Differential effects of attention and input strength in auditory bistability

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The auditory streaming paradigm [1], in which alternating high- A and low-frequency tones B appear in a repeating ABA- pattern, has been shown to be perceptually bistable for extended presentations (order of minutes). In [2] it was shown that auditory and visual bistability share common traits of exclusivity, randomness and inevitability using such ABA- sequences and visual motion plaids. In each modality there are alternations between a grouped percept (a single galloping ABA-ABA- stream; coherent pattern motion) and a split percept (segregated streams A-A-A-A- and -B—B–; drifting transpent motion). They further investigated the effect of volitional control at equidominance (where the durations for each percept are equal) and found that attending to one percept (grouped or split) reduced the mean dominance durations of the unattended (weaker) percept. Three bistable visual stimuli were in investigated in [3] and Levelt's proposition II (Levelt 1968) that describes the effect of input strength manipulations around equidominance was generalised to: "the mean dominance duration of the stronger percept changes more than that of the weaker percept". These findings are incompatible with [2] if one makes the common assumption that attention increases the strength of the targeted percept.

The three population tonotopically organised model that we present was developed alongside concurrent psychoacoustics experiments and is motivated from physiological studies of cortical responses to streaming stimuli; see Fig. 1A. A model time course in Fig. 1B shows the central population encoding the grouped percept and the peripheral populations encoding the split percept. Mutual inhibition, adaptation and noise are incorporated, which are important mechanisms to account for the dynamics of perceptual bistability [4]. Bifurcation analysis is used to bring the model into a regime where a balance of adaptation and noise drive alternations. The inclusion of slow NDMA recurrent excitation was introduced to deal with the periodic inputs. The statistics of the switching durations from our experiments and the known perceptual organisation from [1] constrain the model's parameters. The validated model provides a platform to show that a proposed state-dependent, top-down attention mechanism can resolve the apparent conflict between input strength and attention in auditory streaming.

References

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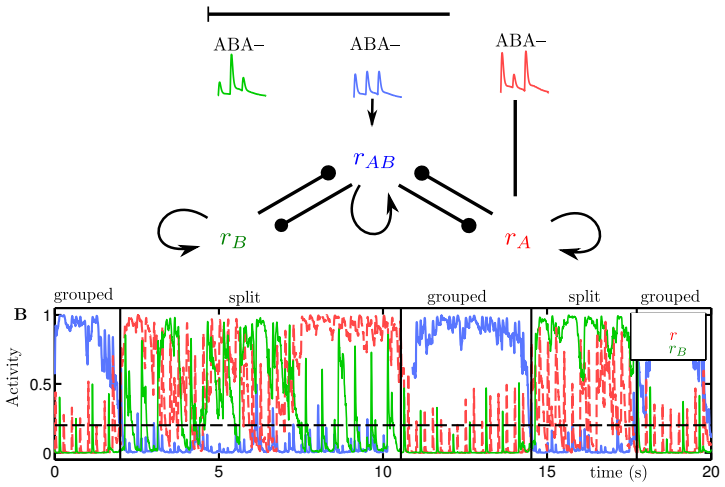

Figure 1: **A:** Tonotopically organised populations r_A, r_{AB} and r_B have best frequencies A, $(A+B)/2$ and B, respectively. Input profiles mimic A1 responses from Fishman et al (2001) and Micheyl et al (2005); our network is assumed to be in a higher perceptual competition area that takes input from A1. Each populations has intrinsic adaptation (not shown), self inhibition (not shown) and recurrent NMDA excitation; there is mutual inhibition between the units. **B:** Activity time course where central population encodes the grouped percept and the peripheral populations encode the split percept.