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A neural oscillator model of auditory selective attention

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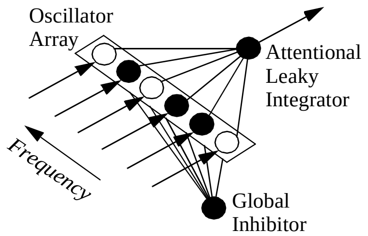
Auditory Scene Analysis (ASA: Bregman, 1990) describes how multiple simultaneous sounds can be separated into distinct perceptual objects called *streams*, each describing a single sound source. This process takes place in two conceptual stages: segmentation, in which the mixture is split into its atomic units, followed by grouping in which segments which are likely to have arisen from the same source are recombined.

ASA has traditionally been seen as a precursor to attentional mechanisms, which simply select one stream as the attentional focus. However, recent work by Carlyon *et al.* (2001) suggests that auditory attention plays a key role in the ASA process. They found that listeners failed to perform auditory streaming of alternating tones when they were instructed to attend to a distractor task in the contralateral ear - when listeners attended to the tones, streaming occurred as normal.

The work presented here incorporates this finding into a new model of ASA in which attentional factors play a role in both the grouping and stream selection stages. The model is based upon an oscillatory correlation framework, in which neural oscillators representing a single perceptual stream are synchronised, and are desynchronised from oscillators representing other streams.

Initial stages of the model consist of auditory peripheral processing followed by pitch and harmonicity analysis. The core of the model consists of a single dimensional array of oscillators, each of which corresponds to a frequency channel (figure 1). Lateral connections between oscillators encode segments and harmonically related groups of segments. Each oscillator is connected to the 'Attentional Leaky Integrator' (ALI) by connections whose weights are modulated by attentional interest. ALI output represents the stream in the attentional foreground.



The model displays a good quantitative match to the stream segregation/temporal coherence behaviour described by van Noorden (1975). In addition, the network can account for sequential tone capturing; segregation of a mistuned harmonic from a complex tone and associated pitch shift phenomena (Darwin *et al.*, 1995); and involuntary reorientation of attention in response to a loud sound.

The model has been expanded to include binaural effects allowing the full range of inter-ear attentional competition phenomena to be simulated (e.g. Carlyon *et al.* 2001; Darwin *et al.* 1995) and preliminary results are encouraging.

References

Bregman AS. Auditory Scene Analysis. Cambridge MA: MIT Press, 1990.
Carlyon RP, Cusack R, Foxton JM, Robertson IH. J Exp Psychol Human, 2001; 27(1): 115-127.
Darwin CJ, Hukin RW, Al-Khatib BY. J Acoust Soc Am, 1995; 98(2)Pt1: 880-885.
van Noorden LPAS. Temporal coherence in the perception of tone sequences. Doctoral thesis, Institute for Perceptual Research, Eindhoven, NL, 1975.