



## UvA-DARE (Digital Academic Repository)

### Size matters: Grounding quantifiers in spatial perception

Pauw, S.

**Publication date**  
2013

[Link to publication](#)

#### **Citation for published version (APA):**

Pauw, S. (2013). *Size matters: Grounding quantifiers in spatial perception*. Institute for Logic, Language and Computation.

#### **General rights**

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

#### **Disclaimer/Complaints regulations**

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

---

# Contents

<b>Acknowledgments</b>	<b>ix</b>
<b>I Introduction</b>	<b>1</b>
<b>1 Preface</b>	<b>3</b>
1.1 Introduction . . . . .	3
1.2 Outline . . . . .	5
1.2.1 Part 1 . . . . .	5
1.2.2 Part 2 . . . . .	6
1.2.3 Part 3 . . . . .	6
<b>2 Literature</b>	<b>9</b>
2.1 Introduction . . . . .	9
2.2 Numerosity perception . . . . .	10
2.2.1 Perceptual features of approximate number . . . . .	12
2.3 Results from Developmental Psychology . . . . .	14
2.3.1 Innate Numerosity Perception . . . . .	14
2.3.2 Development of Numerosity Perception . . . . .	16
2.4 Results from Psycholinguistics . . . . .	18
2.4.1 Expected Frequency (Norm) . . . . .	18
2.4.2 Perceptual Features . . . . .	21
2.5 Conclusion . . . . .	23
<b>II Methodology and Technical Background</b>	<b>25</b>
<b>3 Language Processing</b>	<b>27</b>
3.1 Introduction . . . . .	27

3.2	Meaning Representation . . . . .	28
3.2.1	Operations . . . . .	31
3.2.2	Entities . . . . .	33
3.2.3	Networks . . . . .	35
3.3	Meaning Processing . . . . .	36
3.3.1	Interpretation . . . . .	36
3.3.2	Conceptualization . . . . .	39
3.4	Communication . . . . .	42
3.4.1	Grammar . . . . .	43
3.4.2	Flexible Interpretation . . . . .	44
3.5	Discussion . . . . .	48
<b>4</b>	<b>Perceptual Deviation</b>	<b>51</b>
4.1	Introduction . . . . .	51
4.1.1	Spatial Language Games . . . . .	53
4.1.2	Sources of Perceptual Deviation . . . . .	54
4.2	Strict Semantics . . . . .	55
4.3	Lenient Semantics . . . . .	58
4.4	Comparing Strict and Lenient Spatial Semantics . . . . .	61
4.5	Discussion . . . . .	64
4.6	Final Remarks . . . . .	65
<b>5</b>	<b>Clustering Quantifiers</b>	<b>67</b>
5.1	Introduction . . . . .	67
5.2	Embodied Interaction . . . . .	68
5.3	Clustering Quantification . . . . .	70
5.3.1	Acceptability . . . . .	71
5.3.2	Contrast . . . . .	72
5.4	Generalized Quantifiers . . . . .	75
5.5	Experimental Setup and Results . . . . .	76
5.6	Conclusion . . . . .	80
<b>III</b>	<b>Formation Experiments</b>	<b>83</b>
<b>6</b>	<b>Norm Dependency</b>	<b>85</b>
6.1	Introduction . . . . .	85
6.2	Embodied interaction . . . . .	87
6.3	Experiment 1: Absolute quantification . . . . .	89
6.3.1	Baseline experiment . . . . .	90
6.3.2	Acquisition experiment . . . . .	93
6.3.3	Acquisition operator . . . . .	93
6.3.4	Unbiased alignment operator . . . . .	94

6.3.5	Alignment with convexity assumption . . . . .	96
6.3.6	Formation experiment . . . . .	99
6.4	Experiment 2: Scalable quantification . . . . .	102
6.4.1	Baseline experiment . . . . .	103
6.4.2	Acquisition experiment . . . . .	105
6.4.3	Formation experiment . . . . .	107
6.5	Experiment 3: Strategy competition . . . . .	108
6.6	Conclusion . . . . .	110
6.A	Data . . . . .	112
<b>7</b>	<b>Adjectival Origins</b>	<b>115</b>
7.1	Introduction . . . . .	115
7.2	Robotic Language Games . . . . .	116
7.3	Model . . . . .	118
7.3.1	Conceptual system - IRL . . . . .	119
7.3.2	Grammar - FCG . . . . .	125
7.4	Language Innovation . . . . .	126
7.5	Experiments and Results . . . . .	129
7.5.1	Baseline . . . . .	129
7.5.2	Strategy Comparison . . . . .	131
7.5.3	Strategy Competition . . . . .	131
7.6	Conclusion . . . . .	133
<b>8</b>	<b>Grammaticalization</b>	<b>137</b>
8.1	Introduction . . . . .	137
8.2	Experimental Framework . . . . .	139
8.2.1	Model . . . . .	141
8.3	Baseline Experiment . . . . .	143
8.3.1	Baseline Communicative Success . . . . .	143
8.3.2	Baseline Cognitive Effort . . . . .	145
8.3.3	Baseline Lateral Stability . . . . .	147
8.4	Selection Experiment . . . . .	149
8.5	Grammaticalization Experiment . . . . .	150
8.5.1	Reanalysis Operator . . . . .	153
8.5.2	Experiment . . . . .	154
8.6	Discussion . . . . .	158
8.6.1	Conclusion . . . . .	158
8.6.2	Future research . . . . .	159
<b>IV</b>	<b>End Matter</b>	<b>161</b>
	<b>Bibliography</b>	<b>163</b>

Index	174
Samenvatting	179
Abstract	181