied in terms of varied in ter  $m_{\alpha\beta}$  is a set of  $m_{\alpha\beta}$  of  $m_{\alpha\beta}$  component, independent of which of which of which  $\alpha$  $\mathcal{A} = \mathcal{A}$ component  $\mathcal{A} = \mathcal{A} \mathcal{A}$  in stimulus was variable and independent of  $\mathcal{A}$  $\frac{1}{2}$  of the presence of  $\frac{1}{2}$  is the active visual active in the vocal folds may be possible may explain the poor visual contribution of  $\frac{1}{2}$ tion to voicing identification.  $\frac{1}{2}$   $\mathbb{Z}$  by  $\mathbb{Z}$ , to  $\mathbb{Z}$ ,  $1$ ,  $\mathbb{Z}$ , or which which which  $\frac{1}{2}$  and  $\frac{1}{2}$  and  $\frac{1}{2}$  and  $\frac{1}{2}$  and visual visu mode different different different type  $\frac{d}{dx}$  noise type different  $e = e^{-\frac{2}{3}}$  depend on  $\mathcal{U}$  at the  $\mathcal{U}$  attribute is being assessed.

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# *1. AV recordings*







FIG. 2. Mean percent correct responses in the AO and AV congruent conditions in quiet and in babble noise at 0 and −12 dB SNRs. Mean percent auditory responses for all AV-incongruent stimuli in quiet and in babble noise at 0 and −12 dB SNR are also included. The AV- congruent and AV- incongruent  $r$ esponses were collected in the current study, whereas the AO responses were collected in a parallel study.

sponses.



#### **III. RESULTS**

### **A. Comparisons with audio-only and AV congruent stimuli**

 $A_j$   $\gamma_i$  congruent  $(A_j)$  for  $A_j$  and  $A_j$  for  $A_j$  and  $A_j$  for  $c_4$  for  $\mathcal{R}$  (1)  $c_{\text{cell}}$   $c_4$   $c_5$   $c_6$   $c_6$   $c_6$   $c_6$   $c_7$  $\mathcal{L} = \mathbb{R}^d \times \mathbb{R}^d$  respectively to the categories,  $\mathcal{L} = \mathbb{R}^d \times \mathbb{R}^d$  $\ell \phi = \frac{1}{2} \phi + \frac{1}{$  $p = \frac{p}{p}$  $w \neq \emptyset$  in  $\overline{w}$  incongruent stimuli  $\overline{w}$  incongruent stimuli were likely to be based on chance.  $R_{\rm eff}$  condition the AO condition  $A$  condition  $A$  condition  $A$  $\lim_{n \to \infty} \frac{1}{n} \log \frac{1}{n} \leq C_1 \log \frac{1}{n} \log \frac{1}{n} \log \frac{1}{n}$  in the current study.  $\frac{1}{2}$   $\mathbf{w}_1 = \mathbf{c}_1 = \begin{pmatrix} 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$  ,  $\mathbf{w}_2 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$  $\int_{a}^{a} \frac{dx}{y} = \int_{a}^{b} D^{\frac{1}{2}} = 0$ ,  $\int_{a} \frac{1}{2} [1 - \frac{1}{2}]$ ,  $\int_{a}^{b} = 2 \int_{a}^{b}$  $\mathcal{W}_n$  balanced for general for general for  $\mathcal{W}_n$  groups  $\mathcal{W}_n$  groups  $\mathcal{W}_n$  groups  $\mathcal{W}_n$  $A^R$  and almost identical response  $\frac{1}{2}$  resp  $\frac{1}{2}$ incongruent conditions e.g., mean percents and percent conditions  $\frac{1}{2}$  and  $\frac{1}{2}$  $\mathbf{A}^{\mathbf{I}}$  stimuli were  $\mathcal{C}^{\mathbf{I}}$  and  $\mathcal{C}^{\mathbf{$  $> 0$ . ]).  $F_{\text{max}} = \frac{f(\mathbf{x}, y, \epsilon)}{f(\mathbf{x}, y, \epsilon)}$  for  $\mathbf{x} = \frac{f(\mathbf{x}, y, \epsilon)}{f(\mathbf{x}, y, \epsilon)}$  $\mathbf{A}$  -congruent conditions conditions conditions collapsed for all syllables. A  $\mathbf{A}$  $r_{\rm sh} \propto \alpha_{\rm sh} \frac{1}{\sigma} \frac{1$ rospective categories, with participants getting nearly all respective near  $\frac{1}{2}$  $\sigma_{\mathbf{S}}^{\mathbf{S}}$ sonses correct in  $\mathcal{S}_{\mathbf{S}}^{\mathbf{S}}$  in  $\mathcal{S}_{\mathbf{S}}^{\mathbf{S}}$  in babble noise of  $\mathcal{S}_{\mathbf{S}}$  in  $\mathcal{S}_{\mathbf{S}}^{\mathbf{S}}$  in  $\mathcal{S}_{\mathbf{S}}^{\mathbf{S}}$  in  $\mathcal{S}_{\mathbf{S}}^{\mathbf{S}}$  in  $\mathcal{S}_{\mathbf{S}}^{\mathbf{S}}$  in  $\frac{1}{2}$  sharp drop of independent responses at  $\frac{1}{2}$  dB SNR in correct responses at  $\frac{1}{2}$  $\Delta$  A condition is greatly condition is greatly computed for by relevant via  $\Delta$   $s_{\rm eff}$  in the AV-congruent condition in the AV-congruent condition. The  $\sim$  $\int_{\mathbb{R}^d} e^{-\frac{1}{2} \omega} \frac{1}{\omega} \frac{1$  $r = \frac{1}{2} \sum_{k=1}^{n} c_k$  $R_{\text{eff}} \in \mathbb{R}$  for  $\mathbb{R}^n$  the  $\mathbb{R}^n$  further indicate the theorem indicate the theorem indicate the theorem in  $a_n = \frac{1}{n}$  becomes in babbles in babbles in babbles is robust in babbles is robust in babbles in babbles in babbles in  $\alpha$  $E_{\text{eq}}$  at  $\mathbf{N} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$  of  $\mathbf{C}_{\text{eq}}$  of  $\mathbf{C}_{\text{eq}}$   $\mathbf{N} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$  $k_{\text{c}}$  correct. We consider the set of  $\mathcal{C}$  $T = T - T + T$ incongruent stimuli did not allow for correct or correct o  $\mathbf{r}^{\mathbf{r}}$  incorrect response of response options either matched the response of  $\mathbf{r}$  $\Gamma_{\mathcal{C}_{\mathbf{z},\mathbf{z}}}$ visual component, the audio component, or were intermediated as  $\mathcal{C}_{\mathbf{z},\mathbf{z}}$ ate to the two. In the AO and AV-congruent conditions,  $\alpha$  $t_{\text{tot}}$   $\epsilon_{\text{tot}}$  17%  $(100\%$  divided by six response alternative alternative six response alterna $t_{\text{ref}}(x)$  or  $\alpha_{\text{ref}}(x) = \alpha_{\text{ref}}(x)$  correct response by chance.  $\frac{1}{\sqrt{2}}$  and  $\frac{1}{\sqrt{2}}$  correct response percentage obtained for the AO and  $\frac{1}{\sqrt{2}}$  and  $\frac$  $A^{\prime}$ -tongruent stimuli renders it under the next state of  $A$  and  $B$  $e = \cos^2 \theta + \$ 

 $F_{\rm eff} = F_{\rm tot} = 0$  in contract and  $F_{\rm eff} = 0$  and  $F_{\rm eff} = 0$  $r$ responses for all  $r$   $\mathcal{A}$  that stead from  $r$   $\mathcal{A}$  the current study.  $320$ , for  $r = 100$  responses shows that  $r = 300$  $i$ s negatively influenced by incongruent visual cues. Com- $i$  $p^2$  and the AO condition, the introduction of incongruent  $\mathcal{A}$  introduction of incongruent  $\mathcal{A}$  $\mathcal{E}_{\mathbf{z}}$  in a decrease in a decrease in the overall reliable in the overall reliable  $\mathcal{E}_{\mathbf{z}}$  $\frac{1}{2}$   $\frac{1}{2}$  and  $\frac{1}{2}$  dB  $\frac{12}{4}$  $\mathcal{S}_1$ ,  $\mathcal{S}_2$  in the Average function  $\mathbf{A}_{\mathbf{S}_1}$  incongruent  $\mathbf{A}_{\mathbf{S}_2}$  in  $\mathbf{A}_{\mathbf{S}_3}$  in  $\mathbf{A}_{\mathbf{S}_4}$  in  $\mathbf{A}_{\mathbf{S}_5}$  in  $\mathbf{A}_{\mathbf{S}_6}$  in  $\mathbf{A}_{\mathbf{S}_7}$  in  $\mathbf{A}_{\mathbf{S}_7}$  in  $\mathbf{A}_{$  $\mathcal{A} = \mathcal{A}$  respectively. As a contact of  $\mathcal{A}$  incongruent means  $\mathcal{A}$  in  $\mathcal{A}$  $\frac{1}{\epsilon}$   $\sum_{i=1}^{n}$ .  $\sum_{i=1}^{n}$  $a_1 = a_1$  variation of the considered in details visual influence are considered in details are considered in details and considered in details are considered in details are considered in details are considered in details  $\mathbf{r} = \mathbf{r} + \mathbf{r} + \mathbf{r}$  in the analysis of the AV-incongruent stimuli, where  $\mathbf{r} = \mathbf{r} + \mathbf{r} + \mathbf{r}$  $\tilde{u}$ used as a means of assessing the relative influence of white influence of white  $\tilde{u}$  $\mathbf{A}^{\text{max}}$  and  $\mathbf{A}^{\text{max}}$  or  $\mathbf{A}^{\text{max}}$  or  $\mathbf{A}^{\text{max}}$  and  $\mathbf{A}^{\text{max}}$  and  $\mathbf{A}^{\text{max}}$ 

## **B. AV incongruent stimuli**



<span id="page-5-0"></span>



*2. POA stimuli*



#### *1. Quiet condition*



 $n_{\rm m}$  for  $n_{\rm m}$  and  $\Delta$ -matches for responses than babble noise for  $n_{\rm m}$  $\mathbf{v}^2$  ( $\leq 0.0$ )  $\mathbf{v}$   $\mathbf{v}$   $\mathbf{v}$  and  $\mathbf{v}$   $\mathbf{v}$  and  $\mathbf{v}$   $\leq 0.01$ )  $\mathbf{v}$   $\mathbf{v}$  $0$  dB  $\frac{12}{3}$  snrt $\frac{12}{3}$  dB  $\frac$  $0.01$ ), before  $\mathbf{A} = \begin{bmatrix} 0.01 \\ 0.01 \end{bmatrix}$ , but  $\mathbf{A} = \begin{bmatrix} 0.01 \\ 0.01 \end{bmatrix}$  $32 - 10$  responses to a sig-d the visual component to a sig- $\frac{1}{2} \sum_{k=1}^{n} \sum_{k=1}^{n} f_{k,k}$  in  $\sum_{k=1}^{n} \sum_{l=0}^{n} \sum_{l=1}^{n} f_{l,k}$  in  $\sum_{l=1}^{n} \sum_{l=1}^{n} f_{l,k}$  in  $\sum_{l=1}^{n} \sum_{l=1}^{n} f_{l,k}$  in  $\sum_{l=1}^{n} f_{l,k}$ revealed noticed noticed noticed stimuli in the voice of  $\mathcal{F}_k$  for voiced stimuli in the voice of  $\mathcal{F}_k$ the 0 dB SNR, but white noise resulted in significantly more  $V_{\rm{c}}$  match responses to the babble noise for voiceless stimuli in  $V_{\rm{c}}$  $\frac{1}{2}$  0  $\left($   $\sqrt{0.01}\right)$  *p*<sub>9</sub>  $\frac{1}{2}$   $\frac{1}{2}$   $\frac{1}{2}$   $\frac{1}{2}$   $\frac{1}{2}$   $\frac{1}{2}$  $1 \t (\sim 0.01).$ 

*(b) Noise level*. Consistent with previous findings e.g.,  $E_{\mathbf{r}}$ , 1969  $\mathbf{r}$ ,  $\mathbf{r}$ ,  $\mathbf{s}$ <sup>m</sup>, 1987  $\mathbf{r}$ , 1987  $\mathbf{r}$ , 1987  $\mathbf{r}$ , 1987  $\mathbf{r}$  $(00)$  finds  $\begin{pmatrix} 1 & 1 & 1 \end{pmatrix}$  in  $\begin{pmatrix} 1 & 1 \end{pmatrix}$  i  $u_{\rm min} = \frac{1}{2} \sum_{i=1}^n \frac{1}{$  $f(x) = \frac{f(x)}{2}$  denote the  $f(x) = \frac{f(x)}{2}$  or  $f(x) = \frac{f(x)}{2}$  denote corresponse corresponses correspons responding  $\mathcal{M}$  and less with the visual component and less with the visual component and less with the visual component  $\mathcal{M}$  $\alpha = \frac{1}{2}$  and the component for a set of  $\frac{1}{2}$  and  $\frac{1}{2}$  $\frac{1}{2}$ of  $\frac{1}{2}$  and  $\frac{1}{2}$  and  $\frac{1}{2}$  and  $\frac{1}{2}$ 

 $A_{\text{max}}$  is  $\frac{1}{2}$  and  $\frac{1}{2}$  responses to a audio comparison the audio compoint to a significant to a significant in the  $\frac{1}{2}$  significant in the  $\frac{1}{2}$  dB  $\frac{1}{2}$  $(-\frac{1}{2}, \frac{1}{2})$ , **s**<sub>2</sub><sup>+</sup> $\frac{1}{2}$ , **s**<sub>2</sub><sup>+</sup> $\frac{1}{2}$  **c** 1<sup>th</sup> (-1 %,  $E-1$ . ).  $\cdots$  **Post defined that the definition of**  $\mathbf{A}$  **6 6 0**  $r_{\rm sh}$  the  $r_{\rm h}$  A-match responses than the  $1$ 

 $f_{\rm a}$   $f_{\rm$ *p*0.012-, and for voiced *p*0.012- and voiceless stimuli **1.**  $\frac{1}{2}$  and  $\frac{1}{2}$  ( $\frac{1}{2}$  ( $\frac{1}{2}$  ). The noise level effect on  $\frac{1}{2}$  is the noise level of  $\frac{1}{2}$  is  $V = \frac{1}{\sqrt{2}}$  average  $\frac{1}{\sqrt{2}}$  on  $\epsilon_1 = \frac{1}{\sqrt{2}}$ .

 $(\alpha, \beta)$  $(\alpha, \beta)$  $(\alpha, \beta)$   $C$  is specified in the second from  $\mathbf{A}$  , considering  $\mathbf{A}$  , considering  $\mathbf{A}$  $s^2$ songa  $v^2$  ,  $s^2$  ,  $s$  $\mathcal{L}_{\text{L}}(s) = \frac{1}{2} \int_{0}^{1} \mathcal{R}_{\text{L}}(s) \mathcal{R}_{\text{R}}(s) \mathcal{R}_{\text{R}}(s)$  in more results results results results results results in more re A- $\frac{1}{\sqrt{2}}$   $\frac{1}{\sqrt{2}}$ construction  $c$  ( =  $\%$ ,  $E$  = 2.5).  $\frac{1}{2}$   $\$ previous findings e.g., Behne and *et al.*[, 2006](#page-9-9) Magne and **et al.**  $M_{\rm p}$  The most remarkable observation in th respect is the size of the difference in mean  $A^2$  and  $A^2$  and  $A^ \mathcal{S}_{\mathcal{S}}^{\mathcal{S}}$ sponses between voice $\mathcal{S}_{\mathcal{S}}$  and  $\mathcal{S}_{\mathcal{S}}^{\mathcal{S}}$  and the voice of the voice  $\mathcal{S}_{\mathcal{S}}$  $v_{\alpha}$ voicing effects consistency across conditions. Voice  $\mathcal{K}_{\alpha}$  and  $\alpha_{\alpha}$  and  $\alpha_{\alpha}$  $r_{\rm el}^{\rm min}$  has significantly more  $A-$ match responses than  $v_{\rm cl}^{\rm min}$ . less stimuli in the  $\frac{1}{2}$   $\frac{1}{2}$  first  $\frac{1}{2}$   $\frac{1$  no<sub>n</sub> f<sup>o</sup>ng ≰ 12 dB (, < 0.012), <sub>but</sub> fonn<sub>i</sub> fong <sub>in</sub> which in the <sub>in</sub> t  $\frac{1}{2}$  dB  $\frac{1}{2}$  dB  $\frac{1}{2}$ Responses match the visual component to a lesser  $f_a - \mathcal{F}_a$  is  $\mathcal{F}_a$  in  $f_a$  is  $c = \frac{16\pi}{3}\%$ ,  $E_{\text{max}}$  )  $\mathcal{F}_a$  is  $\mathcal{F}_a$  in  $\mathcal{F}_a$ less constants  $\epsilon$  ( =  $\%$ , *E*= .0).  $\mathbb{R}$   $\epsilon$   $\epsilon$   $\epsilon$   $\epsilon$   $\epsilon$   $\epsilon$  $\mathbf{r}$  of  $\mathbf{v}$  and  $\mathbf{r}$  in  $\mathbf{r}$  and  $\mathbf{r}$  in  $\mathbf{r}$  in which is which in which is a string of  $\mathbf{r}$  $n \rightarrow \infty$  in the  $\frac{1}{2}$   $n \rightarrow \infty$  ( $n \rightarrow \infty$ ), in the  $\frac{1}{2}$  in the  $\frac{1}{2}$ 1<sup>2</sup> dB SNR *p*<sup>0</sup> dB S<sub>n</sub><sub>2</sub> dB S<sub>n</sub><sub>2</sub> dB S<sub>n</sub><sub>2</sub> dB S<sub>n</sub><sup>2</sup> dB Sn<sub>1</sub><sup>2</sup> dB 3<sup>2</sup> dB 3<sup>2</sup>  $\mathcal{L}$   $\leq$  0.01 ).

 $A'$  fusi $A''$  and depend  $\Theta_{\text{max}} = \Theta$  . And depend from the vertices finding e.g., [Green](#page-9-14) findings e.g., Green [and Kuhl, 1991](#page-9-14) [McGurk and MacDonald, 1976](#page-10-5)- demon  $s = \frac{1}{2} \log \frac{1}{2}$  and  $\frac{1}{2} \log \frac{1}{2} \log \frac{1}{2}$  $\left(\begin{array}{cc} -11\% & E_{\mathbb{R}} & 1 \end{array}\right)$  is the voice of  $\mathbb{R}$  in the form of  $\left(-1\% \right)$  $E$ = 3.42- $\mathbf{v}$  and a line shows in the effect of constant  $\theta_1$ ,  $\theta_2$ ,  $\theta_3$ ,  $\theta_4$ ,  $\theta_5$ ,  $\theta_6$  is degree of  $\theta_6$  that the noise types;  $\theta_1$ ,  $\theta_2$  $i\in\mathbb{N}$ is, only  $i\in\mathbb{N}$  ,  $j\in\mathbb{N}$  ,  $j\in\mathbb{N}$  ,  $j\in\mathbb{N}$  ,  $j\in\mathbb{N}$  ,  $j\in\mathbb{N}$ *hoc* analyses showed reliably more AV-fusion responses for  $\mathcal{P}_{\text{c}} = -\mathcal{P}_{\text{c}}$ voice officiel $\mathcal{P}_{\text{c}}$  consonants in  $\mathcal{P}_{\text{c}}$  consonants in which noise noise noise noise noise noise noise noise noise  $\bullet$   $\bullet$  0  $($  < 0.01<sup>2</sup>).  $(\begin{array}{ccc} \cdot & \cdot & \cdot & A \end{array})$  summary of PoA stimulation  $\mathcal{A}$  or  $\mathcal{A}$  $p_{\text{max}} = \frac{1}{\sqrt{2}}$  and  $\frac{1}{\sqrt{2}}$  and  $\frac{1}{\sqrt{$  $w \in \mathbb{R}$  in babble noise that  $\mathbb{R}$  is  $\mathbb{R}$  shown by  $\mathbb{R}$  $m^2$  A- $m^2$  and  $m^2$  and  $m^2$  and  $m^2$  and  $m^2$  and  $m^2$ parameterial to the  $1$  dB  $\frac{1}{2}$  dB  $\frac{1}{2}$  snaps constant voice  $\frac{1}{2}$  and  $\frac{1}{2}$  dB  $\frac{1}{2}$  and  $\frac{1}{2}$  a  $m = A-$ ,  $\omega_{\text{p}} = A-$  fusion responses and fewer  $\omega_{\text{p}} = \sqrt{1-\frac{m}{\omega_{\text{p}}}}$  $r$ responses were given for voiceless consortions of voices  $\mathcal{F}_n$  and  $\mathcal{F}_n$  and  $\mathcal{F}_n$  and  $\mathcal{F}_n$ nants.

#### *3. Voicing stimuli*

 $\mathcal{L}$  by  $V_{\alpha}$  for  $V_{\alpha}$  for  $\mathcal{L}$   $\mathcal{$  $M_0 = 0$ ,  $M_0 = 0$  repeated measures  $M_0$  is the noise text of  $M_0$  is the noise text of  $M_0$  $\approx$  and ball  $\frac{1}{2}$  defined by  $\frac{1}{2}$  defined by  $\frac{1}{2}$  $A \bigcup_{i=1}^n A_i$  $\mathcal{A}$  and velocal velocal velocal velocal velocal velocal velocal velocal velocal velocities of  $\mathcal{A}$  $(A_{\mathbf{v}})$   $\mathbf{v}_{\mathbf{v}}$   $\mathbf{A}_{\mathbf{v}}$   $\mathbf{w}_{\mathbf{v}}$   $\mathbf{v}_{\mathbf{v}}$   $\mathbf{v}_{\mathbf{v}}$  $\mathbf{A} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$  and V-match  $\mathbf{A} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$  $r_{\text{el}}$  in the set of these analyses are reported in Table II. Results for  $r_{\text{el}}$  $v_{\alpha}$  voice structure are not discussed in the current structure are not discussed in the current structure in the current structure are not discussed in the current structure in the current structure in the current str  $\frac{1}{n}$  and  $\frac{1}{n}$  i.e.,  $\frac{1}{n}$  i.e., and  $V^{\prime}$  we available for voicing stimuli and any re $s=0.5$  sponse to  $\sqrt{N}$  ,  $\frac{1}{2}$  into  $\frac{1}{2}$  into one of the per $c_{\text{max}}$  A-match is found, the percentage  $A$ -match is already is already value of  $A$ -match is already  $A$ -match i  $x^{\alpha}$  is  $A \in \mathbb{R}^n$  ,  $A \in \mathbb{R}^n$  for  $A = \frac{1}{n}$  of  $A = \frac{1}{n}$  of  $A \in \mathbb{R}^n$ 

<span id="page-9-14"></span><span id="page-9-13"></span><span id="page-9-12"></span><span id="page-9-11"></span><span id="page-9-10"></span><span id="page-9-9"></span><span id="page-9-8"></span><span id="page-9-7"></span><span id="page-9-6"></span><span id="page-9-5"></span><span id="page-9-4"></span><span id="page-9-3"></span><span id="page-9-2"></span><span id="page-9-1"></span><span id="page-9-0"></span>Downloaded 05 Mar 2012 to 142.58.126.186. Redistribution subject to ASA license or copyright; see http://asadl.org/journals/doc/ASALIB-home/info/terms.jsp

<span id="page-10-5"></span><span id="page-10-4"></span><span id="page-10-3"></span><span id="page-10-2"></span><span id="page-10-1"></span><span id="page-10-0"></span> $\Delta = 0$  .  $\int_{-\infty}^{\infty} r \, \partial_x \, \rho_{\rm eff}$  individuals with  $\partial_x \, \partial_y \, \rho_{\rm eff}$  individuals with hearing loss,  $\partial_x \, \partial_y \, \rho_{\rm eff}$  individuals with  $\partial_y \, \partial_z \, \rho_{\rm eff}$  $\sum_{i=1}^{n}$ ,  $\sum_{i=1}^{n}$ , 47, 0 – 0.  $M_{\rm B}$  or  $N_{\rm B}$ ,  $N_{\rm B}$  and  $N_{\rm B}$  and  $N_{\rm B}$  and  $N_{\rm B}$  and  $N_{\rm B}$  and integration of acoustic  $N_{\rm B}$  $\mathbf{r} = \mathbf{r} \cdot \mathbf{q} = \mathbf{w} \cdot \mathbf{q} = \mathbf{w} \cdot \mathbf{q} = \mathbf{q} \cdot \mathbf{q} = \mathbf$  $M^{(0)}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$  (1976).  $\frac{1}{2}$ ,  $\frac{1}{2$  $\sqrt{264}$ ,  $\sqrt{264}$ , 7.  $M_{\rm H}$ ,  $\rm A$ <sub>.</sub>  $\rm A$ <sub>2</sub> . C.  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> . C.  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> . C.  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> .  $\rm A$ <sub>2</sub> .  $\rm A$  $\frac{1}{2}$  6  $\frac{1}{2}$ .  $\frac{1}{2}$ .  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$  $M_{11}$ ,  $A_{12}$ ,  $A_{23}$ ,  $A_{13}$ ,  $A_{21}$ ,  $A_{32}$ ,  $A_{41}$ ,  $A_{52}$ ,  $A_{61}$ ,  $A_{72}$ ,  $A_{81}$ ,  $A_{10}$ ,  $A_{11}$ ,  $A_{12}$ ,  $A_{13}$ ,  $A_{14}$ ,  $A_{15}$ ,  $A_{16}$ ,  $A_{17}$ ,  $A_{18}$ ,  $A_{19}$ ,  $A_{10}$ ,  $A_{11}$ ,  $A_{12}$ ,  $A_{13$ sions among some English consonants," J. Acoust. Soc. Am. **27**, 338–352.  $R(\alpha, \beta, \Lambda_n)$  is  $A \in \mathbb{R}^n$ ,  $A \in \mathbb{R}^n$ ,  $\beta = \beta$ ,  $\beta = \mathbb{R}^n$ ,  $\beta = \beta$ ,  $\beta = \mathbb{R}^n$ ,  $\beta = \beta$ , **2007**-