

# The Role of Binocular Cues in Human Pilot Landing Control

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## Abstract

The paper discusses the possible use of binocular cues by aircraft pilots in the final landing phase through a review of literature. The review includes medical and psychophysical literature, as well as works on pilot training, certification and flight experiments.

The binocular cues can easily be forgotten when selecting candidate cues for simulation or pilot modeling, as their nature is different from pictorial cues such as perspective (e.g., the apparent inclination of the runway sidelines) and position in the visual field (e.g., the distance between touchdown zone markers and the horizon). If mentioned at all, binocular cues are generally said to be insignificant during the visual approach and landing. This paper discusses the verity of the three main arguments for this statement:

- The use of binocular cues is limited to distances too close to be relevant
- Real flight experiments have shown that monocular pilots can still land aircraft safely.
- With many monocular cues available, the contribution of stereopsis is negligible.

A wide variety of limiting distances was found in literature. The experimental methods and environments, as well as the definition of 'limit' appear to vary widely. This paper tries to extract a 'practical limiting distance' with respect to various aircraft-related tasks.

Research papers on binocular versus monocular landing experiments have been reviewed. Pilots can land aircraft safely by using only one eye and adapt quickly to using only one eye. However, observed changes in approach style and the reported increase in pilot workload suggest that binocular cues are used in routine landings, at least for the small aircraft considered in the discussed experiments.

A runway outline provides strong linear perspective cues and familiarity of a pilot with an airport can add 'familiar size' cues for altitude and distance. Literature shows that stereoscopic depth perception may be fused with monocular cues, but will rarely be dominant.

It was concluded that stereopsis can be used as a cue to depth up to distances of several hundreds of meters, but its practical limit should be expected to lie between 20 and 65m and stereopsis is very unlikely to be a cue of significant importance beyond 100m. These limits imply that for small aircraft, helicopters and ground operations stereopsis will be beneficial. For simulation or human pilot modeling regarding the landing of mid-sized jet aircraft stereopsis can be ignored. Other interesting findings include the importance of the wide field of view which comes with binocular vision and the notion that the effective use of monocular cues for depth perception can be trained.

**Keywords:** Aviation Medicine, Human Factors, Aircraft Landing, Visual Cues, Ophthalmology, Stereopsis, Monocular Pilots