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SHORT AND SWEET

Directionless vection: A new illusory self-motion perception

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Abstract. We report a new visual illusion, "directionless vection." When expanding and contracting optic flows are simultaneously presented in the same depth plane, observers can perceive illusory self-motion (vection) without direction.

Keywords: vection, motion direction, visual illusion.

When stationary observers view large patterns of optic flow simulating self-translation or self-rotation, they often experience illusions of self-motion, known as vection (Fischer & Kornmuller, 1930). This vection normally occurs in the opposite direction to the visual motion (e.g. Seno, Ito, & Sunaga, 2009). However, vection can sometimes occur in the same direction (i.e. "inverted vection"; see Nakamura & Shimojo, 2000). Here we report a new visual illusion of self-motion: observers feel they are moving, but cannot determine the direction of self-motion. This "directionless vection" is created by simultaneously presenting expanding and contracting flows in the same depth plane.

The circular vection induced by simultaneously presenting oppositely directed optic flows has been investigated in several previous studies. Brandt, Dichgans, and Koenig (1973) presented observers with two oppositely directed rotational optic flows—one to the central 30° and the other to the rest of the visual field. They found that the larger (peripheral) optic flow dominated circular vection and its perceived direction. Howard and Heckman (1989) later re-examined the effects of competing central and eccentric displays on circular vection. By manipulating the relative distances, motions and areas of these displays, they confirmed that the (real/illusory) motion of the background determines vection direction.

Recently, studies have also examined the linear vection induced by oppositely directed optic flows. Ito and Shibata (2005) simultaneously presented (i) expanding and contracting flows on different stereo-defined depth planes and (ii) two depth-separated expanding flows, each simulating a different horizontal direction of self-motion. In both cases, they found that vection direction was dominated by the background motion.

Here, we looked at the effect of superimposing expanding and contracting optic flow in the same depth plane (as opposed to different depth planes). To our knowledge, this has never been tried before.

Vection was induced in 10 stationary observers by 4 different displays. Optic flow displays (72° × 57°; presented for 30 s) consisted of 16,000 randomly positioned dots (Seno, Ito, & Sunaga, 2010). In expanding conditions, global dot motion simulated forward self-motion (16 m/s). In contracting conditions, global dot motion simulated backward self-motion (16 m/s). In the superimposed condition, half the dots simulated forward and the remainder simulated backward self-motion. Finally, in the dynamic random dot (DRD) condition, dot positions were refreshed every 100 ms (1,240 dots/frame).

Participants were told to: "Please press the appropriate buttons when you perceive forward or backward self-motion or self-motion without a clear direction. Keep the button depressed as long as your experience of self-motion continues in that direction/s. If such a decision becomes difficult or if

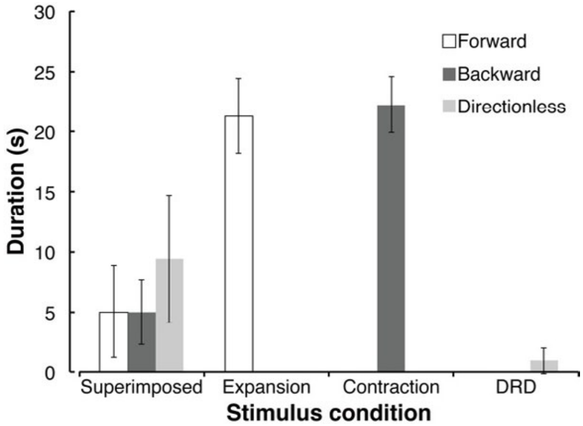

Figure 1. The durations of each type of vection in the four display conditions. Error bars are 95% confidence intervals.

your perception of self-motion disappears, release the button." There were four possible responses, that is, (1) forward vection, (2) backward vection, (3) directionless vection, and (4) no vection.

As expected, (i) only forward vection was reported during expanding flow displays; (ii) only backward vection was reported during contracting flow displays; and (iii) vection was not reported during DRD displays. Superimposed displays induced three types of vection—forward vection, backward vection and directionless vection. The average durations of directionless, forward and backwards vection were 9.3, 5.0 and 4.9 s, respectively (Figure 1). Observers plainly perceived directionless vection when exposed to superimposed conditions. Although some reports of directionless vection were also made during DRD displays, the duration of directionless vection was only significantly larger than zero in the superimposed condition (based on the 95% confidence intervals in Figure 1).

A two-way ANOVA revealed significant main effects of the four conditions and of the three vection directions ($F_{3,27} = 42.80$, $p < 0.01$; $F_{3,27} = 20.82$, $p < 0.01$). The interaction was also significant ($F_{6,54} = 80.99$, $p < 0.01$). The simple main effect of directionless vection was significant ($p < 0.05$) and multiple comparisons revealed that the duration of directionless vection was significantly longer in the superimposed condition than in the other three conditions ($p < 0.05$).

On debriefing, observers reported that although the superimposed condition produced vection, they frequently were unable to determine its direction. This directionless vection did not appear to be simply the result of a bistable perception of these two superimposed optic flows. No one reported perceiving both possible directions of vection (forward and backward) simultaneously. Instead, their reports suggested that directionless vection (induced by the superimposed flow) was a qualitatively different experience from normal forward or backward vection (induced by a single pattern of expanding or contracting flow).

Driven by these reports, we carried out an additional experiment. Each of the eight naïve observers were exposed to the 30-s superimposed displays four times (Figure 2). On each trial, we measured the onset of, and time spent in, the three different vection states (forward vection, backward vection and directionless vection). This time course data (Figure 2) confirmed the subjective reports in the original experiment: Instead of frequent switching between forward and backward vection, vection state/direction was typically stable for about 5 s. The average discrete duration for the three vection states was 4.8 s (4.5 s SD). We also calculated the relative probabilities of transitions to directionless vection. Across the 32 trials (8 subjects viewing the 4 displays), 42 directionless vection periods were obtained. Nineteen of these periods (i.e. 45%) were preceded by no vection, another eight were preceded by forward vection (19%), and the remaining 15 (36%) were preceded by backward vection. The three percentages were not significantly different (one-way ANOVA, $F_{2,14} = 1.02$, $p > 0.05$).

It is known that direction-selective mechanisms (both local and global) are involved in motion perception. Vection has also been thought to be direction-selective—typically occurring in the direction opposite to the global motion signal. However, here we report the existence of a new phenomenon, where vection is experienced apparently without direction. It is not entirely clear (i) what the relationship is between "directionless" and "traditional" vection and (ii) which common mechanisms are shared by them. These intriguing questions should be the focus of future research.

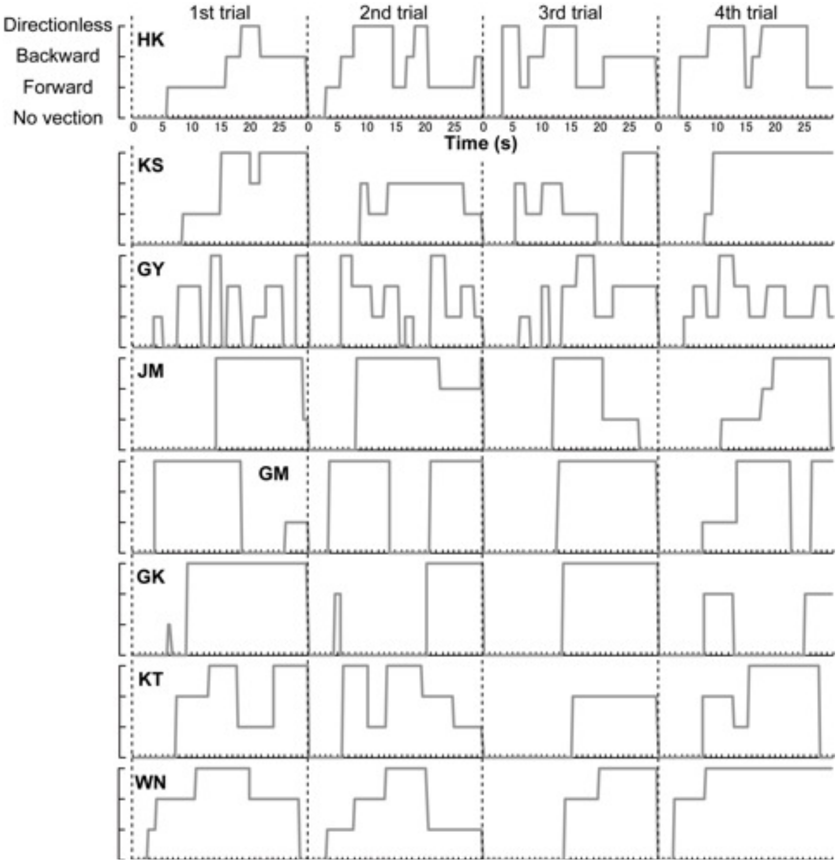

Figure 2. Vection time courses for each trial for each participant (their initials are shown in each first trial graph). The vertical axis indicates vection state (directionless, backward, forward and no vection). The horizontal axis indicates time (30 s per trial). Each panel indicates individual data. The dashed line denotes the start of each trial.

References

Brandt, T., Dichgans, J., & Koneig, E. (1973). Differential effects of central versus peripheral vision on egocentric and exocentric motion perception. *Experimental Brain Research, 16*, 476–491. doi:10.1007/BF00234474

Fischer, M. H., & Kornmuller, A. E. (1930). Optokinetisch ausgeloste Bewegungswahrnehmungen und optokinetischer Nystagmus. *Journal of Psychological Neurology, 41*, 273–308

Howard, I. P., & Heckmann, T. (1989). Circular vection as a function of the relative sizes, distances, and positions of two competing visual displays. *Perception, 18*, 657–665. doi:10.1068/p180657

Ito, H., & Shibata, I. (2005). Self-motion perception from expanding and contracting optical flows overlapped with binocular disparity. *Vision Research, 45*, 397–402. doi:10.1016/j.visres.2004.11.009

Nakamura, S., & Shimojo, S. (2000). A slowly moving foreground can capture an observer's self-motion – a report of a new motion illusion: Inverted vection. *Vision Research, 40*, 2915–2923. doi:10.1016/S0042-6989(00)00149-8

Seno, T., Ito, H., & Sunaga, S. (2009). The object and background hypothesis for vection. *Vision Research, 49*, 2973–2982. doi:10.1016/j.visres.2009.09.017

Seno, T., Ito, H., & Sunaga, S. (2010). Vection aftereffect from expanding/contracting stimuli. *Seeing & Perceiving, 23*, 273–294. doi:10.1163/187847510X532667

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