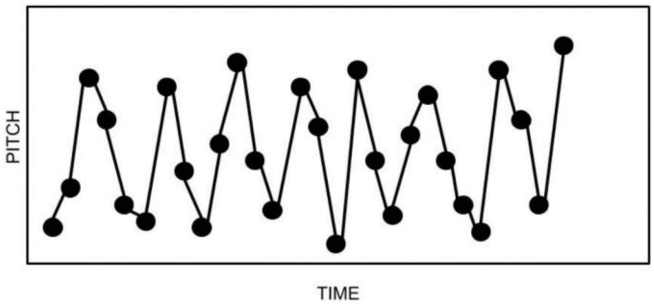
Appendices: An Immersive Guitar System – GASP:
Guitars with Ambisonic Spatial Performance

Appendix 1: ASA and GASP

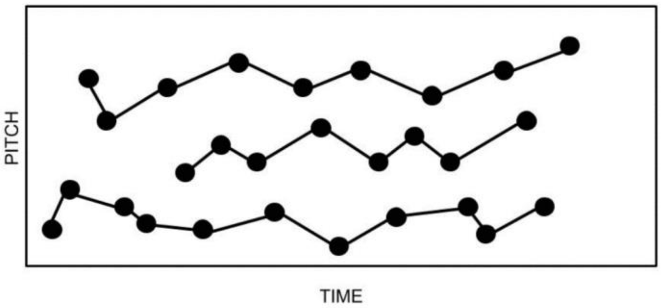
An appreciation of ‘Auditory Scene Analysis’ (ASA) and ‘The Perceptual Organisation of Sound’ (Bregman, A., 2021.) has provided inspiration for some GASP production techniques. By contrasting ASA perceptual grouping and streaming with GASP post-production, then the idea of ‘resynthesised grouping and streaming’ is created, and has informed some of our GASP production techniques.

‘Auditory Scene Analysis (ASA) is the process by which the auditory system separates the individual sounds in natural-world situations, in which these sounds are usually interleaved and overlapped in time, and their components interleaved and overlapped in frequency’ (ResearchGate. 2021).

ASA processes enable both identification and description of individually perceived sound components of a complex sound, or series of sounds. ASA identifies two main grouping principles, broadly categorised as ‘Sequential Grouping mechanisms’, that is, those that operate through time, and ‘Simultaneous Grouping mechanisms’, those that operate across frequency. A simple example of ASA sequential grouping is depicted below:



Depiction of a series of notes perceived sequentially (Upload.wikimedia.org. 2021.)



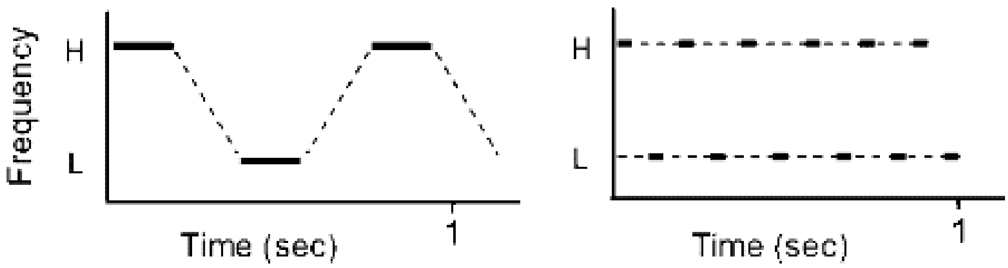
The same set of notes depicted as perceived as three discrete auditory streams (ibid)

A number of GASP post-production techniques may be considered to be derived from, and inspired by, ASA grouping and streaming; these are largely associated with perceived pitch, timbre, loudness, and spatial positioning. In one sense, we can consider GASP post-production techniques to be the resynthesis of some of the ASA perception categories, where we can reinterpret ASA sound perception categorisations for creative GASP post-production outcomes. A way of considering this production process may be coined 'Auditory Scene Synthesis' (ASS).

In a basic sense, the separation of the individual strings of the guitar output into 'stems' in a DAW can be considered to be an example of what might be called 'forced' sequential grouping, although this is one of the most simplistic analyses which may be made in the process of GASP post-production. Other post-production judgements may include the grouping together, or the segregation of individual, or collections of identified notes, which in turn allow creative GASP post-production decisions to be formed; for example, the extraction of a 'hidden' phrase or melody, or other interesting musical elements, which without access to the separate string information would not be available to the music producer.

Appendix 2: ASA streaming

A good example of ASA is the phenomenon of streaming, where a stream may be perceived as either integrated or segregated. If two sounds, A and B, are rapidly alternated in time, A-B-A-B-A- etc, then if the quality of the sounds change after a few seconds, (e.g., speed, pitch, timbre, or spatial location), then the perception will split, such that the listener hears two, rather than one stream of sound, where each new stream corresponds to the repetitions of one of the two sounds, for example, A-A-A-A-, etc. accompanied by B-B-B-B-, etc.



A cycle of alternating high (H) and low (L) pure tones. In Fig 1a (Panel a), the rate is 3 tones per sec, in Fig 1b, it is 12 tones per sec. Dashed lines show the perceptual grouping (ResearchGate. 2021.)

The streaming phenomenon provides a simplified example of sequential grouping. A repeating cycle of sounds is formed by alternating two pure tones, one of high frequency (H) and one of low frequency (L), of equal duration. The cycle begins slowly – say three tones per sec– and gradually speeds up to 12 tones per sec. At the slower speeds listeners hear an up-and-down pitch pattern and a rhythm that contains all the tones. At the faster speed they hear two streams of sound, one containing only the high sounds and a second containing only the low ones. It appears that there has been a perceptual grouping of the tones into two distinct streams (van Noorden, 1982). Intermediate speeds may lead to ambiguous organizations in which the listener can consciously control whether one or two streams are heard.

Appendix 3: Spatial Note Separation and Critical Bands

An interesting feature of the GASP project is that it enables some interesting psychoacoustic listening experiments to be carried out, the effects of which may be utilised creatively in the composition and post-production process. One such feature is the relationship of spatial separation with Critical Bands (Sfu.ca. 2021). In psychoacoustics, Critical Bands are fundamental to our music perception system, in particular our perceptions of musical consonance and dissonance. On the guitar it is quite easy to create chords which have dissonant qualities (whether by choice or accident!). As a simple example in a monophonic environment, if two adjacent strings are played together, and if their fundamental frequencies are close enough together to be within a Critical Band, then this will appear to be musically dissonant. However, if we play the same two strings through headphones with one string to one earphone and the other string to the other earphone, then the dissonant sensation is significantly reduced as each sound is processed though the individual cochleae i.e., one in each ear, and we hear the two tones as two separate events, without the same dissonance as in mono. These are known as first order cochlea effects (in the ear) however, there are also second order neural effects (in the brain), which are not as strong, the descriptions of both being beyond the scope of this document. Recognition of this phenomena can then facilitate new creative approaches within the spatial composition and production medium, where the use of purposeful dissonance effects, as either integrated or segregated, may be exploited within the spatial environment.

References

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