the neural correlates of the jitter illusion

Thesis submitted by Anna Brooks in May 2004

for the degree of Doctor of Philosophy in the School of Psychology James Cook University

Papers and proceedings arising from this research

Refereed Publications

Brooks A, van der Zwan R, & Holden J (2003) An illusion of coherent global motion arising from single brief presentations of a stationary stimulus. *Vision Research*, 43, 2387-2392.

Conference Presentations

Brooks A & van der Zwan R (2001) Integrating first-order and second-order information during form perception. *European Conference on Visual Perception*.

van der Zwan R & Brooks A (2002) Illusory motion from opposite-polarity form cues: It's not a jitter bug. *European Conference on Visual Perception.*

acknowledgements

To my parents, Tony and Judy, who still provide the best education – in every sense of the term – possible. To my sister Amy, whose love and support is so very important to me. And to Rick, whose ideas, friendship and love I treasure.

To Rita, Betty, Margaret and Alec, whose unconditional love (whilst not always warranted) has been a source of such comfort. And finally to Anne, Laura, Sarah and all the other exciting minds to which I consider myself so lucky to have been exposed – may it always be so.

abstract

The work that follows introduces a new visual illusion. The 'jitter' illusion arises in response to single brief presentations of *stationary* Glass patterns composed of decrement- and increment-defined dot-pairs. Remarkably, the perceptions that arise are of coherent global motion in trajectories that are consistent with the spatial configuration of the Glass patterns; patterns configured according to concentric functions give rise to perceptions of motion in concentric trajectories, those configured according to radial functions give rise to perceptions of motion in radial trajectories, and so on. The aim of the work that follows was to develop a model of the neural correlates of this illusion. An additional aim was to explore the implications of such a model for developing a broader understanding of the means by which coherent visual perceptions arise.

Experiments were conducted under the working hypothesis that the jitter illusion is mediated by activity that arises within the magno-cellular (M-), and not the parvo-cellular (P-) pathway of the visual system. It is argued that a model based entirely on M-pathway activity can effectively account for the illusion if two critical conditions are met. The first is that the model must propose the mechanism by which presentations of stationary Glass patterns stimulate activity in the motion-sensitive cells of the M-pathway. The second is that it must propose plausible mechanism(s) by which the ensuing M-pathway activity gives rise to perceptions of coherent global motion. Experiments reported in chapters 3 and 4 address the first of these conditions. Data from these experiments suggest that abrupt changes in luminance introduced at the onset and offset of stationary Glass patterns (and not eye-movements) mediate the M-pathway activity on which the illusion is based. Experiments reported in chapters 5 through to 8 address the second condition. In chapters 5 and 6, the data suggest that the patterns of Off- and On-channel responses elicited by individual Glass pattern dotpairs somehow stimulates cells that act as 'local' motion detectors. In chapters 7 and 8, models of the means by this occurs were tested. The resulting data rule out the possibility that the stimulation is a product of a processing asynchrony in the Mpathway Off- and On-channels. Instead, they are consistent with a model based on the diphasic temporal impulse-response functions attributed to cells that make up the Mpathway. Based on its ability to satisfy each of the stated conditions, the so-called *diphasic TIRF model* is presented as a plausible account of some of the neural correlates of the jitter illusion.

The implications of the diphasic TIRF model are discussed in relation to both the jitter illusion and to visual processing more generally. One of the critical (and novel) implications of the model is that under some circumstances, M-pathway mechanisms 'extract' structural information from static visual images that P-pathway mechanisms cannot. On this basis, it is argued that both the jitter illusion and the diphasic TIRF model offer valuable insights into some of the means by which lightinduced activity within the human visual system gives rise to coherent global perceptions.

table of contents

chapter 1:		
-	general introduction	1
	Glass patterns	2
	The jitter illusion	2 4 5
	Role of the parvo- and magno-cellular pathways	
	Things to come	9
chapter 2:		
chapter 2.	general methods	10
	Equipment	10
	Stimuli	10
	Subjects	13
	Design and procedures	13
	Results	13
	Checks and balances	15
		10
chapter 3:		
-	the role of eye-movements in stimulating the M-pathway	
	activity	16
	Methods	18
	Results	20
	Discussion	26
chapter 4:		
	the role of stimulus onset and offset profiles in stimulating	
	M-pathway activity	29
	Methods	32
	Results	34
	Discussion	35
chapter 5:		
	the role of M-pathway Off- and On-channels in generating	•
	the illusion	38
	Methods	40
	Results	43
	Discussion	44
chapter 6:		
mapter 0.	the role of local motion detectors in generating the illusion	47
	Methods	49
	Results	51
	Discussion	54
		5 1

chapter 7:		
	LMD activity: a model based on asynchronous off- and	
	on-channel processing	57
	Methods	61
	Results	58
	Discussion	68
chapter 8:		
	LMD activity: a model based on diphasic temporal	
	impulse-response functions	70
	Methods	74
	Results	76
	Discussion	78
chapter 9:		
	general discussion	81
	Review of the findings	81
	Higher-order processing	84
	Broader implications of the model	87
	Conclusion	88
chapter 10:		0.0
	references	89
chapter 11:	annandiaas	05
	appendices	95