

# Table of Contents

<b>Declaration</b>	<b>I</b>
<b>Declaration of Contribution of the Candidate</b>	<b>III</b>
<b>Acknowledgements</b>	<b>V</b>
<b>Abstract</b>	<b>IX</b>
<b>Table of Contents</b>	<b>XI</b>
<b>List of Figures</b>	<b>XVII</b>
<b>List of Tables</b>	<b>XIX</b>
<b>1 Synopsis</b>	<b>1</b>
1.1 Vision and Perception . . . . .	3
1.2 Representing and categorising emotional facial expressions . . . . .	6
1.3 Recognising static and dynamic facial expressions . . . . .	8
1.4 Beyond emotional facial expressions . . . . .	11
1.5 Aim and structure of the thesis . . . . .	13
1.5.1 Summary Chapter 2: The MPI Facial Expression Database: A Validated Database of Emotional and Conversational Facial Expressions . . . . .	14
1.5.2 Summary of Chapter 3: Beyond Emotions: Valence and Arousal drive the Evaluation of a large range of Emotional and Conversational Facial Expressions . . . . .	16
1.5.3 Summary of Chapter 4: Perceptual and Conceptual Representations of Facial Expressions: Making the Con- nection . . . . .	16
1.6 Conclusion . . . . .	17
1.7 Future Work . . . . .	19

<b>2</b>	<b>The MPI Facial Expression Database: A Validated Database of Emotional and Conversational Facial Expressions</b>	<b>21</b>
2.1	Abstract . . . . .	23
2.2	Introduction . . . . .	24
2.3	Ethics Statement . . . . .	33
2.4	Development of the facial expression database . . . . .	33
2.4.1	Determination of facial expressions to be recorded . . . . .	33
2.4.2	Expression models . . . . .	40
2.4.3	Materials . . . . .	41
2.4.4	Video recordings . . . . .	43
2.4.5	Face Scan . . . . .	45
2.4.6	Audio Recordings . . . . .	45
2.5	Validation of the new facial expression database . . . . .	46
2.5.1	Participants . . . . .	46
2.5.2	Experimental design . . . . .	47
2.5.3	Materials . . . . .	47
2.5.4	Task and procedure . . . . .	48
2.5.5	Analysis and results for the context condition . . . . .	50
2.5.5.1	Free naming analysis . . . . .	50
2.5.5.2	Confidence ratings . . . . .	52
2.5.6	Analysis and results for the visual condition . . . . .	55
2.5.6.1	Free naming analysis . . . . .	55
2.5.6.2	Confidence ratings . . . . .	60
2.5.6.3	Naturalness . . . . .	61
2.5.7	Brief comparison between conditions . . . . .	63
2.6	Discussion . . . . .	65
2.6.1	Conclusion . . . . .	68
2.6.2	Obtaining the database . . . . .	71
2.7	Acknowledgments . . . . .	71
2.8	Supplementary material . . . . .	72

---

<b>3 Beyond Emotions: Valence and Arousal drive the Evaluation of a large range of Emotional and Conversational Facial Expressions</b>	<b>81</b>
3.1 Abstract . . . . .	83
3.2 Introduction . . . . .	83
3.3 Method . . . . .	86
3.3.1 Participants . . . . .	86
3.3.2 Materials . . . . .	86
3.3.3 Experimental design . . . . .	87
3.3.4 Task . . . . .	87
3.3.5 Procedure . . . . .	87
3.4 Results . . . . .	88
3.4.1 Data analysis . . . . .	88
3.4.2 Valence and arousal interpretation . . . . .	92
3.5 Discussion . . . . .	94
3.6 Acknowledgements . . . . .	97
3.7 Supplementary material . . . . .	98
3.7.1 Similarity matrices of the facial expressions . . . . .	98
3.7.2 Goodness of fit of multidimensional scaling analysis . . . . .	101
3.7.3 Valence and arousal values for each expression type . . . . .	104

<b>4</b>	<b>Perceptual and Conceptual Representations of Facial Ex-</b>	
	<b>pressions: Making the Connection</b>	<b>107</b>
4.1	Abstract . . . . .	109
4.2	Introduction . . . . .	110
4.3	Experiment 1 and 2: Common aspects . . . . .	114
4.4	Experiment 1 . . . . .	117
4.4.1	Method . . . . .	117
4.4.1.1	Participants . . . . .	117
4.4.1.2	Materials . . . . .	117
4.4.1.3	Experimental design . . . . .	118
4.4.1.4	Procedure . . . . .	119
4.4.2	Results . . . . .	119
4.4.2.1	Order effects . . . . .	119
4.4.2.2	Perceptual Representation Matrix . . . . .	120
4.4.2.3	Rating consistency across participants. . . . .	120
4.4.2.4	Rating consistency within participants. . . . .	121
4.5	Experiment 2 . . . . .	122
4.5.1	Method . . . . .	122
4.5.1.1	Participants . . . . .	122
4.5.1.2	Materials . . . . .	122
4.5.1.3	Experimental design . . . . .	124
4.5.1.4	Procedure . . . . .	124
4.5.2	Results . . . . .	125
4.5.2.1	Conceptual Representation Matrix . . . . .	125
4.5.2.2	Rating consistency across participants . . . . .	125
4.6	Experiment 1 and 2 combined . . . . .	126
4.6.1	Pure emotional expression pairs . . . . .	128
4.6.2	Pure conversational expression pairs . . . . .	131
4.6.3	Mixed facial expression pairs . . . . .	134

4.7	A common conceptual space? . . . . .	137
4.7.1	PCA results . . . . .	138
4.7.1.1	Static emotional expressions . . . . .	139
4.7.1.2	Dynamic emotional expressions . . . . .	142
4.7.1.3	Static conversational expressions . . . . .	145
4.7.1.4	Dynamic conversational expressions . . . . .	148
4.7.2	Canonical Correlation Analysis . . . . .	151
4.8	Discussion . . . . .	153
4.9	Acknowledgements . . . . .	159
4.10	Supplementary material . . . . .	160
4.10.1	Model validation . . . . .	160
4.10.1.1	Standardized residuals . . . . .	160
4.10.1.2	Cook's distance and leverage values . . . . .	162
4.10.1.3	Assumption of normally distributed errors . . . . .	163
4.10.1.4	Assumption of independent errors . . . . .	164
4.10.1.5	Assumption of no-multicollinearity . . . . .	164
4.10.1.6	Adjusted $R^2$ . . . . .	167
4.10.1.7	Bootstrapping . . . . .	168
4.10.2	Pretest and component extraction for PCA . . . . .	170
<b>Bibliography</b>		<b>173</b>