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RESEARCH ARTICLE

Interaction between location- and frequency-based inhibition of return in human auditory system

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Abstract Using a cue–target paradigm, this study investigated the interaction between location and frequency information processing in human auditory inhibition of return (IOR). The cue and the target varied in terms of location and frequency and participants were asked to perform a target detection, localization or fre-

perceptual processing (Handy et al. 1999; Lupiáñez et al. 1997; Posner and Cohen 1984; Pratt et al. 1997; Reuter-Lorenz et al. 1996), with the activity of the oculomotor system (Rafal et al.1989; Rafal and Henik 1994 a response tendency which participants have to inhibit. This inhibition may persist and slow the response to the subsequently presented target. The inhibitory eff

response 2,000 ms after target onset, a feedback signal was presented. There were also 20 catch trials in each

information processing in auditory IOR. The second aim was to examine the eVect of task demand on the pattern of auditory IOR. Three experiments consistently observed interactions between location and frequency information, indicating that spatial and frequency IOR share some common mechanisms in auditory processing. However, the details of interaction changed with diVerent task demands. Experiment 1 showed that, when neither location nor frequency was particularly relevant to the detection task, there was a location-based IOR only when the cue and the target were identical on frequency and there was a frelocation and frequency, the response time to the target would be the longest; if the target is different from the cue on both location and frequency, the response time would be the shortest. Sharing one dimension between the cue and target would prolong the differentiation of memory representations and delay the detection response to the target.

This account, however, has problems in accounting for the results of Experiments 2 and 3. Why was IOR for the task-relevant feature influenced differentially by the task-irrelevant feature? According to Mondor et al. (1998b), location and frequency are integral perceptual dimensions because they cannot be attended or selected independently from each other. Therefore, in the second process of differentiating memory representations, the task-irrelevant feature would function in essentially the same way as the task-relevant feature. Task demand should play no significant role in determining the pattern of cueing effects. Clearly, the patterns of effects in the localization and discrimination tasks observed here (Figs. 2, 3) do not fit with this prediction. Moreover, the augmenting of the IOR effect for the task-relevant feature when the cue and the target had different task-irrelevant features was found to be due to both the slowdown of responses to the target when it had the same task-relevant feature as the cue and the increase of efficiency in response to the target when it had a different task-relevant feature from the cue. Whether the task-irrelevant feature increased or decreased the RTs to the target depended not only on whether the target and the cue had the same or different task-irrelevant feature, but also on the cue validity of the task-relevant feature. The dual-process model has no mechanism for such an interaction.

The response inhibition accounts

Another possible mechanism for IOR appearing in the cue–target paradigm is response inhibition in which participants must suppress their natural tendency to respond to the cue (Harvey 1980; Prime and Ward 2002; Tassinari et al. 2002; De Jong et al. 1994). This suppression or inhibition may persist and slow down the later response to the target. When applying this account to the present data, however, we find that this account will meet the same problems as the dual-processes account does. The response inhibition account assumes that, the more similar the cue and the target, the greater the persisting inhibition affecting the response to the target. However, although this hypothesis can explain the results of Experiment 1 in which the RTs to the target were the slowest when the cue and the target shared both the location and the frequency and the fastest when the cue and the target differed on both features, it cannot account for the results of Experiments 2 and 3, as we discussed above.

Another form of the response inhibition account of IOR, suppression of oculomotor activity, assumes that IOR is due to the conflict between maintenance of fixation and the natural tendency to move the eyes to the cue (Rafal et al. 1989; Tassinari et al. 1987, 2002; Taylor and Klein 1998). Oculomotor suppression necessary to maintain fixation may retard subsequent oculomotor responses to the ipsilateral targets, either because it reduces the allocation of attentional resources to target processing, due to the functional links between oculomotion and spatial attention, or because it biases the general set controlling motor output (Tassinari et al. 2002). However, it is not clear how the effect of task demand and the interaction between task-relevant and task-irrelevant features in producing IOR can be incorporated into this account, as there is no mechanism for the maintenance of eye fixation being differentially affected by task-relevant and irrelevant features.

The third form of the response inhibition account assumes that the presence of a cue establishes "inhibitory tagging" for the subsequently presented target sharing the manipulated feature with the cue. Although inhibitory tagging may not affect the accumulation of information and perceptual processing of the target, it temporarily disconnects the link between perceptual processing and response activation (Fuentes et al. 1999; Tipper et al. 1994

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