Comments

Comment by Moore:

Contralateral release from masking does sometimes occur psychophysically, but only under conditions where the signal is "confusable" with the masker (Moore 1980; Moore and Glasberg 1982, 1985). In this case, the release from masking does not depend critically on the properties of the contralateral "releaser", such as its frequency or level. This type of release from masking is unlikely to depend on any form of "hard wired" inhibition. Therefore, the effect that you have observed is unlikely to correspond to the psychoacoustical effect.

Moore, B. C. J., 1980. Detection cues in forward masking. In: G. van den Brink and F. A. Bilsen (Eds.) *Psychophysical, Physiological and Behavioural Studies in Hearing*, Delft University Press, Delft, pp. 222-229.

Moore, B. C. J. and Glasberg, B. R. (1982) Contralateral and ipsilateral cueing in forward masking. J. Acoust. Soc. Am. 71, 942-945.

Moore, B. C. J. and Glasberg, B. R. (1985) The danger of using narrowband noise maskers to measure suppression. J. Acoust. Soc. Am. 77, 2137-2141.

Reply:

"Confusion" occurs when there is no gap between the masker and the probe. Its effects are additional to masking and they do make it difficult to assess the amount of uncontaminated masking. It is true that most demonstrations of contralateral release have featured zero gap conditions and this complicates the issue. However, none of the articles quoted above use conditions with gaps greater than zero. As a result it cannot be concluded that "confusion" is the only factor responsible for the reduction in thresholds when the contralateral cue is introduced. When Delahaye (2002, op. cit.) recently tested for contralateral release from masking, his design ruled out the possibility of confusion but found the effect nonetheless. We are therefore optimistic that contralateral masking release may be a real if weak phenomenon.

However, it is important to stress that our aim was to explore the circuitry underlying ipsilateral masking release by using parallel contralateral circuits. The use of contralateral stimulation was motivated by the need to avoid the contaminating effects of mechanical suppression. It was not our aim to explain contralateral masking release, *per se*. However, if the model serves as such, it is a bonus.

Moore:

It is not the case that confusion occurs only when there is no gap between the masker and probe; see, for example, Moore (1981). The stimuli used by Delahaye (2002) are of the type where it is known that confusion effects can be very large, namely an amplitude-modulated masker followed by a signal that resembles one cycle of masker modulation (Neff, 1985; Neff, 1986). The 10-ms masker-signal interval used by Delahaye was probably not sufficient to eliminate confusions effects. Therefore, the contralateral release from masking found by Delahaye could well have been the result of resolution of confusion. Consistent with this, the subjects who had relatively high thresholds in the no-cue condition (suggesting confusion) showed release from masking, while the subjects who had relatively low thresholds in the no-cue condition (suggesting lack of confusion) showed little or no release from masking.

Moore, B. C. J. (1981) Interactions of masker bandwidth with signal duration and delay in forward masking. J. Acoust. Soc. Am. 70, 62-68.

Neff, D. L. (1985) Stimulus parameters governing confusion effects in forward masking. J. Acoust. Soc. Am. 78, 1966-1976.

Neff, D. L. (1986) Confusion effects with sinusoidal and narrowband-noise forward maskers. J. Acoust. Soc. Am. 79, 1519-1529.

Comment by Oxenham:

It is important to distinguish between masking, which is a reduction in the detectability of a probe, and inhibition or rate reduction, which does not necessarily imply masking. This point is best made in the study of Relkin and Turner (1988), where they showed that the rate reduction in response to a probe following a 'forward masker' did not result in much actual masking in the auditory nerve, as the firing rate in the absence of the probe was similarly reduced by the presence of the masker.

Also, the study seems in part to be an attempt to find a neurophysiological correlate for a psychoacoustic effect that does not exist. The psychoacoustic literature is clear with respect to the lack of an inhibitory-like release from forward masking produced by either ipsi- or contralateral flanking stimuli. Effects that are observed ipsilaterally (Houtgast 1973; Shannon 1976) are rather narrowly tuned and can be attributed to peripheral suppression effects that are likely to have their origins in basilar-membrane mechanics (Ruggero *et al.* 1992), rather than neural inhibition.

Houtgast, T. (1973) Psychophysical experiments on "tuning curves" and "two-tone inhibition". Acustica 29, 168-179.

Relkin, E. M., and Turner, C. W. (1988) A reexamination of forward masking in the auditory nerve. J. Acoust. Soc. Am. 84, 584 - 591.

Ruggero, M. A., Robles, L., and Rich, N. C. (1992) Two-tone suppression in the basilar membrane of the cochlea: Mechanical basis of auditory-nerve rate suppression. J. Neurophysiol. 68, 1087-1099.

Shannon, R. V. (1976) Two-tone unmasking and suppression in a forward masking situation. J. Acoust. Soc. Am. 59, 1460-1470.

Reply:

We suggest that considerable caution is exercised when interpreting the results of Relkin and Turner. This is the only study of its kind and their explorations were confined to a single condition where there was no gap between the masker and the probe. This condition is well known to produce over estimates of the amount of forward masking because of confusion between the masker and the probe. If their measurements in the auditory nerve are not subject to confusion, we would expect them to show less masking than that found in psychophysical studies. Of course our measurements and the putative source of masking are not in the auditory nerve but the cochlear nucleus.

We do not agree with the assertion that the literature is clear that masking release does not exist over and above effects that can be attributed to mechanical suppression. We do agree that mechanical suppression is a complicating factor for ipsi-lateral measurements. That is why we were obliged to use a paradigm employing contralateral stimulation. However, even in the case of ipsi-lateral stimulation Moore and Glasberg (1985) concluded "Unmasking was found to occur even for components which were extremely unlikely to produce a significant suppression of the masker".

Moore, B. C. J. and Glasberg, B. R. (1985) The danger of using narrowband noise maskers to measure suppression. J. Acoust. Soc. Am. 77, 2137-2141.

Oxenham:

The masking found by Relkin and Turner was on the order of a few dB, which is much lower than that found psychophysically, even when confusion effects can be ruled out. Thus, the discrepancy cannot be due only to confusion. It remains the fact that once the effects clearly due to confusion (as illustrated in the comments by Moore) and suppression are accounted for, there is no psychophysical unmasking effect left to explain in terms of lateral inhibition.

Reply to Moore and Oxenham:

Moore argues that "confusion" might also contribute to the release from masking by contralateral stimulation found by Delahaye. This is despite the fact that Delahaye's study is the only relevant unmasking experiment to directly address the issue of confusion in its design. In our view the study is satisfactory. However, if there are problems, then we are indeed left with no unequivocal psychophysical demonstrations of confusion-free unmasking because most of the relevant psychophysical studies have used maskers and probes with no gap separation between the two. This does not mean that release from low-level masking has not occurred; only that the effect has not been separated from confusion. Our original starting point for this study concerned comodulation masking release which certainly does occur with contralateral stimulation. In our experiments using amplitude modulated pure tones the thresholds for the probe were decreased when the flanking tones were added even though the probes occurred in the modulation dips of the flanking tones.

We must not, however, lose sight of the fact that masked thresholds are reduced when appropriate ipsilateral flanking tones or contralateral sounds are introduced and this effect would be predicted from our physiological observations. A possible additional psychological component labelled “confusion” does not undermine the physiological account but raises new and interesting issues as to how the two accounts can be reconciled. We do not doubt that some aspects of masking phenomena may involve circuits above the level of the cochlear nucleus. However, we also believe that a complete account of masking should take full account of the substantial effects that are occurring at the level of the brainstem.

Meddis, R., Delahaye, R., O'Mard, L., Sumner, C., Fantini, D.A., Winter, I and Pressnitzer, D. (2002) A model of signal Processing in the Cochlear Nucleus: Comodulation masking Release. Acustica, 88, 387-398.