Supplementary material

Auditory motion discrimination study
To ensure that the motion sounds provided motion cues that enable reliable motion discrimination, three additional naïve subjects were presented with leftward auditory motion, rightward auditory motion and non-motion sound stimuli in an auditory motion discrimination task. The stimuli were identical to the auditory stimuli presented in the binocular rivalry experiment. The experiment presented 60 trials of each sound condition in a randomized fashion in three runs. After each sound of 2 s duration, subjects indicated the direction of auditory motion via button response (left = left motion; right = right motion; no button = no motion). As shown in supplementary table 1, all subjects achieved performance accuracy > 90 %. These results demonstrate that the motion sounds created by generalized HRTFs provided sufficient motion cues to enable reliable auditory motion discrimination.

<table>
<thead>
<tr>
<th></th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>93.34%</td>
<td>88.33%</td>
<td>95%</td>
</tr>
<tr>
<td>Run 2</td>
<td>91.67%</td>
<td>95%</td>
<td>96.67%</td>
</tr>
<tr>
<td>Run 3</td>
<td>93.34%</td>
<td>91.67%</td>
<td>93.34%</td>
</tr>
<tr>
<td>Mean</td>
<td>92.78%</td>
<td>91.67%</td>
<td>95%</td>
</tr>
</tbody>
</table>

Performance accuracy for auditory motion discrimination

Supplementary table 1

In–depth analysis of the relationship between signal changes and perceptual alternations in experiments 2 and 3

Previous experiments have demonstrated that subjects continue seeing with the dominant eye and report a perceptual alternation, when the stimuli are interchanged between the two eyes (Blake et al. 1980). Further, several rivalry experiments have demonstrated that transients in the stimuli can induce perceptual switches with and without changes in eye dominance (Blake & Fox, 1974; Wolfe, 1984; Kanai et al., 2005; Bartels & Logothetis, 2010). We therefore investigated whether perceptual changes in experiments 2 and 3 were related to changes in physical stimuli and whether these perceptual changes favoured congruent or incongruent percepts. We hypothesized that perceptual alternations would increase shortly after the physical change and favour the congruent percept.
To characterize the relationship between motion signal changes and perceptual alternations in experiments 2 and 3, we sorted the perceptual alternations as a function of time after physical change in auditory and visual motion direction. Perceptual alternations were then assigned to equally spaced time bins of 200 ms (within the 2 s range that is defined by two subsequent alternations in motion direction).

**Experiment 2:** Supplementary Figure 1 shows the empirical distributions of perceptual alternations over time bins. We have classified the perceptual changes into four categories: (i) indeterminate -> congruent, (ii) indeterminate -> incongruent, (iii) incongruent -> congruent, (iv) congruent -> incongruent. A perceptual alternation refers to the subject’s report of, for instance left visual motion followed by right visual motion or vice versa. Since every 2 s the motion direction of the visual signal was swapped across the two eyes, a subject would report alternating left-right-left-right motion percepts every 2 s, if a single eye dominates for periods longer than 2 s. This response pattern would increase the probability of a perceptual alternation time-locked to the change in motion signal leading to a non-uniform distribution of perceptual changes. Because of response delays, a perceptual alternation that follows the congruent eye would be reflected in a perceptual switch from incongruent percept (= immediately after the physical change, i.e. too early to be indicated by the subject) to the congruent percept (= after subject indicates the perceptual alternation) shortly after the physical change. Conversely, a perceptual alternation that follows the incongruent eye should be reflected in a change from congruent into incongruent percept shortly after the physical change. In addition to those perceptual alternations that emerge when the physical stimulus changes and a particular eye stays dominant, perceptual alternations can emerge because of switches in eye dominance in the absence of a physical change. These should be reflected in direct switches between congruent and incongruent percepts that are not time-locked to the physical change. Finally, given the short dominance periods, perceptual alternations would occur primarily as changes from indeterminate to congruent or incongruent percepts. Since stimulus transients can induce perceptual alternations, these changes may also be time-locked to the physical change. For all perceptual alternations, we expected more changes towards congruent than incongruent percept indicating the bias induced by the motion sound.

Indeed, the analysis revealed that perceptual alternations occurred with increased probability shortly after a signal change in visual and auditory motion direction. Supplemental Figure 1 shows that most alternations into the congruent percept occurred after a piecemeal period, and that the majority of these switches occurred immediately following a change in stimulus direction, with nearly twice as many changes towards congruent than incongruent percepts. Furthermore, we also observed more changes from incongruent to congruent percept than vice versa, again time-locked to the physical change. These time-locked changes between congruent and incongruent percepts immediately after the physical change most likely indicate the maintenance of eye dominance across a physical change. Thus, the auditory motion signal stabilized the dominance particularly of the eye that is presented with congruent visual motion. The likelihood of remaining dominant was increased for the congruent eye.
Supplemental Figure 1. Distribution of perceptual alternations as a function of time after change in motion direction for Experiment 2

Supplementary Figure legends:
Supplemental Figure 1
Perceptual alternations (across subjects' mean +/- SE) as a function of time bin after change in motion direction are displayed for all possible perceptual transitions: (i) indeterminate towards congruent, (ii) indeterminate towards incongruent, (iii) incongruent towards congruent and (iv) congruent towards incongruent. The number of transitions refers to the mean across one 200 s run.
**Experiment 3:** Supplemental Figure 2 shows the empirical distributions of perceptual alternations over time bins for the two motion-sound conditions. In contrast to experiment 2, subjects reported whether they perceived coherent or random motion. Hence, a perceptual alternation here refers to a change in subject’s report from coherent visual motion to random motion or vice versa. This difference between experiment 2 and 3 is essential, because ‘perceptual alternations’ in motion direction as in experiment 2 (e.g. left motion followed by right motion) are not coded as a perceptual alternation in experiment 3. Instead, in experiment 3, the percept of coherent visual motion with alternating directions is regarded as one persistent percept which is either congruent or incongruent with respect to auditory motion direction throughout an entire 200s run. Further, perceptual alternations between coherent and random motion reflect changes in eye dominance in experiment 3 while perceptual alternations between left and right visual motion in experiment 2 may coincide with persistent dominance of one eye. The histograms of perceptual alternations (and hence switches in eye dominance) in Figure 3 show a relatively uniform distribution suggesting that switches in eye dominance were not strictly time-locked to changes in auditory or visual motion direction, even though the perceptual switches towards the coherent percept were slightly elevated immediately following the physical direction change.
Supplemental Figure 2. Distribution of perceptual alternations as a function of time after change in motion direction for Experiment 3

Supplemental Figure 2
Perceptual alternations (across subjects' mean +/- SE) as a function of time bin after change in motion direction are displayed separately for switches towards coherent and random motion percept for the two (i.e. congruent and incongruent) motion-sound conditions over a 200s trial. A perceptual alternation refers to subjects' reporting a transition into the coherent visual motion or random visual motion. Hence, a perceptual alternation is associated with a change in eye dominance. The histograms of perceptual alternations (and hence switches in eye dominance) in Figure 2 show a relatively even distribution, yet small increases similar to those in sup. fig. 1 can be observed in the leftmost and rightmost graphs.