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# Effects of a benzodiazepine, lorazepam, on motion integration and segmentation: an effect on the processing of line-ends?

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**Abstract**

Previous studies have shown that the perceptual integration of component motions distributed across space is inhibited whenever segmentation cues, such as line-ends, are salient. Herein, we investigate to what extent enhanced inhibition induced by lorazepam, a benzodiazepine facilitating the fixation of GABA on $GABA_A$ receptors, modifies the balance between motion integration and motion segmentation at the behavioural level. Motion integration was tested in 16 healthy volunteers taking a single and oral dose of either placebo or lorazepam (0.038 mg $kg^{-1}$). The stimulus consisted of an outlined diamond presented behind four, otherwise invisible, apertures and translating along a circular trajectory (Lorenceau & Shiffrar (1992). *Vision Research*, *32*, 263–273). Under these conditions, recovering the global diamond direction requires the integration of the component motions available within each aperture. The observers were asked to discriminate the global, clockwise or counter-clockwise, diamond direction under difficult—at high luminance contrasts—or easy—at low luminance contrasts—conditions. Overall, reaction times and error rates increased in the lorazepam group as compared to the placebo group, suggesting strong non-specific effects. However, the changes in performance in the lorazepam group are not homogeneous across conditions, suggesting that lorazepam also induces specific effects that modulate the integration/segmentation balance. Additional experiments performed with visible apertures or visible diamond vertices indicate that the effects of lorazepam are unlikely to reflect a deficit of motion processing or motion integration mechanisms since performance is only slightly impaired in the lorazepam as compared to the placebo group under these conditions. These results suggest that lorazepam might specifically modulate the saliency of line-ends, presumably because processing these features involves inhibitory mechanisms using GABA as a neuromediator, and in turn modify the balance between motion integration and segmentation. 

*Keywords:* Motion Integration; Aperture problem; Benzodiazepine; GABA

## 1. Introduction

The use of benzodiazepines such as lorazepam is widespread in many countries. Although the mechanisms by which lorazepam acts on the central nervous system are known to involve the GABA neurotransmittor, which largely contributes to visual processing at various stages (Bolz & Gilbert, 1986; Norton & Godwin, 1992; Sillito, 1992; Morin & Molotchnikoff, 1994), the effects of lorazepam at the perceptual level have not been thoroughly studied. The target of lorazepam is the benzodiazepine fixation site which is part of the $GABA_A$ receptors. Lorazepam has no effect on $GABA_B$ or $GABA_C$ receptors. Moreover, it has no direct effect on the GABA receptor but acts only in the presence of GABA and potentiates its effect (Hill & Bowery, 1981; Drew, Johnston & Wheatherby, 1984; Johnston, 1994; Mohler, Benke, Benson, Lüscher & Fritschy, 1995; Smith & Olsen, 1995).

In the present study, we used lorazepam in a neuropsychological-like approach to dissociate the different effects of lorazepam on visuo-perceptual processes. Given the relative specificity of the pharmacological action of lorazepam, this approach may provide insights into the functional role of $GABA_A$ connections at the behavioural level and help to relate electrophysiological studies to perceptual processes.

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This approach has already been used to dissociate the different effects of lorazepam on sedation, on the processing of spatial frequencies, on contour integration or attentional processes (Giersch, Boucart, Speeg-Schatz, Muller-Kauffmann & Danion, 1996; Giersch, Boucart & Danion, 1997). It was discovered that perceptual tasks requiring the integration of contours from static stimuli like fragmented, compound letters or fragmented pictures, are particularly affected by lorazepam (Giersch, Boucart, Danion, Vidailhet & Legrand, 1995; Giersch et al., 1996, 1997; Giersch (in press)). The results from these studies were consistent with the hypothesis that lorazepam acts by facilitating the processing of segmentation cues, such as line-ends. Herein, we attempt to generalize these findings to determine to what extent the balance between motion integration and motion segmentation is affected by lorazepam. Indeed, recovering the motion of objects requires that the local responses from cortical neurons to an input image are bounded together. Although the distributed architecture of the primary visual cortex calls for integration processes, spurious associations between features belonging to different objects must also be avoided, implying that segmentation processes are also involved. It has been argued that both processes work in a cooperative/competitive way (Grossberg & Mingolla, 1985; Peterhans & von der Heydt, 1989; Heitger, Rosenthaler, von der Heydt, Peterhans & Kubler, 1992; Gove, Grossberg & Mingolla, 1995) and heavily rely on line-ends processing (Shimojo, Silverman & Nakayama, 1989; Lorenceau & Shiffrar, 1992).

Experimental evidence (Biederman, 1987; Shimojo et al., 1989; Bregman, 1990; Shimojo & Nakayama, 1990; Lorenceau & Shiffrar, 1992; Stoner & Albright, 1992) suggests a straightforward distinction between features produced by accidental occlusion and features that intrinsically belong to objects (Fig. 1). The former do not intervene in visual segmentation whereas the latter signal real contour discontinuities and strongly constrain the parsing of the retinal image into distinct entities (Nakayama, Shimojo & Silverman, 1989; Stoner, Albright & Ramachandran, 1990).

To determine whether lorazepam influences the integration and segmentation of component motions, we used aperture stimuli and manipulated the status, extrinsic or intrinsic, of line-ends that occur at apertures' borders. Using this class of stimuli, Lorenceau and Shiffrar (1992) found that motion integration is easy whenever the line-ends are extrinsic or when their salience is reduced (e.g. at low luminance). On the other hand motion integration is difficult whenever the line-ends are intrinsic (e.g. when the apertures are invisible).

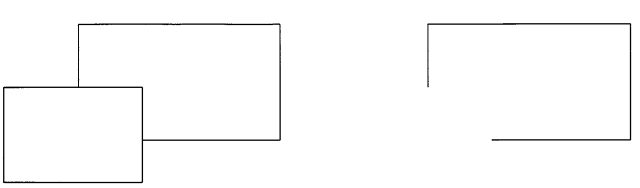

Fig. 1. Examples of intrinsic line-ends (on the left) and extrinsic line-ends with T occlusions (on the right).

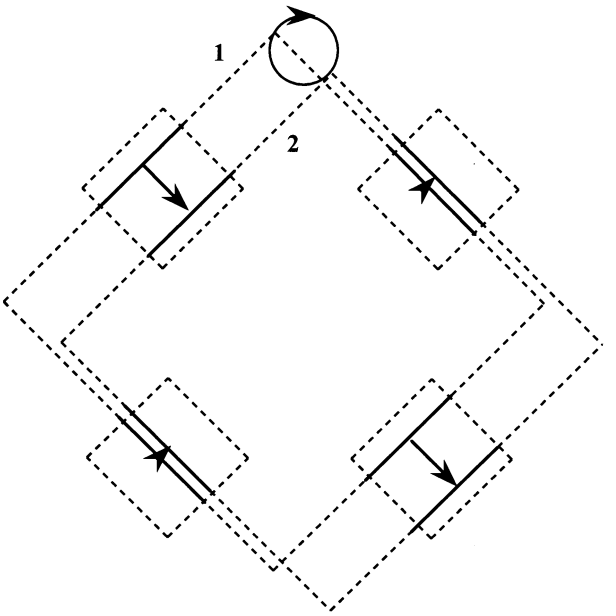


Fig. 2. A diamond seen through four, otherwise invisible, rectangular apertures translates along a circular path in a clockwise or counter clockwise direction, such that only four line-segments are visible. Two frames of an animation sequence are shown. Integrating motion components are required to recover the global diamond's direction.

In the present experiments, we used a display consisting of a diamond outline visible through four invisible stationary apertures such that the diamond's edges were visible, but its corners were hidden. Under these conditions, a circular motion -clockwise or counter-clockwise of the diamond results in local segments motions which may differ from the global motion. In particular, the motion of line-ends at aperture borders, straight and parallel to the borders, is inconsistent with the clockwise or counter-clockwise diamond trajectory (Fig. 2). Lorazepam could affect motion integration performance in a variety of ways: it could decrease contrast sensitivity (Harris & Phillipson, 1995) or impair eye movements (Fafrowicz, Unrug, Marek, van Luijtelaar, Noworol & Coenen, 1995; Hopfenbeck, Cowley, Radant, Greenblatt & Roy-Byrne, 1995). Benzodiazepines might also affect the processing of orientation or direction (Sillito, 1975; Berman, Douglas & Martin, 1992; Bradley, Qian & Andersen, 1995; Somers, Nelson & Sur, 1995). Note that these different potential effects are non-specific, in the sense that they should affect similar experimental conditions that yield easy or difficult motion integration. To isolate a specific effect of lorazepam on motion integration, one must ensure