

Nonverbal communication in schizophrenia: A 3-D Analysis of patients' social interactions

Lavelle, Mary

For additional information about this publication click this link.

<http://qmro.qmul.ac.uk/jspui/handle/123456789/2485>

Information about this research object was correct at the time of download; we occasionally make corrections to records, please therefore check the published record when citing. For more information contact scholarlycommunications@qmul.ac.uk

Nonverbal communication in schizophrenia: A 3-D Analysis of patients' social interactions.

Mary Lavelle

Submitted for the degree of Doctor of Philosophy

Queen Mary, University of London

2011

Declaration

I declare that the work presented in this thesis is my own work carried out under normal terms of supervision and that the research reported here has been conducted by myself unless otherwise indicated.

I was personally responsible for the study design, the data collection and the design and implementation of the data analyses. Dr Christopher Frauenberger and Dr Stuart A. Battersby designed and coded the software to run the analyses.

TABLE OF CONTENTS

<i>List of Figures</i>	8
<i>List of Tables</i>	9
<i>Acknowledgements</i>	11
Chapter 1: Thesis Introduction	13
1.1 Social deficits in schizophrenia.....	13
1.2 Normative social interaction	14
1.3 Applying social interaction research to the study of patients’ social deficits	17
1.4 Thesis aims and objectives	18
Part I : Literature Review	21
Chapter 2: Social deficits in schizophrenia	22
2.1 Schizophrenia	22
2.1.1 Symptoms of schizophrenia	22
2.1.2 Illness course and prognosis.....	23
2.1.3 Gender differences in schizophrenia.....	24
2.1.4 Burden of disease	25
2.2 Social functioning deficits in schizophrenia	25
2.3 What underlies social functioning deficits in schizophrenia?.....	27
2.3.1 Neurocognitive impairments	27
2.3.2 Social cognitive impairments	27
2.4 What happens when patients interact with others?.....	30
2.4.1 Findings from patients’ clinical interactions.....	30
2.4.2 Behaviour of patients and their partners outside the clinical context.....	37
2.5 Associations between patients’ social functioning and their clinical, cognitive and nonverbal features	38
2.5.1 Association between patients’ symptoms and social cognition	40
2.5.2 Association between patients’ symptoms and their nonverbal behaviour.....	41
2.6 Chapter summary	41
Chapter 3: Nonverbal dynamics of social interaction	43
3.1 Introduction	43
3.2 Face-to-face social interaction	43
3.2.1 Individual level processes.....	44
3.2.2 Systemic level processes	44

3.3	Multiparty Interaction	46
3.4	Application to the study of social deficits in schizophrenia.....	47
3.5	Nonverbal regulatory processes	48
3.5.1	F-Formation system	49
3.5.2	Interpersonal Co-ordination	50
3.5.3	Function of interpersonal coordination in social interaction.....	60
3.6	Nonverbal behaviours involved in the conversation management processes	62
3.6.1	Nonverbal Feedback	62
3.6.2	Turn Exchange	64
3.7	Chapter summary	65
<i>Part II : Interpersonal Coordination.....</i>		67
Chapter 4: Is nonverbal interpersonal coordination reduced in social interactions involving a patient with a diagnosis of schizophrenia?		68
4.1	Introduction	68
4.1.1	Patterns of interpersonal coordination over time	69
4.2	Methods	70
4.2.1	Study design	70
4.2.2	Study participants.....	70
4.2.3	Assessment measures & equipment.....	72
4.2.4	3-Dimension motion capture equipment	74
4.2.5	Experimental procedure.....	75
4.2.6	Data Analysis	78
4.2.7	Statistical Analysis.....	84
4.3	Results.....	86
4.3.1	Patients' clinical characteristics	86
4.3.2	Sociodemographic characteristics.....	87
4.3.3	Comparison of interaction length by condition.....	89
4.3.4	Comparison of patient and healthy participants' head movement.....	89
4.3.5	Association between patients' medication dose and head movement.....	90
4.3.6	Comparison of interpersonal coordination between conditions.....	90
4.3.7	Patterns of coordination over time.....	95
4.4	Discussion.....	97
4.4.1	Study strengths	98
4.4.2	Study limitations	99
4.4.3	Interpretation of the findings.....	101
4.5	Conclusion.....	104

Chapter 5: Is interpersonal coordination associated with patients’ clinical features, social cognition and social functioning? 106

5.1 Introduction 106

 5.1.1 Association between coordination and patients’ clinical features 106

 5.1.2 Association between patients’ coordination and social cognition 107

 5.1.3 Association between patients’ coordination, rapport and social functioning..... 108

5.2 Methods 108

 5.2.1 Participants 108

 5.2.2 Assessments of executive functioning and IQ 108

 5.2.3 Social cognitive assessments 109

 5.2.4 Social functioning assessments 110

 5.2.5 Assessment of rapport..... 111

 5.2.6 Procedure for administering the assessment tools 111

 5.2.7 Data Analysis 112

 5.2.8 Statistical Analysis..... 114

5.3 Results 115

 5.3.1 Comparison of patient and healthy participants’ anxiety, cognitive and social features 115

 5.3.2 Investigating the impact of antipsychotic medication on patients’ coordination 116

 5.3.3 Association between patients’ coordination and clinical, cognitive and social features..... 118

 5.3.4 Association between patients’ symptoms, rapport and their partners’ coordination 119

5.4 Discussion..... 121

 5.4.1 Coordination and patients’ symptoms 121

 5.4.2 The influence of antipsychotic medication on coordination 122

 5.4.3 Coordination and patients’ rapport 123

 5.4.4 Patients’ coordination and social cognition..... 124

 5.4.5 Patients’ coordination and social functioning 124

5.5 Conclusion..... 125

Part III: Interaction Participation 127

Chapter 6: What is the pattern of participation of patients and their partners in three-way interactions? 128

6.1 Introduction 128

6.2 Conversation role in three-way interactions 128

 6.2.1 Relationship between patients’ interaction participation and their clinical and social features 129

6.3 Method 131

 6.3.1 Participants 131

 6.3.2 Assessment measures..... 131

6.3.3 Data analysis	131
6.3.4 Statistical Analysis.....	134
6.4 Results.....	135
6.4.1 Three-way interaction information	135
6.4.2 Comparison of time spent in each conversation role.....	136
6.4.3 Pattern of interaction participation over time.....	138
6.4.4 Relationship between conversation role and patients' clinical and social features	140
6.5 Discussion.....	142
6.5.1 Chapter strengths and limitations.....	142
6.5.2 Interpretation of the findings.....	142
6.6 Conclusion.....	145
<i>Part IV: Nonverbal cues</i>	<i>146</i>
Chapter 7: Are the nonverbal cues of nodding and gesture atypical in patients' three-way interactions?	147
7.1 Introduction	147
7.1.1 Nonverbal cues and patients' symptoms	148
7.1.2 Nonverbal cues and patients' social functioning and social cognition.....	149
7.2 Method.....	150
7.2.1 Participants	150
7.2.2 Assessment measures.....	150
7.2.3 Data analysis	151
7.2.4 Statistical Analysis.....	152
7.3 Results.....	155
7.3.1 Comparison of patients and healthy participants' hand and head movement	155
7.3.2 Association of medication on patients' individual movement.....	155
7.3.3 Comparison of nodding and gesture by participant type.....	155
7.3.4 Patterns of nodding and gesture over time	159
7.3.5 Relationship between nonverbal cues and patients' clinical and social features.....	161
7.4 Discussion.....	165
7.4.1 Strengths and limitations	166
7.4.2 Interpretation of the findings.....	167
7.5 Conclusion.....	172
<i>Part V: Methodological Interlude.....</i>	<i>173</i>
Chapter 8: Methodological Interlude.....	174
8.1 Introduction	174

8.2 Global level analysis: Interpersonal coordination.....	174
8.3 Interaction context: Conversation role.....	175
8.4 Individual level analysis: Nonverbal cues.....	175
8.5 Summary.....	176
<i>Part VI: Discussion.....</i>	<i>177</i>
Chapter 9: Concluding Discussion.....	178
9.1 Introduction.....	178
9.2 Chapter summaries.....	180
9.3 Contributions to knowledge.....	181
9.4 How do these findings fit with previous research in the field?.....	183
9.4.1 Nonverbal behaviour of patients and their partners.....	183
9.4.2 Interpersonal coordination.....	184
9.4.3 Links with patients' clinical features & rapport.....	185
9.4.4 Links with social cognition & functioning.....	185
9.5 Thesis strengths and limitations.....	186
9.6 Implications of these findings.....	190
9.7 Future directions.....	191
9.7.1 Employing the current data.....	191
9.7.2 Collection of new data.....	193
9.8 Concluding remarks.....	194
<i>Appendix A.....</i>	<i>209</i>
<i>Appendix B.....</i>	<i>213</i>
<i>Appendix C.....</i>	<i>216</i>

List of Figures

Figure 1. Infrared cameras in the Augmented Human Interaction (AHI) laboratory	74
Figure 2. Three dimensions of movement: Vertical, horizontal and depth.....	75
Figure 3. Participants' three-way interaction	76
Figure 4. 3-D wire-frame representation of a three-way interaction	78
Figure 5. Raw motion data of a participant's vertical head movement.....	81
Figure 6. Cross-correlation time series of participants' coordinated head movements	82
Figure 7. Distribution of r in the vertical, horizontal and depth axes with original sign.....	84
Figure 8. Relationship between head movement r and delay	91
Figure 9. Two-way interaction: Unadjusted mean r (A) and delay (B) by condition	92
Figure 10. Three-way interaction: Unadjusted mean r (A) and delay (B) by condition.....	93
Figure 11. Relationship between coordination and time in two-way interaction by condition.....	95
Figure 12. Relationship between coordination and time in three-way interaction by pair type.....	97
Figure 13. Mean r (A) and delay (B) displayed by patients' medication type.....	117
Figure 14. ELAN speaker identity annotation for a three-way conversation.....	132
Figure 15. Assignment of primary and secondary recipient conversation role.....	133
Figure 16. Percentage of time spent in each conversation role by participant type.....	137
Figure 17. Unadjusted mean percentage of time spent in the active pair over time.....	139
Figure 18. Unadjusted mean percentage of patients spent as speakers and primary recipients over time.....	140
Figure 19. Mean percentage of nodding (A) and gesture (B) by conversation role and participant type.....	156
Figure 20. Pattern of nodding and gesture in the role of speaker (A) and primary recipient (B) over time by participant time.	160

List of Tables

<i>Table 1. Chlorpromazine equivalents for antipsychotic medication</i>	71
<i>Table 2. Motion capture data for one three-way interaction</i>	80
<i>Table 3. Patients' clinical characteristics</i>	87
<i>Table 4(a). Sociodemographic information by participant type</i>	88
<i>Table 4(b). Sociodemographic information by condition</i>	88
<i>Table 5. Interaction length (seconds) by condition</i>	89
<i>Table 6. Head movement by participant type</i>	90
<i>Table 7. Pair-wise comparison of adjusted mean coordination by condition</i>	94
<i>Table 8. Pair-wise comparison of adjusted mean coordination by pair type within the patients' three-way interaction</i>	94
<i>Table 9. Mean scores on clinical, cognitive and social measures by participant type</i>	116
<i>Table 10. Adjusted mean r and delay by medication type</i>	118
<i>Table 11. Pair-wise comparison r and delay by medication type</i>	118
<i>Table 12. Correlation of patients' coordination with their clinical, cognitive and social features</i>	119
<i>Table 13. Association of healthy participants' coordination, patients' symptoms and rapport</i>	120
<i>Table 14. Predictors of coordination between healthy participants in the patient group</i>	120
<i>Table 15. Predictors of patients' rapport</i>	121
<i>Table 16. Mean percentage of time in each speaker combination by condition</i>	136
<i>Table 17. Adjusted mean percentage of time participants spend in conversation roles</i>	137
<i>Table 18. Pair-wise comparison of time spent in conversation roles by participant type</i>	138
<i>Table 19. Relationship between patients' time spent in each conversation role and their symptoms and social functioning</i>	141
<i>Table 20. Predictors of patients' time speaking</i>	141
<i>Table 21. Predictors of patients' Quality of Life (MANSA)</i>	141
<i>Table 22. Head and hand movement speed by participant type</i>	155
<i>Table 23. Adjusted means of percentage of nodding by conversation role and participant type</i>	157
<i>Table 24. Pair-wise comparison of nodding by conversation role and participant type</i>	157
<i>Table 25. Adjusted means of percentage of gesture by conversation role and participant type</i>	158
<i>Table 26. Pair-wise comparison of gesture by conversation role and participant type</i>	158
<i>Table 27. Trend analysis of the relationship between participants' nonverbal cue production and time</i>	161
<i>Table 28. Association between patients' nonverbal cues and their symptoms and social features</i>	162
<i>Table 29. Predictors of patients' nodding in the role of primary recipient</i>	163
<i>Table 30. Predictors of patients' social network size (SNS-size)</i>	163

Table 31. *Predictors of patients' social functioning (SIX).....163*

Table 32. *Association of healthy participants' nonverbal cues and patients' symptoms.....164*

Table 33. *Predictors of patients' healthy participant partners' hand gesture when speaking.....165*

Table 34. *Predictors of patients' healthy participant partners' nodding in the role of primary recipient.....165*

Acknowledgements

This thesis would not have been possible without the help of some amazing people that I am fortunate enough to have in my life. Firstly, I owe a great deal of thanks to my supervisors Rose McCabe and Pat Healey for their support, both personally and professionally, throughout the course of this thesis. Their enthusiasm for the research topic and encouragement in taking on new challenges has helped me stay motivated and develop as a researcher. Thank you for sticking with me.

I would also like to thank the fantastic people in IMC who make this group a vibrant and exciting place to work. I feel privileged to have been able to spend the past four years there and I know the friendships I made will endure for much longer than that. In particular, I extend a big thank you to Stu, Colombine, Chrystie, Arash and Chris who made the whole thesis experience much more fun!

It is impossible to sum up how indebted I am to my family. My parents and sisters have been a constant source of encouragement, optimism and care throughout my life and this was no exception. Thank you all for always being at the end of the phone when I needed you, and for all the comedy tales from the worlds of motor-home travel, wrestling and fashion that kept me entertained.

Most of all, I am especially grateful to Meirion for his unwavering support and understanding over the past four years. In the guises of proof-reader, chef and best friend he has celebrated the highs and endured the lows of this thesis with me and managed to keep me smiling throughout. Thank you for everything, I could not have done it without you.

Finally, I wish to thank the patients who participated in this study. I know for some the prospect was daunting. Thank you for summoning up the courage to take part. It was much appreciated.

Nonverbal communication in schizophrenia: A 3-D Analysis of patients' social interactions

Background: Schizophrenia is a severe mental illness affecting approximately 0.4% of the population. A core feature of schizophrenia is social dysfunction, however, the precise nature of patients' social deficits remain unknown. During face-to-face interaction we use nonverbal cues to coordinate, regulate and manage conversation. Patients have difficulty perceiving nonverbal cues in social cognitive tests, but it is unclear if this difficulty persists in their social encounters. The aim of this thesis is to determine if patients' social deficits are manifest in the nonverbal behaviour of their social interactions, specifically investigating; (1) interpersonal coordination between the head movements of interacting partners and (2) the head and hand movements of patients and their partners in the context of conversation role. The relationship between nonverbal behaviour and patients' symptoms, social cognition, rapport and social outcomes will also be assessed.

Methods: The experimental study involved twenty patient (1 patient, 2 healthy participants) and twenty control (3 healthy participants) three-way groups. Groups were motion captured while discussing a moral dilemma. Healthy participants were unaware a patient was present.

Results: (1) interpersonal coordination was reduced in patients' three-way interactions (2) patients displayed less head and hand movement, while their healthy participant partners displayed more. Increased patients' negative symptoms intensified this pattern and were associated with reduced patient rapport. Patients spending more time actively involved in their three-way interactions had poorer social outcomes. Patients' performance on social cognitive assessments showed no association with their nonverbal behaviour.

Interpretation: Patients' three-way interactions display atypical patterns of nonverbal behaviour. The presence of a patient changes the behaviour of the healthy participants they are interacting with; even when they are unaware a patient is present. Patients' symptoms mediate the behaviour of patients and their partners, and influence patients' rapport.

Chapter 1: Thesis Introduction

1.1 Social deficits in schizophrenia

Schizophrenia is a severe mental illness, affecting approximately 0.4 % of the population (McGrath, Saha, Chant, & Welham, 2008). A core diagnostic feature of the disorder is marked difficulties in social functioning (DSM-IV, 2000), defined as ‘difficulty functioning in one or more major areas of life such as work, interpersonal relationships and self-care’ (DSM-IV, 2000). This deficit has a profound impact on patients’ daily lives, for example in establishing and maintaining relationships with friends and family to securing and staying in employment (Erickson, Beiser, & Iacono, 1998; Marwaha & Johnson, 2004). Social deficits have been shown to be present prior to the onset of any positive symptoms, such as sensory hallucinations (Addington, Penn, Woods, Addington, & Perkins, 2008), remain stable over time and predict poorer patient prognosis (Monte, Goulding, & Compton, 2008). Improving social deficits within this patient group would greatly benefit patients’ quality of life and prognosis. However, currently the treatments that successfully target these aspects of the disorder are limited (Marder, 2008). One reason for this may be the lack of satisfactory means of directly measuring social impairment in patients.

Recent initiatives such as the 'Measurement and Treatment Research to improve Cognition in Schizophrenia' (MATRICS) (Marder & Fenton, 2004) have collaborated with drug developers and the Food and Drug Association (FDA) to create the MATRICS Consensus Cognitive Battery (MCCB). This is a battery of cognitive assessments that can be employed during clinical trials to investigate the benefit of drugs on social aspects of schizophrenia. Social cognitive assessments typically require patients to watch video footage of simulated social interactions, which is followed by a series of questions regarding the thoughts and feelings of the actors that they have just watched. Patients with a diagnosis of schizophrenia have difficulty perceiving and interpreting nonverbal social cues when assessed by these tests (Penn, Sanna, & Roberts, 2007). However, such assessments are removed from real-life social situations, and it is unclear if patients’ performance on such tests is reflective of

the social deficit present in their daily lives. As patients' social deficits lie in their social interactions with others, ideally, their social interactions should be directly observed to assess their social deficits. Hence, the primary aim of this thesis is to investigate if patients' social deficits are observable in the nonverbal behaviour of their face-to-face encounters with others. In order to achieve this, we must firstly understand the process of normative social interaction.

1.2 Normative social interaction

The ability to interact socially is an integral part of everyday life. On a daily basis, we engage in numerous, varied social encounters, such as a quick hello to a passing neighbour, a discussion over coffee with a friend or a formal business meeting. Although these interactions may be very different in their content and style, they all require commitment and co-ordination from those involved to allow them to happen.

During an interaction, those involved (i.e. interacting partners) take turns at speaking. Multiparty interactions (i.e. more than 2 people) occur more frequently in naturally occurring conversations (BNC)(Eshghi, 2009). Indeed, patients too frequently engage in multiparty interactions during their routine psychiatric consultations (McCabe, Skelton, Heath, Burns, & Priebe, 2002). In such situations, it would be expected that knowing when to take a turn of speech would be a complex process marred with overlapping speech, pauses and possibly verbal requests for clarity on who should speak next. However, if we consider our own interactions, it is clear that this is not the case. During interaction, even under multiparty conditions, the change of speaker occurs, for the most part, with minimal confusion about who will speak next and when they should begin. So how do we get it right so often?

A successful face-to-face social interaction is achieved by interacting partners coordinating and communicating with each other on a number of levels. Below the surface of the verbal content, over half of the communication between interacting partners is conveyed through use of nonverbal cues such as facial expressions, posture, head and body movement and position, and hand and arm gestures (Burgoon, Buller, & Woodall, 1989).

Consider a meeting between three friends John, Mark and Kate in a café. John and Mark made the journey to the cafe together, where Mark received a parking ticket. Mark is regaling the incident to Kate. At this stage of the interaction Mark, as speaker, directs his gaze towards Kate, making her the recipient of his speech (i.e. addressed recipient). John is currently unaddressed by Mark, yet is none-the-less a ratified member of interaction (i.e. unaddressed recipient). Mark and Kate form the ‘active pair’ in the interaction at this point.

As the addressed member of the conversation, Kate is listening attentively to Mark’s story. This is clear from her nonverbal behaviour. Firstly, Kate is returning Mark’s eye gaze, informing him that he has her attention. Secondly, Kate provides positive feedback to Mark in the form of head nods, facial expressions and possibly, short verbal phrases such as ‘yes’ or ‘um hmm’ known as back channeling. This communicates that she has understood what he has said and that he should continue with his story. The timing of Kate’s feedback is not random but is highly coordinated with Mark’s speech, and occurs at specific junctures in his story.

Coordination between interacting partners is fundamental to the success of an interaction. During the interaction, Mark, John and Kate’s behaviours become coordinated, both in form (i.e. similar behaviour) and timing (i.e. synchronous behaviour), although both may occur beyond the conscious awareness of the interacting partners. Interpersonal coordination adds predictability to the interaction, enabling the interacting partners to coordinate the timing of their behaviour at key points in an interaction such as speaker exchange. More coordination is required at these complex stages of an interaction and is the key ingredient, which allows the ending of one turn and the start of another to appear smooth and seamless.

So back to the café, and Mark is still speaking. He is trying to explain to Kate where he was when he received the ticket. Kate is finding it difficult to understand and although she does not verbalize her difficulty, Mark has detected it through her facial expressions and her reduced positive feedback (i.e. less head nodding or back channeling). In response to this,

Mark tries to clarify his speech using hand and arm gestures to depict the scene adding information and emphasis. Mark also begins to request feedback from Kate by nodding his head to nonverbally to convey the message '*do you know what I mean?*' However, Kate continues to look confused. As a result, Mark decides to hand the floor to John to give him an opportunity to explain it to Kate. Mark does not verbalise this decision but conveys it to John through his nonverbal cues. Firstly, as Mark is still speaking he shifts his gaze and gesture towards John, making him the addressed recipient. Secondly, Mark displays nonverbal cues to convey the ending of his turn of speech, including leaning backwards and lowering his hands from the gesture position. John, interpreting these cues from Mark, realises that he is being requested to take the next turn of speech. As Mark displays the cues to end his turn, John displays the cues conveying that he will begin to speak, including moving his body forwards and becoming increasingly more coordinated with the timing of Mark's speech. This coordination allows the seamless exchange of turns between Mark and John to take place.

From this short scenario it can be seen that the verbal communication in a social interaction is only part of the story. The communication on a nonverbal level provides information about the dynamics of the social interaction, such as; when the interaction starts and finishes, when a turn starts and finishes, the role of each interacting partner in the conversation (e.g. speaker, addressed, or unaddressed recipient), the level of shared understanding between interacting partners, the level of mutual engagement, the joint focus of attention and the syntactic and semantic structure of each utterance (Bavelas & Gerwing, 2007; Goodwin, 1979b; Kendon, 1970). There is strong evidence to suggest that interpersonal coordination plays a key role in rapport, increasing liking and the feeling of connection between interacting partners (Bernieri & Rosenthal, 1991; Chartrand & Bargh, 1999; Miles, Nind, & Macrae, 2009). Thus, the nonverbal exchange between partners works both on a mechanical level, to coordinate partners helping them negotiate conversational processes, and a higher level, establishing the relationships between partners.

1.3 Applying social interaction research to the study of patients' social deficits

As mentioned previously, patients with a diagnosis of schizophrenia have difficulty perceiving and interpreting nonverbal cues when these skills are measured using social cognitive assessments (Penn, Sanna, & Roberts, 2007). Furthermore, some clinicians have reported an intuitive feeling of a lack of rapport when interacting with a patient who has a diagnosis of schizophrenia, known as the Praecox feeling (Rumke, 1990). Taken together, these features point towards a problem in patients' nonverbal communication.

Few studies have assessed what actually happens nonverbally in patients' social encounters. Those that have are predominantly observational analysis of patients' two-way interactions with a clinically trained partner (e.g. a psychiatrist) in a treatment context. Findings of such studies report an overall reduction in patients' expression of nonverbal behaviour. Pro-social expressions of facial affect (Brüne et al., 2008; Fairbanks, McGuire, & Harris, 1982; Gaebel & Wolwer, 2004; Krause, Steimer, Sanger-Alt, & Wagner, 1989), head movement (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010; Troisi, Spalletta, & Pasini, 1998) body movement (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010) eye gaze (Fairbanks, McGuire, & Harris, 1982; Pitman, Kolb, Orr, & Singh, 1987; Troisi, Pasini, Bersani, Di Mauro, & Clani, 1991) and gesture (Troisi, Spalletta, & Pasini, 1998) appear to be particularly reduced. The findings from studies investigating a link between patients' nonverbal behaviour and symptoms have been mixed, with some reporting a greater reduction in patients with negative symptoms (Brüne et al., 2008) and others reporting no association (Troisi, Spalletta, & Pasini, 1998). However, it is unclear how this pattern of reduced behaviour influences patients' social interactions, and their longer term social functioning.

Social interaction is systemic, with the behaviour of each interacting partner influencing the behaviour of all others (Battersby, 2011; Watzlawick, Bavelas, & Jackson, 1967). As such, anomalous behaviour displayed by patients will influence the behaviour of patients' interacting partners. Few studies have examined how others react to patients, based on their social behaviour, when they are unaware of their diagnosis. Measuring the changes in the partners' behaviour provides another perspective on the behaviour of the patient. For

example, going back to the short scenario in the café, Kate's inability to understand Mark is manifest in a reduction in nonverbal movement from Kate, and an increase in hand gesture and head nodding from Mark. Even if Kate's reduction in movement was subtle, this difference can still be detected in the exaggerated movements from Mark. Thus, even subtle changes in the patients' nonverbal communication, may have a greater, measurable impact on the behaviour of their interacting partners. By investigating all individuals within the interaction system, a more comprehensive picture of patients' behaviour can be revealed.

The context in which behaviour is produced is also important for inferring functional meaning to nonverbal behaviour. Returning to the example in the café, if we had analysed the behaviour of Kate out of the context of the situation we could say that she nodded her head but did not use hand gesture. However, if we add the context of conversation role, we can see that she was primarily in the role of addressed recipient during this interaction, therefore head nodding would be expected and hand gesture is likely to occur less frequently.

Identifying the specific patterns of nonverbal behaviour displayed by patients and their partners in the context of their conversation roles in the environment of live conversation would enhance our knowledge of what actually happens in patients' social interactions. Furthermore, it would be a crucial first step in deciphering the interactional and functional impact of any detected anomalies in nonverbal behaviour.

1.4 Thesis aims and objectives

The aim of this thesis is to identify whether anomalies arise in the nonverbal behaviour of patients and their healthy participant partners as they engage in social interaction, and to investigate the link between such anomalies and patients' clinical features, social cognitive abilities, social functioning and rapport. In order to achieve this, the nonverbal behaviour of patients and their partners in two-way and three-way interactions will be measured using 3-D motion capture techniques. Anomalies in nonverbal behaviour will be investigated in three steps: (i) Investigating nonverbal **interpersonal coordination** between interacting partners; (ii) Investigating the pattern of **participation** in patients' three-way interactions

(i.e. participation in the conversation roles of speaker, addressee and unaddressed participant) and (iii) Investigating patients and their partners use of specific **nonverbal cues** when they are actively involved (i.e. in the active pair as speaker and addressee) in patients' three-way interaction.

The relationship between these nonverbal aspects of patients' interactions and their clinical features, social cognition and social functioning will also be considered.

The objectives are as follows:

1. To identify if nonverbal **interpersonal coordination** is reduced in patients' interactions.
2. To explore the **participation** of patients and their partners in three-way interactions.
3. To identify if patients and their partners use of **nonverbal cues** (i.e. nodding and gesture) is anomalous when actively participating (i.e. speaker or addressee) in three-way interaction.
4. To identify if interpersonal coordination, interaction participation, or use of nonverbal cues are associated with patients' **clinical and social** features.

Following these objectives, there are three sets of empirical questions:

Three sets of research questions were posed:

1. Interpersonal coordination

- (a) Is interpersonal coordination reduced in patients' two and three-way interactions?
- (b) What is the pattern of coordination over time?
- (c) Is interpersonal coordination associated with patients' clinical features, social cognition, social functioning and rapport?

2. Participation in three-way interaction

- (a) Is the pattern of participation (i.e. as speaker, addressed or unaddressed recipient) in patients' three-way interactions atypical?
- (b) Is this pattern associated with patients' clinical features and social functioning?

3. Nonverbal cues in the three-way interaction

- (a) Is patients' use of nonverbal cues (i.e. nodding and gesture) atypical when actively involved in the three-way interaction (i.e. as speaker or addressed recipient)?
- (b) Is this associated with their clinical features, social cognition and social functioning?
- (b) Do patients' partners adapt their nonverbal cues to compensate for the patient?
- (d) Is this associated with the patients' clinical features?

Part I : Literature Review

2.1 Schizophrenia

Schizophrenia is one of the most severe and debilitating mental illnesses (World Health Organization, 2004). The reported lifetime prevalence rates of schizophrenia vary from 0.16% to 1.2% (McGrath, Saha, Chant, & Welham, 2008) with a recent systematic review and the World Health Organization (World Health Organization, 2004) both reporting the lifetime prevalence rate of 0.4% (McGrath, Saha, Chant, & Welham, 2008). Although incident rate ratio of males and females was 1.4:1, lifetime prevalence rates for males and females did not differ and were found to be 0.37% and 0.38% respectively (McGrath, Saha, Chant, & Welham, 2008).

Genetic factors and gene-environment interactions together contribute to over 80% of the liability for developing schizophrenia (Tandon, Keshavan, & Nasrallah, 2008). Environmental factors that are linked to a higher likelihood of developing schizophrenia include a history of migration, living in an urban setting, cannabis use, prenatal infection or malnutrition and obstetric complications (McGrath, Saha, Chant, & Welham, 2008; Tandon, Keshavan, & Nasrallah, 2008). The interactions between genetic and environmental features and the process by which they contribute to the development of schizophrenia are not yet understood (Jablensky, 2000; Tandon, Keshavan, & Nasrallah, 2008).

2.1.1 Symptoms of schizophrenia

Patients with a diagnosis of schizophrenia may experience a combination of positive, negative and cognitive symptoms (DSM-IV, 2000). Positive symptoms represent a change in patients' behaviour or thoughts and include sensory hallucinations (e.g. auditory, visual, tactile or olfactory hallucinations) delusional beliefs (e.g., paranoid or persecutory delusions, believing that others are 'out to get you' with no external evidence to support the belief) and disorganized speech (e.g. frequent derailment or incoherence in speech). Negative symptoms represent a withdrawal or reduction in functioning, including blunted affect (i.e. a reduction in the range and intensity of

emotion expressed), avolition (i.e. difficulty initiating or persisting in goal directed behaviour, this may appear as disinterest on the part of the patient as it is manifest in a reduction in interest or enthusiasm for things the individual once enjoyed) and alogia (i.e. poverty of speech, reduced fluency and productivity of speech). Cognitive symptoms refer to difficulty in concentration, memory, following instructions and completing tasks.

2.1.2 Illness course and prognosis

Prior to the onset of any acute symptoms of schizophrenia, patients display a heterogeneous group of behaviours involving difficulty with a variety of areas of functioning that may continue for weeks or years (Yung & McGorry, 1996). Although illness course varies greatly between patients, a substantial number of patients present with multiple episodes of psychosis between which they show, at least, partial remission (Allardyce & van Os, 2008). After diagnosis, many patients display recurrent psychopathology during the first 10 to 15 years (Jobe & Harrow, 2010). Even after the first 10 years, outcome and potential for periods of complete recovery are poor, with the majority of patients being vulnerable to recurring positive and negative symptoms with more persistent symptomatic and functional impairment over time (Jobe & Harrow, 2010). Longitudinal research suggests that outcome for patients with schizophrenia is significantly poorer than that of other psychiatric disorders, including other types of psychotic disorders (Allardyce & van Os, 2008; Jobe & Harrow, 2010). Compared to the general population and other psychiatric disorders, patients with schizophrenia are one of the most socially excluded in society (Social Exclusion Unit, 2004). They have fewer social networks, poorer social functioning and quality of life (Macdonald, Hayes, & Baglioni, 2000)¹. Patients with schizophrenia have a very low employment rate of

¹ The specific social functioning deficits of patients will be discussed in more detail later in this chapter.

approximately 10%-20% (Marwaha & Johnson, 2004). In the UK specifically, employment rates of patients have shown little improvement in recent years compared to the increased employment rates in the general population or those with physical disabilities (Social Exclusion Unit, 2004).

2.1.3 Gender differences in schizophrenia

Males have an earlier age of onset of schizophrenia than women by approximately three to five years (Hafner et al., 1998; Leung & Chue, 2000). The distribution in age of onset for males peaks between the ages of 15-25, followed by a steady decline as age increases (Hafner et al., 1998). However, females show a more complex distribution pattern with two ages of onset, the first occurring between the ages of 15 -30, the second between the ages of 45-49 (late onset) (Hafner et al., 1998). Those studies sampling individuals over the age of 60 have noted a third smaller peak for female age of onset, occurring over the age of 65, indicating a sub group of females displaying very late onset schizophrenia (Castle & Murray, 1993). Over the age of 40, the incidence rate ratios favour females and rise with increasing age, leading to the lack of difference in lifetime prevalence rates between the sexes (Hafner et al., 1998). Males and females also differ in their premorbid functioning, symptoms and illness course. Compared to females, males display poorer pre-morbid functioning in a variety of domains including premorbid adjustment, interpersonal functioning, school and work functioning (Leung & Chue, 2000). Hafner et al. (1998) found that compared to males, females are twice as likely to be married at the time of their first hospital admission. The comparatively better premorbid functioning of females may be a reflection of their later illness onset, providing them with a greater opportunity to build interpersonal relationships and complete educational or vocational training before onset of the illness. In terms of symptoms, male patients present with more negative and cognitive deficits, whereas females present with more affective symptoms (Leung & Chue, 2000). Prognosis is more favorable for females, including less deterioration from baseline functioning, fewer hospital admissions and shorter psychotic episodes (Kohler et al., 2009). Increased age of onset was also associated with better outcome, although in very late onset (65+) the results are mixed (Kohler et al., 2009).

2.1.4 Burden of disease

Positive symptoms of schizophrenia rank third among the most incapacitating conditions for the general population (Ustun et al., 1999). In the World Health Organizations global burden of disease 2004 study, schizophrenia is the sixth leading cause of Years Lived with Disability (YLD) at the global level accounting for 2.8% of the total global YLD's (World Health Organization, 2004). The estimated total societal cost of schizophrenia in 2004/2005 was 6.7 billion pounds in England alone, with the greatest cost being derived through lost productivity due to unemployment, absence from work and premature mortality (Mangalore & Knapp, 2007). The cost of lost productivity through carers was estimated to be 32 million pounds (Mangalore & Knapp, 2007). It is estimated that current interventions at their very best can only reduce 25% of the burden of disease (McGrath, Saha, Chant, & Welham, 2008), thus 75% will remain without the development of new treatment strategies for this patient group.

2.2 Social functioning deficits in schizophrenia

One of the most debilitating features of schizophrenia is social dysfunction. It is a core feature of schizophrenia and must be present for a minimum of six months prior to a diagnosis of schizophrenia being given (DSM-IV, 2000). Social dysfunction encompasses a variety of diverse skills described as 'difficulty functioning in one or more major areas of life such as work, interpersonal relationships and self-care' (DSM-IV, 2000).

Retrospective assessment of patients' pre-morbid social functioning indicates that the impairment is present prior to the onset of any positive symptoms (Addington, Penn, Woods, Addington, & Perkins, 2008; Ballon, Kaur, Marks, & Cadenhead, 2007; Daivdson et al., 1999; Monte, Goulding, & Compton, 2008; Tarbox & Pogue-Geile, 2008). Social functioning deficits remain relatively stable over time and have been associated with poorer prognosis (Monte, Goulding, & Compton, 2008) and resistance to treatment (Caspi et al., 2007).

Social dysfunction has a far-reaching impact on patients' daily lives, from interpersonal relationships with friends and family (Erickson, Beiser, & Iacono, 1998) to obtaining

employment (Kurtz, Wexler, Fujimoto, Shagan, & Seltzer, 2008; Marwaha & Johnson, 2004). As mentioned previously, patients with schizophrenia have very low rates of employment (Marwaha & Johnson, 2004) and are one of the most socially excluded groups in society (Social Exclusion Unit, 2004). Compared to matched healthy controls, or patients with other psychotic disorders, patients have fewer social networks and fewer people to turn to in a crisis (Erickson, Beiser, Iacono, Fleming, & Lin, 1989; Macdonald, Hayes, & Baglioni, 2000). This reduction in social networks and social exclusion leads to a reduced availability of social support. The benefits of increased social networks, and patients' perceived satisfaction with those social support networks, is predictive of improvement in patients' negative symptoms (O'Brien et al., 2006), a more hopeful, goal oriented outlook on their recovery (Corrigan & Phelan, 2004) and improved social functioning (Erickson, Beiser, & Iacono, 1998). Further to this, it has even been suggested that greater social support may even extend the life of patients with a diagnosis of schizophrenia (Christensen, Dornink, Ehlers, & Schultz, 1999). These findings highlight the importance of social support in the development, course and outcome of schizophrenia. For patients and their families, vocational and social functioning has been shown to be one of the most important indicators of the impact of schizophrenia on their lives (Allardyce & van Os, 2008). Indeed, patients themselves deem the ability to function socially in their community as a more important treatment outcome than other frequently disturbing symptoms, such as sensory hallucinations (San, Ciudad, Alvarez, Bobes, & Gilaberte, 2007).

Improving social deficits within this patient group would greatly benefit patients' quality of life and long-term prognosis. However, the precise nature of patients' social deficits remains unknown. Pharmacological treatments have contributed to effective control of positive symptoms and better clinical improvements. However, social functioning has not been found to improve with current medications (Marder, 2008). One key reason for this may be the lack of satisfactory means of directly measuring patients' social impairment. Uncovering the nature of these specific social deficits is a crucial first step in allowing therapeutic targeting and clinical advances in this area.

2.3 What underlies social functioning deficits in schizophrenia?

2.3.1 Neurocognitive impairments

Neurocognitive deficits are estimated to account for approximately 40% of the variance in patients' social deficits, which is seen independent of symptoms (Velligan, Bow-Thomas, Mahurin, Miller, & Halgunseth, 2000). Executive functioning (Bellack, Gold, & Buchanan, 1999; Jaeger & Douglas, 1992) and verbal fluency (Bellack, Gold, & Buchanan, 1999; Brekke, Hoe, Long, & Green, 2007) have been found to predict community social functioning in a variety of patients, including first episode (Johnstone, MacMillan, Frith, Benn, & Crow, 1990) and treatment resistant patients (Meltzer, Thompson, Lee, & Ranjan, 1996). However, a large proportion of the variance in patients' social deficits remains unexplained.

2.3.2 Social cognitive impairments

Social deficits in schizophrenia have received much attention in the field of social cognition. Social cognition is defined as 'the mental operations underlying social interactions, including the human ability and capacity to perceive the intentions and dispositions of others (Brothers, 1990). The behaviour we choose to implement in interaction is based on the interpretations we formulate about the social cues we perceive. Difficulty correctly perceiving or interpreting social cues in interaction has the potential to result in behaviour that is unexpected or deviates from social norms. Studies in the field of social cognition hypothesize that patients' social deficits are attributable to impairments in the social cognitive process. Three key aspects of social cognition commonly investigated in patients with a diagnosis of schizophrenia are (i) Affect perception: recognition of social cues for emotion, including both facial and vocal cues; (ii) Social perception: recognition of nonverbal socially relevant stimuli such as gestures, head and body movements, facial and vocal cues; and (iii) Theory of Mind (ToM): the ability to correctly attribute mental states such as thoughts, beliefs, and intentions to others.

2.3.2.1 How are impairments in patients' social cognition assessed?

Research in the field of social cognition uses lab-based assessments to measure social cognitive skills. Facial affect is most commonly assessed using the “Pictures of Facial Affect Test” (Ekman & Friesen, 1976), in which patients are presented with still pictures of faces displaying either a neutral expression or one of six emotions; happiness, sadness, fear, surprise, disgust or anger. Patients are asked to identify the emotion being expressed.

Assessments of social cue perception typically involve participants watching a series of video clip vignettes of individuals engaging in social interactions. Participants are then provided with a list of statements about the interaction that they have just watched and asked to say which statements they think are true. One such test is the “Social Cue Recognition Test” (Corrigan & Green, 1993) In this test the statements vary in their level of abstraction from concrete statements about social cues e.g. ‘*Mark and Sally were assembling a puzzle together*’ to more abstract statements requiring participants to infer thoughts or feelings of the interacting individuals, e.g. ‘*Carl did not say anything because he was depressed*’. Patients are scored based on their ability to correctly identify the social cues.

Theory of mind (ToM) can be assessed using a variety of lab-based measures. Two measures predominantly used are (i) false belief tasks and (ii) tests of hinting or irony. The false belief tasks assess first or second order theory of mind. First order ToM tests assess patients' ability to understand that someone can hold a belief that is different from the actual truth (e.g. Sally Anne Task (Baron-Cohen, Leslie, & Frith, 1985)). Second order theory of mind is more complex and assesses patients' ability to make inferences about what one person believes about another persons' belief (e.g. Ice-cream Van task (Baron-Cohen, 1989)). In assessments of this kind, participants are given a scenario involving a number of characters and asked to infer the belief of the characters. The tests of hinting or irony (e.g. The hinting task (Corcoran, Mercer, & Frith, 1995)) have a similar structure to the false belief tasks, where patients are read aloud statements in which someone gives a hint. An example is: A child and his mother are in the sweet

aisle and the child says ‘*Those treacle toffees look delicious Mum*’, the participant is then asked to infer what they really mean.

2.3.2.2 Findings from studies employing social cognitive assessments

Findings from such studies demonstrate that patients with schizophrenia have difficulty recognising emotion in the faces of others, particularly negative emotions such as; fear, anger and disgust (Addington & Addington, 2008; Bigelow et al., 2006; Kohler et al., 2003; Lewis & Garver, 1995; Phillips et al., 1999; Toomey, Schuldberg, Corrigan, & Green, 2002; Turetsky et al., 2007). Furthermore, patients tend to over-attribute negative emotions to neutral expressions (Kohler et al., 2003; Phillips, Drevets, Rauch, & Lane, 2003; Toomey, Schuldberg, Corrigan, & Green, 2002; Turetsky et al., 2007). Similarly, compared to healthy controls, patients show impaired performance on measures assessing their sensitivity to nonverbal social cues such as the profile of nonverbal sensitivity test (Sergi et al., 2007; Sergi & Green, 2003; Toomey, Wallace, Corrigan, Schuldberg, & Green, 1997), with patients displaying greater impairment when the social cues are more abstract and require patients to infer the thoughts and feelings of others (Addington & Addington, 2008; Corrigan & Addis, 1995; Corrigan & Nelson, 1998; Corrigan & Toomey, 1995; Ihnen, Penn, Corrigan, & Martin, 1998). Similarly, patients display impaired performance when inferring the beliefs of others in assessments of theory of mind (Binz & Brune, 2010; Brune, 2003; Corcoran & Frith, 2003; Corcoran, Mercer, & Frith, 1995; Mazza, De Risio, Surian, Roncone, & Casacchia, 2001).

2.3.2.3 Limitations of social cognitive assessments

It is clear that patients with a diagnosis of schizophrenia demonstrate impaired performance on social cognitive assessments, however it is difficult to ascertain precisely what poor performance on these tests actually means. Firstly, patients with a diagnosis of schizophrenia typically experience difficulty with neurocognitive features of memory and vigilance (Addington & Addington, 2008; Braff, 1993) and demonstrate poorer performance than healthy controls on a range of cognitive tasks, not only those related to social cognition (Braff, 1993). Therefore, patients are at a disadvantage in completing these tasks from the outset. Indeed, performance on assessments of facial

affect and social cue perception have been associated with patients' memory (Corrigan, 1997; Schneider, Gurb, Gurb, & Shtasel, 1995). Secondly, the process of completing a lab-based social cognitive test is removed from real life social interaction. During actual interaction we must perceive and interpret streams of social cues and respond appropriately within fractions of a second. The process may occur beyond the conscious awareness of the individual. Therefore, patients' ability to make explicit judgments about social cues in a test situation may be a different skill to those that occur beyond conscious awareness in actual interaction. As such, patients' test performance may not necessarily represent their ability to perform these skills in the corresponding real world social situation. Evidence for a discrepancy between task performance and real world skill has been demonstrated in patients' theory of mind (McCabe, Leudar, & Antaki, 2004). Although patients display poor performance on assessments of theory of mind, patients have been shown to display both first and second order theory of mind in their clinical consultations (McCabe, Leudar, & Antaki, 2004). In this study, patients' clinical consultations were analyzed using conversation analysis techniques. Patients designed their contributions on the basis of what they thought their interacting partners knew, furthermore, they recognised that others did not share in their delusional beliefs and attempted to reconcile others beliefs with their own (McCabe, Leudar, & Antaki, 2004). It is within patients' actual social interactions that the social deficits arise, therefore, we propose, that it is this that should be investigated. If patients do experience difficulty sending, perceiving and interpreting social cues during actual interaction, it would be expected that this would manifest in a variety of ways in patients' interactions with others.

2.4 What happens when patients interact with others?

2.4.1 Findings from patients' clinical interactions

Some psychiatrists have suggested that they could intuitively sense when they were interacting with a patient who had schizophrenia, as they experienced a feeling that 'something was wrong' in the interaction (Rumke, 1990; Schefflen, 1981; Schwartz & Wiggins, 1987). This feeling was described more specifically as a feeling of being unable to connect with the patient and that the relationship lacked rapport. This was labeled the 'Praecox feeling' (Rumke, 1990). In an attempt to explain the underlying

nature of the 'Praecox feeling', Rumke suggested that it is something within the patient that determines interpersonal relationships which is affected and this results in the social interaction, which lacks rapport (Rumke, 1990). The Praecox feeling occurs in the absence of any verbal indicators by the patient, and is an intuitive recognition of subtle abnormalities in the patients' behavior (Rumke, 1990; Scheflen, 1981).

A study conducted by Grube (2006) was one of the first empirical investigations of the diagnostic reliability of the Praecox feeling. In this study, 67 patients with acute symptoms belonging to the schizophrenic spectrum, such as paranoid delusions and hallucinations, were interviewed by experienced psychiatrists that were unfamiliar to the patients. Psychiatrists interviewed the patient using the present state exam and did not know the patients' history or diagnosis. The interview was interrupted after a few minutes and the psychiatrist was asked to rate the intensity of the Praecox feeling for the patient they were interviewing on a four-point scale consisting of: not present, mild, moderate or high. Diagnosis using ICD-10 or DSM-IV was carried out by an independent rater separately. Psychiatrists' rating of Praecox feeling correlated with the diagnostic classification in about 80% of the cases. This suggests that psychiatrists are detecting something in the patients' behaviour which is associated with their diagnosis of schizophrenia and detrimental to patient rapport (Grube, 2006).

2.4.1.1 Interpersonal coordination in patients' clinical interactions

A key feature of rapport is coordination between interacting partners. Interpersonal coordination has been identified under a variety of names, such as synchrony and mimicry. However, all names refer to the same construct defined as 'degree to which the behaviours of interacting partners are non-random, patterned or synchronized in both timing and form' (Bernieri & Rosenthal, 1991). A detailed discussion of interpersonal coordination will be presented in chapter 3. However, only one study to date has investigated coordination in interactions involving a patient with a diagnosis of schizophrenia, and it is presented below.

Condon and Ogston (1966) were the first to discover the phenomenon. The original premise of their study was twofold, firstly, to discover discrete measurable units of

behaviour within, and between, people involved in an interaction, and secondly, to compare this pattern of behaviour to that of patients with a diagnosis of schizophrenia. During the process of the study, their findings led them to change the focus of their investigation from identifying units of behaviour to identifying points of synchronous change between body motion and speech. Interactions between two-way healthy control participants were recorded at 48 frames per second, twice the standard frame rate used for similar studies at this time, allowing for greater accuracy in the discrimination of changes in body motion. Both the verbal and nonverbal interaction was recorded using a single camera. The body motion of participants' head, facial features, trunk, arms, hands and fingers were transcribed alongside speech. The speech of sections of the interaction was transcribed frame by frame at the phoneme level, the smallest unit of speech. Concurrently, the movement of each body part was analysed frame by frame and the exact points of behavioural change were recorded alongside the transcribed speech, creating a behavioural stream. A point of behavioural change was designated as the initiation, or termination, of a movement or change in speed or direction of any body part. Changing and sustaining any body movement was termed a "process unit", beginning with the initiation and terminating when the movement changes direction. Analysis of the behavioural stream revealed that patterns of change of body movements, (i.e. process unit boundaries) of the speaker occurred synchronously with the phonemes of their speech. On a broader level, as the phone becomes the syllable, which becomes the word, the bodily movements were seen to coordinate with the transition points in the speakers' articulatory process. This coordination of the speakers' speech to their body movements was described as speakers' dancing to their own speech. On an interactional level, the transcription revealed that the patterns of change displayed by the body movements of the listener co-occurred with the phrase or utterance length of the speakers' speech. Thus, demonstrating coordination between the speakers' speech and their partners' body movement. Condon and Ogston found both self and interaction coordination to be pervasive in two-way interaction between healthy control participants.

In the assessment of behaviour in schizophrenia, one patient with a diagnosis of schizophrenia was used as a case study. The patient, described as chronic, was recorded while engaged in a two-way clinical interview with their psychiatrist. The interview was

recorded and transcribed as described previously. Analysis of the patient's behaviour revealed they had reduced body and head movement, reduced intonation in speech, and an overall flat appearance (i.e. blunted affect) with reduced variance in facial expression with a particular reduction in upper facial movements such as brow and eyelids. The patient showed less mutual gaze with the psychiatrist and tended to orient away from them. Compared to control participants, patients displayed less coordination. Interviews with two other patients with a diagnosis of schizophrenia were also analysed in this study. The findings indicated a marked reduction in coordination in one patient and minimal reduction in a second. Little information was provided on the patients' symptoms at the time of the interaction. However, the patient who displayed minimal reduction was reported to be 'much improved' by their psychiatrist. Unfortunately, no other information was provided, thus it is impossible to make inferences about the association with symptoms in this case.

The findings from this detailed case study point to a potential difficulty in patients' behavioural coordination. The strength of this study is the level of detail employed to discover the minute level of intra and interpersonal coordination. Similarly, the weakness of this methodology is that the minute level of analysis is so exhaustively time and labour intensive that it would not be feasible to employ such a methodology on a large scale. As only three patients were involved in this study, and with only one being fully reported, it is difficult to draw any definitive conclusions from this analysis. This question of whether behavioural coordination is impaired in patients' social interactions remains open and will be a central research question in this thesis.

2.4.1.2 Patients' nonverbal behaviour during clinical interactions

Moving from micro-analytic methods, more recent studies of patients' interactions have been conducted using observational ethological methodology. Typically, such methods catalogue discrete elements of behaviour. Most ethological studies use a variant of an ethological coding system developed by Grant (1968). One of the most frequently used forms is the Ethological Coding System for Interview (ECSI) (Troisi, 1999). Simple or more complex movements such as eye blink, gaze direction, facial movements and body posture are coded during interviews. The recorded behaviours are allocated to an

appropriate category which describes that behaviour in the case of the ECSI the categories include: eye contact, affiliation, submission, pro-social behaviour, flight, assertion, gesture, displacement and relax. The majority of ethological studies have investigated the nonverbal behaviour of the patient as they engage in a two-way interaction with their clinician. The findings revealed that, compared to healthy control participants, patients display less pro-social nonverbal behaviour designed to invite and maintain social interaction such as smiling, eye gaze, head tilting and leaning towards their interacting partner (Brüne et al., 2008; Brüne, Abdel-Hamid, Sonntag, Lehmkämpfer, & Langdon, 2009; Dimic et al., 2010; Pitman, Kolb, Orr, & Singh, 1987; Troisi, Pasini, Bersani, Di Mauro, & Clani, 1991; Troisi, Pompili, Binello, & Sterpone, 2007; Troisi, Spalletta, & Pasini, 1998). Similarly, patients display reduced facial expressions, particularly those conveying positive facial expression (Davison, Frith, Harrison-Read, & Johnstone, 1996; Gaebel & Wolwer, 2004; Troisi, Pompili, Binello, & Sterpone, 2007). These findings are similar to those identified in Condon and Ogston's case study (1966). One study found patients to show less hand gestures, including those accompanying speech (Troisi, Spalletta, & Pasini, 1998). These findings were independent of medication (Brüne et al., 2008; Brüne, Abdel-Hamid, Sonntag, Lehmkämpfer, & Langdon, 2009; Pitman, Kolb, Orr, & Singh, 1987; Troisi, Spalletta, & Pasini, 1998).

Although these studies provide information on patients' nonverbal repertoire during clinical interactions, their main limitation is that they look at patients' behaviour in isolation, neglecting all other aspects of the interaction. This type of analysis limits the inferences that can be made from such data, as they lack the information about what the patient is producing these behaviours in response to. Social interaction occurs in an "open system" (Watzlawick, Bavelas, & Jackson, 1967)², meaning that the entire

² The open system theory of social interaction will be presented in detail in chapter 3.

interaction, and all parts of it, are influenced and changed by the actions and reactions of everyone involved in the system. Therefore, to view one person in isolation is similar to hearing one side of a phone call, assumptions can be made about what the phone call is regarding but the judgments may be flawed, as it lacks context. Measuring the behaviour of all parties involved in the interaction will provide another level of detail when building up the picture of patients' social deficits.

2.4.1.3 Nonverbal behaviour of patients and their partners during clinical interactions

With the exception of Condon and Ogston's (1966) study described previously, only four studies have investigated the behaviour of patients and their interacting partners during interaction. These studies have done so with varying levels of detail, both within and outside the clinical context. Each of these studies will be presented in turn.

As part of a larger study of nonverbal behaviour of psychiatric inpatients, Fairbanks and colleagues (Fairbanks, McGuire, & Harris, 1982) included a small sample of six medication free patients with a diagnosis of schizophrenia. Patients were recorded during their clinical interview with a psychiatrist, which took place within the first 72 hours of their admission. The control comparison group consisted of 25 employees within the health service who were not undergoing any psychiatric treatment. They too were interviewed by the psychiatrist. All interviews followed the same format and lasted approximately 20 minutes. The nonverbal behaviour of the patient and their psychiatrists was coded every ten seconds for two five-minute segments of the interview. Specifically, body posture (lean forward/back), arm and leg symmetry (crossed/uncrossed), head orientation (towards/away from partner), hand and foot movements and facial expressions were coded. The findings revealed that patients displayed more leg symmetry (legs not crossed) more posture shifting, more grooming and repetitive stereotyped behaviours compared to control participants. In line with studies mentioned previously (Brüne et al., 2008; Brüne, Abdel-Hamid, Sonntag, Lehmkämer, & Langdon, 2009; Dimic et al., 2010; Pitman, Kolb, Orr, & Singh, 1987; Troisi, Pasini, Bersani, Di Mauro, & Clani, 1991; Troisi, Pompili, Binello, & Sterpone, 2007; Troisi, Spalletta, & Pasini, 1998), patients showed less eye gaze and less positive facial affect such as smiling. Psychiatrists' behaviour when interviewing a patient was

compared with their behaviour during a control interview. During the patient interview, the psychiatrist spent more time looking towards the patient, and they showed less smiling and less bodily movements.

A recent study by Kupper and colleagues (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010) utilised new techniques to investigate the nonverbal behaviour of both patients and their clinicians during a social role play task. This study employed a motion detection technique called Movement Energy Analysis (MEA) to automatically detect the head and body movements of individuals from video recordings of their interactions. Hand coding videos of social interactions for nonverbal movements is time and labour intensive and results in studies with smaller sample sizes. However, the recent development of motion detection techniques means that social interactions can be analysed without the need for hand coding, thus enabling studies with larger sample sizes and eliminating the risk of human error or bias. Kupper and colleagues investigated the head and body movement of 27 outpatients, with paranoid type schizophrenia, and their clinician partners as they engaged in a social role-play. The MEA technique is based on the premise that each frame in a black and white filmed sequence has a fixed number of pixels that represents a distribution of grey scale values ranging from 0 (black) to 255 (white). In this study the head and body of each individual were selected as 'regions of interest' (ROI) within the video, and frame-by-frame any change in the number of pixels within each range of interest was quantified as the degree of movement change per frame. This method only assesses movement, and takes no account of the direction or purpose of that movement. The movement speed and percentage of frames in movement was calculated for each ROI on each individual. Patients' nonverbal movement was compared with that of their interacting partner and was found to show only a slight reduction in the amount of movement. Medication showed no association with nonverbal behaviour.

There are two limitations to this study; firstly, the interaction was a role-play task, therefore more contrived than unscripted social interaction. This limits the inferences that can be made from such a study, as the nonverbal behaviour produced may not be the same as would occur during unscripted communication. The use of confederates or role-play tasks instead of natural communication may have unintended effects on the

interaction (Beattie & Aboudan, 1994). Secondly, nonverbal patterns of the patient are being compared to their interacting partner. This does not take into account the systemic impact of the social interaction and the fact that the nonverbal behaviour of the clinician may be influenced by the presence of the patient. However, this study demonstrates the benefits of using motion detection techniques to assess nonverbal behaviour in patients' social interactions.

2.4.2 Behaviour of patients and their partners outside the clinical context

One of the only studies to empirically assess nonverbal behaviour of patients and their interacting partners outside of a clinical context with individuals who were unaware of their diagnosis was conducted by Krause et al. (1989). In this study, ten patients with a diagnosis of schizophrenia were recorded during a twenty-five minute discussion about politics with a healthy control participant, who was unaware of their diagnosis. The facial affect of both the patient and their control interacting partner were measured using the emotional facial action coding system (EFACS) (Ekman & Friesen, 1976). The results indicated that patients and control participants did not differ on the sum of facial activity, or the frequency of facial activity when listening or speaking. Control participants did show an increased diversity and complexity in their facial expressions and used more upper facial expressions. Patients showed an overall rejecting style, displaying predominantly facial displays that convey negative emotions, including those to promote distance such as contempt. In line with other studies, patients displayed less upper facial movements, which are those used to convey positive affect such as smiling (Davison, Frith, Harrison-Read, & Johnstone, 1996; Gaebel & Wolwer, 2004; Troisi, Pompili, Binello, & Sterpone, 2007). As with the clinicians in the Fairbank study, patients' partners were seen to adapt their nonverbal behaviour to align with that of the patient, resulting in a reduction in their levels of facial affect particularly pro-social affect (Krause, Steimer, Sanger-Alt, & Wagner, 1989).

The only study to investigate the nonverbal behaviour of patients and their partners outside of a clinical context assessed the facial expressions of patients' and their relatives during interaction (Ellgring, 1986). This study involved 10 patient two-way interactions while discussing a point of disagreement. As a control sample, the relatives

also engaged in an interview with a clinician to discuss the patient. Similar to Krause's study, the facial behaviour of all interacting partners was measured using the facial action coding system (FACS)(Ekman & Friesen, 1978). Behaviour was assessed in the context of the conversation role it occurred in, i.e. as speaker or listener. The results revealed that patients displayed approximately 50% of their facial expression when in the role of speaker, and 50% in the role of listener, whereas relatives interacting with the clinician (i.e. no patient present), showed approximately 90% of their facial expressions when in the role of the speaker. Ellgring suggested that this difference demonstrated patients' lack of coordination between nonverbal expression and speech. Furthermore, relatives interacting with the patient also displayed approximately 60% of their facial expressions in the role of speaker, aligning with the pattern of the patient.

Overall, this review of studies assessing patients' actual social interactions reveals that relatively little research has been conducted within this area. Studies of patients' two-way interactions reveal that patients display less nonverbal behaviour, and their interacting partners adapt their behaviour to display similar patterns. However, the interactional impact of this pattern of behaviour is unclear. In order to build on this research and bridge the gap between patients' behaviour and their social deficits, patients' interactionally meaningful nonverbal patterns should be investigated. Exploring behaviours that have a specific function in interaction would be the first step in deciphering the impact of nonverbal anomalies on patients' social interactions. This will form a central feature of the current thesis.

2.5 Associations between patients' social functioning and their clinical, cognitive and nonverbal features

Many studies have tried to identify associations between patients' performance on social cognitive tests, symptoms and social functioning. One of the challenges in this area is the inconsistency in methods used to measure social functioning. All of these measures come under the umbrella term of 'functional outcome' (Couture, Penn, & Roberts, 2006; Green, 1996; Green, Kern, Braff, & Mintz, 2000) and fall into two main categories (1) Community outcome measures: Self, or other, rated assessments of patients' global functional attainment in key areas of life such as occupational or educational attainment,

relationships with peers and family and level of social support (e.g. The objective social outcomes index (SIX) (Priebe, Watzke, Hansson, & Burns, 2008). (2) Social-skill assessments: Lab-based measures aimed at detecting specific social skills of receiving, processing and sending social cues. In such tests, a problem-solving task assesses patients' receiving and processing skills. Patients watch short videos of social interactions, are asked to identify problems within these interactions and plan a course of action to deal with those problems. Patients then act out their solutions in a role-play task with a confederate. Patients' ability to produce nonverbal cues (sending skills) is assessed separately during a role-play task. Patients' behavioural features such as speech clarity and fluency, appropriateness of tone, facial expression of affect, posture, gesture, and eye gaze are rated by an independent observer. An example of this type of measure is the assessment of Interpersonal Problem Solving Skills (AIPSS) (Donahoe, Carter, Bloem, Hirsch, & et. al., 1990). Other forms of the social skills test use only the role-play task, assessing only sending skills as an indicator of functional outcome (e.g. conversation probe (CP)).

The method used to assess functional outcome must be kept in mind when identifying an association between patients' social cognitive performance and their social functioning. The receiving and processing skills assessed in social skills measures displays some similarity with assessments of social perception, e.g. the SCRT. In both measures, patients are asked to watch a short clip of an interaction and then answer questions based on what they have just watched. The ability to perceive and process social information is being assessed in both tasks, using similar methodology. Shared method variance may play a role in artificially inflating an association between these two measures (Ihnen, Penn, Corrigan, & Martin, 1998). The final part of the social skills measures assesses patients' ability to send social information during a, sometimes scripted, role-play task with one other individual. Although this is not a natural interaction and should not be treated as such, it demonstrates patients' repertoire of verbal and nonverbal behaviour, which are the tools they will be using in their encounters with others. Community functioning measures reflect patients' global functioning in real world terms and can be used as an indicator of how well they are functioning in society. With this in mind, the findings of such studies revealed that patients' performance on measures of affect perception have been associated with poorer occupational functioning, social

functioning, interpersonal relationships and community participation (Brekke, Nakagami, Kee, & Green, 2005; Kee, Horan, Mintz, & Green, 2004; Poole, Tobias, & Vinogradov, 2000). Impaired affect recognition was also predictive of impaired social functioning using role-play tasks (Ihnen, Penn, Corrigan, & Martin, 1998; Pinkham & Penn, 2006)

Poor performance on assessments of social perception was predictive of impaired social behaviour in the milieu for inpatients (Appelo et al., 1992; Ihnen, Penn, Corrigan, & Martin, 1998), community functioning (Kim, Doop, Blake, & Park, 2005; Sergi & Green, 2003; Vauth, Rusch, Wirtz, & Corrigan, 2004) and quality of life for out-patients (Addington, Saeedi, & Addington, 2006). Lab-based measures of functional outcome were also associated with social cue perception (Addington, Saeedi, & Addington, 2006; Corrigan & Toomey, 1995; Toomey, Wallace, Corrigan, Schuldberg, & Green, 1997). However, using the role-play task as a measure of functional outcome (i.e. measure of sending skill) saw a weak or absent association (Ihnen, Penn, Corrigan, & Martin, 1998).

Impaired performance on assessments of theory of mind were associated with reduced premorbid social functioning (Schenkel, Spaulding, & Silverstein, 2005) and reduced community functioning (Bora, Eryavuz, Kayahan, Sungu, & Veznedaroglu, 2006; Brune, 2005; Roncone et al., 2002). Few studies have investigated the association between nonverbal behaviour and social functioning, however, reduced pro-social facial expressions have been found to be associated with reduced social functioning, occupational functioning and poor prognosis (Troisi, Pompili, Binello, & Sterpone, 2007).

2.5.1 Association between patients' symptoms and social cognition

Research suggests that poorer performance on assessments of affect and social perception was seen in patients with more negative symptoms (Mueser, Bellack, Douglas, & Wade, 1991; Schneider, Gurb, Gurb, & Shtasel, 1995; Strauss, Jetha, Ross, Duke, & Allen, 2010) and those in the acute phase of the disorder (Mueser et al., 1996; Revheim & Medalia, 2004). However, patients with more paranoid symptoms perform better than those without paranoid symptoms (Lewis & Garver; Nelson, Combs, Penn, &

Basso, 2007; Toomey, Schuldberg, Corrigan, & Green, 2002). Negative, positive symptoms and disorganised symptoms also showed an association with poor performance on theory of mind tasks (Frith & Corcoran, 1996; Pickup & Frith, 2001; Sprong, Schothorst, Vos, Hox, & van Engeland, 2007). However, there is mixed evidence for remitted patients, with some studies reporting no impairment in these patients (Frith & Corcoran, 1996) and others reporting significant impairment (Herold, Tényi, Lénárd, & Trixler, 2002).

2.5.2 Association between patients' symptoms and their nonverbal behaviour

The findings regarding associations between nonverbal behaviour and symptoms have been contradictory, with some studies reporting no association with patients' symptoms (Gaebel & Wolwer, 2004; Troisi, Spalletta, & Pasini, 1998), and others reporting an association between reduced nonverbal behaviour and greater negative symptoms (Brüne et al., 2008). Patients with symptoms of thought disorder have also showed more grooming behaviour during social interaction (Fairbanks, McGuire, & Harris, 1982).

2.6 Chapter summary

Overall, it is clear that patients with a diagnosis of schizophrenia have severe social impairments that have a substantial impact their daily functioning and quality of life. However, the nature of these social deficits remains unknown. Patients display significant impairment in their ability to perceive and interpret social and emotive cues when assessed using social cognitive assessments. However, it is unclear if this impairment is reflective of patients' difficulties in the real life equivalent. Analysis of the nonverbal behaviour patterns of patients' two-way social interactions revealed that patients display less nonverbal behaviour, particularly pro-social expressions of facial affect, head movement, eye gaze and gesture. Furthermore, their interacting partners display reduced nonverbal expressions similar to that of the patient. However, the interactional relevance of this pattern is unknown. In order to advance the research in uncovering the nature of patients' social deficits, this thesis suggests that patients' social interactions should be analysed in a manner that is interactionally meaningful.

In the field of human social interaction, certain behaviours have been identified as being interactionally meaningful and having specific functional relevance. By measuring functionally specific nonverbal behaviours in patients' social interactions, the functional impact of the atypical patterns could then be inferred. The next chapter will present an overview of nonverbal aspects of normative social interaction, detailing how the knowledge from the field of human interaction research can be applied to examine the nonverbal anomalies of patients' social interactions in an interactionally meaningful way.

Chapter 3: Nonverbal dynamics of social interaction

3.1 Introduction

The previous chapter described the social deficits experienced by patients with a diagnosis of schizophrenia. The premise of this thesis is to identify if these social deficits are manifest in the nonverbal patterns of patients' social interactions with others. In order to identify behavioural anomalies in patients' interactions, and to provide interpretations about how these might impact the success of those interactions, we must firstly provide a description of the normative interaction processes.

The following chapter will present an overview of the nonverbal features of human face-to-face social interaction. A theoretical framework of social interaction on an individual and systemic level will be introduced, highlighting the relevance to the study of social deficits in schizophrenia. Within this conceptual framework, the spatial and temporal organization of the communicative system is described, paying particular attention to the pivotal role of nonverbal behaviour in establishing and regulating the social interaction system. The methods used to measure nonverbal behaviour in actual interaction will be presented; revisiting those discussed in chapter 2 and presenting alternatives. The specific nonverbal behaviours involved in the conversation management processes of feedback and turn exchange will then be presented, focusing on the hand and head movements and their different functions in the context of conversation role. Finally, the central questions of this thesis and their motivation will be described.

3.2 Face-to-face social interaction

Face-to-face communication is a highly interactive, collaborative process (Goodwin, 1979a). It is comprised of both the verbal transmission of information and is accompanied by non-verbal expression including, eye gaze, gesture, head and body movements, facial displays and vocal aspects such as prosody (Burgoon, Buller, & Woodall, 1989).

3.2.1 Individual level processes

A number of theories suggest that for the reciprocal process of interaction to progress successfully, interacting partners need to cooperate and collaborate with each other to establish a level of mutual understanding (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008; Clark & Schaefer, 1989). This may be referred to as grounding (Clark & Schaefer, 1989). This collaborate process is achieved through a feedback system between interacting partners, comprised of cues of perception, understanding and contact (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008). 'Perception' is demonstrating awareness that speakers message has been received. 'Understanding' is conveying the level of understanding of the speakers' speech and 'contact' is communicating to the speaker the continuation of the interaction, either by providing feedback, or taking a turn of speech (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008). The precise nonverbal behaviours used to maintain this feedback system will be discussed in detail later in this chapter³. Break down in the feedback system will result in interactions that are less efficient and potentially more problematic, but importantly, may still function, as these elements diminish (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008).

3.2.2 Systemic level processes

On a systemic level, Watzlawick and colleagues conceptualized face-to-face interaction as being an 'open system' having four important features; wholeness, openness, a feedback-loop and equifinality (Watzlawick, Bavelas, & Jackson, 1967). 'Wholeness' highlights the systemic nature of the social interaction. Once the communication is initiated, all interacting partners become part of one unified, coordinated 'interacting system'. The conversation regulatory processes of spatial and temporal coordination play a key role in creating wholeness in social interaction and will be discussed in greater

detail later in this chapter.⁴ The second feature, 'openness', illuminates the fact that social interaction does not occur in a vacuum, but is dependent upon the context the interaction occurs in. If you imagine trying to chat to a friend in a library, it is clear that the environment around us influences our interactions and equally, our interactions influence the social milieu.

The third feature, the 'feedback-loop', is one of the most important features of social interaction. It is pivotal in ensuring reciprocal feedback between individuals in real time, drives the interaction forward. The behaviour of each individual within an interaction influences the behaviour of all others through this process (Cappella, 1996). The properties of the feedback loop are those referred to in the previous section as contact, perception and understanding (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008). Head, hand and body movements are all used to convey these cues and will be presented in more detail later in this chapter. The feedback process is the means by which equilibrium is maintained during a social interaction. This feedback process is achieved on a variety of levels within a social encounter. The 'interaction adaptation theory' (Burgoon, Stern, & Dillman, 1995) suggests that when people enter into an interaction they do so with expectations about what will happen, based on our knowledge of norms and previous experience in social situations. The behaviour of the interacting partners will be judged against these expectations. When a partners' behaviour corresponds to the expected behaviour, the feedback between these partners will be reciprocal. However, partners' behaviour that deviates from expectancies will result in compensatory behaviour (Burgoon, Stern, & Dillman, 1995)⁵. In practical terms, imagine a two-way

⁴ Spatial and temporal regulatory processes are the F-formation system and interpersonal coordination respectively. These will be discussed in detail later in this chapter.

⁵ Real life social interactions are dynamic processes, and as such, interacting partners may move between reciprocal and compensatory feedback processes throughout an interaction.

interaction with two standing partners A and B. Interacting partner A changes their position and moves closer to partner B. Partner B may adapt their behaviour to compensate for this by taking a step back and creating the desired distance between the partners again.

The final feature of the communication system is equifinality. This feature is intertwined with the feedback process, highlighting the non-linear nature of the communication system. Conversation is by no means uni-directional, on the contrary it is a dynamic process requiring cooperation by all interacting parties. It is this process of change between the partners during the course of an interaction which informs the end communicative result. Equifinality ensures that all interacting partners are responsible for the resulting outcome, as they have all contributed to the process of change over the course of the interaction.

3.3 Multiparty Interaction

In natural social interactions, multiparty situations are more commonly encountered than two-way. Indeed, in a random sample of ordinary conversations from the British National Corpus (BNC), over 80% involve three or more people according to the transcript headers (Eshghi, 2009). This striking figure indicates the frequency of multiparty interaction in natural conversation. Indeed, in a sample of patients' routine psychiatric consultations over one third of consultations involved more than two people. As the number of people in an interaction increases, so does the complexity of the conversation. The basic speaker-hearer model of two-way interaction is insufficient, and a wider range of conversation roles becomes available (Goffman, 1981). Within a multiparty social interaction, speakers are identified as the individual producing the

speech⁶, however a range of hearers can be identified. Ratified members of the interaction fall into one of two categories (i) addressed recipient: the individual who the speaker is addressing and directing their attention towards (ii) unaddressed recipient: ratified members of the interaction who the speaker is not currently directing their attention towards (Goffman, 1981).

Due to the greater number of interacting partners in multiparty interactions, the process of turn exchange would be expected to be a competitive process, plagued with overlapping speech and interruptions. However, if we consider the multiparty interactions we are involved in, we know that, for the most part, we are remarkably skillful at steering our way through such interactions, with minimal conscious effort. Much of this seamless interaction can be attributed to the non-verbal cues that enable regulation and management of our social interactions. In multiparty situations, such nonverbal cues become even more salient as individuals must continually monitor their interacting partners for potentially relevant cues about the dynamics of the interaction, including, among other things, their conversation role, turn exchange processes, and when and how to provide appropriate feedback.

3.4 Application to the study of social deficits in schizophrenia

Applying this framework to the previous ethological studies of social interaction in schizophrenia discussed in chapter 2, we see that the majority of studies view the patients in isolation, thereby removing the features of wholeness and openness from the outset. Furthermore, by neglecting the actions and reactions of patients' interacting partners, information on the feedback process or the process of change between the interacting partners over the course of the interaction cannot be derived. Thus, such

⁶ Goffman's participation framework also describes differences in the speaker, and in unrated individuals such as over-hearers however these are not relevant to the current review and as such are not presented here.

studies eliminate all four interactive features of a social encounter. Such studies are useful in gleaning information on patients' behavioural repertoire, but do not provide any information on what patients' atypical behavioural patterns mean interactionally.

The current study aims to investigate patients' social interactions within the conceptual framework of face-to-face social interaction. Of particular pertinence in the study of patients' social deficits are the features of equifinality and feedback. These contradict the idea of a unilateral communication stream, and suggest that if social interactions are problematic, this arises through the reciprocal process of change between interacting partners over the course of the interaction (Watzlawick, Bavelas, & Jackson, 1967). Therefore, the problems in patients' social interactions are not just attributable to the actions of the patient but of all interacting partners. This highlights the importance of analysing the whole interaction to uncover the nature of patients' social deficits and their interactional relevance.

The feedback loop relies heavily on the ability of the individual to perceive, interpret and deliver social nonverbal cues to and from their interacting partners (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008; Watzlawick, Bavelas, & Jackson, 1967). As discussed in chapter 2, social cognitive studies show that patients have difficulty perceiving and interpreting social cues in social cognitive tests. However, it is unclear if this deficit persists in patients' real time social interactions with others. By measuring the specific nonverbal behaviours that function to achieve and maintain the feedback in patients' social interactions, we may be able to uncover if these processes are atypical in patients' interactions. Traditionally, studies investigating patients' social interactions have been exclusively two-way. However, if patients do experience difficulty perceiving or interpreting nonverbal behaviours during their social interactions, it would be expected that this would be more easily detected in the more demanding and complex multiparty situations.

3.5 Nonverbal regulatory processes

Non-verbal regulatory processes include the F-formation system and interpersonal coordination, both acting on a systemic level of the interaction. Firstly, on a spatial level,

the F-formation patterns describe the spatial organization of ratified members of a conversation (Kendon, 1976). Interpersonal coordination facilitates coordination between interacting partners (Condon & Ogston, 1966; Kendon, 1970). The F-formation system and interpersonal coordination establish the feature of ‘wholeness’ in an interaction by delineating the ratified members of the conversation, both spatially and temporally, as a single synchronous unit. Interpersonal coordination also functions to regulate and support the intra-individual level tasks involved in conversation management such as feedback and turn-exchange.

3.5.1 F-Formation system

On a systemic level, within an interaction, the spatial arrangements of interacting individuals are not random (Kendon, 1976). Interacting partners position themselves in such a way so as to allow the interaction to be conducted easily. Each individual, when engaged in solitary activities, does so in the space directly in front and to the side of them which they have easy access to physically. Individuals may have visual access to a wider area but the actual space which can be physically used is limited by the physical capabilities of the human body. This area where action occurs is known as the “Transactional segment” (Kendon, 1976). An individual’s transactional segment is used, by that individual, almost exclusively, with others actively avoiding its intrusion. When initiating a face-to-face interaction, people position themselves so their transactional segments overlap, forming a joint interaction space termed the “o-space”. This space should be equally accessible to all parties involved in the interaction, and as such, all parties have equal responsibility to maintain it from internal and external disturbances, such as people leaving the interaction or others encroaching on their space. Ratified members of the communication system must cooperate to maintain and re-shape the o-space as and when it is required. The whole system created by the individuals is called an F-formation system, which exists from the moment the o-space is observed, and changes in shape and size depending on the context of the communication.

The arrangement of an F-formation functions to delineate ratified members of the conversation from those who are not, making the interaction appear to outsiders as a unit. Only those whose transactional segments overlap are involved in the F-formation

and have any rights or responsibilities over the o-space. As with transactional spaces, people external to the F-formation tend not to enter it. However, they are seen to hide their heads and apologise while doing so (Kendon, 1996). This action is evidence that others are aware that this is an interaction unit and one in which they do not belong.

The F-formation arrangement also has clear practical value for aiding successful communication. Firstly, when an individual desires to communicate with another, they must gain the attention of the person they wish to address. The most common way to do this is to obtain mutual gaze, thus requiring a position in the line of sight of the targeted recipient (Kendon, 1976). Forming the F-formation arrangement will permit this initial visual contact, and makes the individuals involved aware that they are engaged in a communication system. Furthermore, the spatial structure allows maximum visual, acoustic and tactile contact between participants, which enables the flow of information across the o-space. Indeed, failure to create an F-formation prior to conversation is likely to result in difficulties in the conversation. Consider two strangers sitting next to each other on a train. One person decides they wish to talk to the other. If this individual just begins to speak without firstly turning to face the other person to establish mutual gaze and an o-space, there may be some confusion as to where the speech is directed. The intended recipient may assume that the speech is directed at someone else as their role as recipient and ratified member of the conversation is undefined. The F-formation clearly fulfils both the open system attributes of openness, as it is interchangeable with the external environment, and wholeness, as the presentation of the F-formation system delineates it as a unified group. On an individual level, all members of the interaction must cooperate to maintain the o-space, using attention to monitor the actions and reactions of other group members and providing feedback appropriately

3.5.2 Interpersonal Co-ordination

The second systemic level feature of social interaction is interpersonal coordination. As mentioned in the previous chapter, the phenomenon was first identified by Condon & Ogston (1966). Since then, a variety of studies have created their own individual conceptualizations of it, and based on these have developed their own criteria and methods of measurement. This has resulted in a vast number of studies employing

numerous terms such as; mimicry, matching, simultaneity, coordination, convergence, congruence, attunement and reciprocity to describe different aspects of interpersonal coordination in a variety of behavioural features including, but not limited to; facial expression (Sato & Yoshikawa, 2007) walking (Zivotofsky & Hausdorff, 2007), postures (Lafrance & Broadbent, 1976; Schefflen, 1964) and vocal aspects such as prosody (Neumann & Strack, 2000). Interpersonal coordination is used as an umbrella term encompassing all aspects of behavioural coordination defined as ‘the behavioural coordination between interacting partners and is the degree to which the behaviours of interacting partners are non-random, patterned or synchronized in both timing and form’ (Bernieri & Rosenthal, 1991).

The various conceptualisations of interpersonal coordination can be broken down into two main categories; (1) Movement similarity, a static form of coordination concerned with the degree of similarity between the static behaviour of interacting partners such as posture, (2) Temporal coordination, a dynamic form of coordination concerned with how close in time behaviours occur. These categories are by no means mutually exclusive, frequently occurring simultaneously in interactions, however the majority of research tends to focus on them individually.

3.5.2.1 Movement similarity

A pervasive finding in social interaction is that interacting partners display mimicry with in a range of behaviours such as; speech rhythm (Cappella & Panalp, 1981), facial expressions (Blairy, Herrera, & Hess, 1999; Dimberg, Thunberg, & Elmehed, 2000), posture (Dabbs, 1969; LaFrance, 1985) and co-speech gestures (Holler & Wilkin, 2011)

Movement similarity is manifest as changes of an individual’s behaviour to match that of their partners (Chartrand & Bargh, 1999). Behaviour matching may occur simultaneously or sequentially. The majority of studies investigating movement similarity have done so with the goal of deciphering a link with a social construct such as empathy or rapport (Chartrand, Maddux, & Lakin, 2005; Lakin & Chartrand, 2003).

3.5.2.1.1 Observer rated movement similarity

Psychiatrist Albert Schefflen (1964) theorized that mirroring of postures between interacting partners was indicative of shared mental states. Schefflen suggested that a behavioural congruence was an interactional marker for group cohesion, with a lack of behavioural congruence signifying a lack of togetherness within the interaction (Schefflen, 1964). Similarly, Dabbs (1969) found evidence that posture congruence in interaction lead people to believe that their interacting partners were more similar to them and viewed them more positively. Observational research investigating postural congruence of teachers and students in classroom settings found the extent of posture similarity was positively correlated with ratings of rapport, involvement and togetherness (LaFrance & Broadbent, 1976). In this study, independent observers scanned classrooms and counted the number of students simultaneously displaying the same postural configuration as the teacher. This was repeated at various points over a period of time (LaFrance & Broadbent, 1976). In later studies, this link was unfounded when the interacting partners were strangers. The authors suggested that coordination between strangers is reflective of an attempt to reach rapport, rather than rapport itself (LaFrance & Ickes, 1981).

3.5.2.1.2 Experimental analysis of movement similarity

Bernieri (1988) experimentally investigated the link between behaviour matching and rapport in teacher-student interactions. 19 teacher–student dyads were recorded. Pseudo interactions acted as a control group and were created by splicing the real videos and pairing a student from one interaction with a teacher from another. Independent raters judged the degree of behaviour matching between the pairs. Behaviour matching was not found to differ significantly between real and pseudo interactions and showed no relationship with rapport.

In a series of experiments, Chartrand & Bargh (1999) investigated; (i) the existence of mimicry in actual interaction between strangers, (ii) the association between mimicry and interpersonal rapport and the smoothness of interactions. In experiment (i), a participant interacted with a confederate who manipulated their mannerisms (foot shake

or face rub) and their degree of smiling (smiling or not). The results revealed that mimicry occurred above chance levels for facial and behavioural mimicry. This demonstrates the natural adaptation of one person's behaviour to that of an unfamiliar interacting partner. In experiment (ii), participants interacted with a confederate who either mirrored the behavioural mannerisms of the participant or did not. Participants were then asked to report how much they liked the confederate and how smoothly they felt the interaction had gone. Participants who were mirrored reported significantly more liking of their confederate and a smoother interaction, even though the individuals had not previously met. These findings contradict those of LaFrance & Ickes (1981). The association between behavioural mimicry and affiliation has also been demonstrated experimentally in real world situations, with waiters who repeated customers orders receiving larger tips than those who did not (van Baaren, Holland, Steenaert, & van Knippenberg, 2003).

Experimental evidence suggests that mimicry is increased when individuals have a goal to affiliate with their interacting partner (Lakin & Chartrand, 2003). Furthermore, when an attempt to affiliate is unsuccessful, such as in the case of individuals who are socially excluded, the prevalence of nonconscious mimicry is greater in those participants compared to individuals who have not experienced such a failure (Lakin & Chartrand, 2003; Lakin, Chartrand, & Arkin, 2008).

The association between behavioural matching and positive social outcomes is not limited to human-human interactions. An empirical study by Bailenson & Yee (2005) found that participants interacting with an embodied artificial intelligent agent in a virtual reality environment rated agents that mimicked their head movements at a four second delay more positively than agents displaying a repertoire of prerecorded movements. Furthermore the mimicking agents were also found to be more persuasive (Bailenson & Yee, 2005). These findings were reported in the absence of participants' conscious awareness of behavioural mimicry by the agent.

Overall, the research suggests that behavioural similarity is pervasive in social interactions, even when the interacting individuals had not previously met and it plays a key role in positive social outcomes.

3.5.2.2 Temporal coordination

Investigations of temporal coordination are concerned with the temporal organization of movements of interacting partners; the spatial aspects may even be irrelevant (Grammer, Kruck, & Magnusson, 1998). Temporal coordination has three components; rhythm, simultaneous movement and smooth meshing of the interaction (Bernieri & Rosenthal, 1991). The greatest difficulty encountered in the research of temporal coordination is the lack of convenient methods of measuring coordination between individuals. For this reason, the following account has been divided into the various types of measurements used to detect temporal coordination.

3.5.2.2.1 Micro-Analytic measurement techniques

Early studies of interpersonal coordination used micro-analytic techniques to investigate coordination between interacting individuals (Condon & Ogston, 1966; Dittmann & Llewellyn, 1969; Kendon, 1970; McDowall, 1978). Such studies recorded the verbal and nonverbal behaviour of interacting partners. Raters analysed the recording frame by frame, transcribing the speech alongside the body movements creating a behavioural stream, which clearly displayed the points of coordination between the individuals.

Condon and Ogston (1966) were the pioneers of this technique, discovering coordinated points of speech and nonverbal movements both within and between interacting individuals. They suggested that the coordination occurred due to entrainment to the speakers' speech, and that it was pervasive in normative social interactions. Similar observations by Dittman and Llewellyn (1969) also noted that movement of speakers' hands, head and feet are more likely to occur early in phonemic clauses and in speech hesitations, i.e. movements that were not distributed randomly throughout the course of speech but corresponded to the rhythm of speech. Kendon (1970) successfully replicated Condon and Ogston's original methodology. However, in contrast to lab-based dyads, Kendon filmed multiparty interaction in natural environments. In accordance to Condon's findings, Kendon reported the presence of interpersonal coordination. However, Kendon disagreed with Condon's theory of entrainment, suggesting instead an "analysis by synthesis" theory of speech perception, whereby the listener forms a

running hypothesis of what the speaker will say and intermittently checks on it to ensure it is correct (Kendon, 1970). He hypothesised that co-ordination arises due to the listener's behavioural response to the speaker's speech. Kendon observed a pattern of coordinated behaviour, which corresponds to points in the interaction. Coordinated movements were more pronounced at important junctures in the interaction, such as speaker changes, topic changes and turn taking. Others have made corroborating observations that gross changes in posture do not occur at random but are temporally coordinated with topic shifts or new stages in an interaction (Kendon, 1970; Schefflen, 1973). Furthermore, Rutter and Stephenson (1977) found that, in face-to-face interactions, interpersonal coordination is maintained even when verbal behaviour is disrupted by speech disturbances such as interruptions or pauses. They suggested that the nonverbal coordination functioned to compensate for temporary breakdowns in speech during interaction. These later observational studies built on and expanded Condon & Ogston's original theory, and provided the first indication that interpersonal coordination had a functional role in communication. Micro analytic measurement techniques have the benefit of deriving rich data, however it is labour and time intensive, limiting the data sample and in turn the generalizability of the findings.

3.5.2.2.2 Observer ratings of temporal coordination

A different approach was taken by Bernieri and colleagues (Bernieri, Reznick, & Rosenthal, 1988), who investigated interpersonal coordination based on the assumption that it is an observable phenomenon, which can be perceived by a rater. They used a paradigm in which raters are shown real two-way interactions and fake two-way interactions (i.e. taking clips of two individuals from two separate interactions and pairing them together in film to mimic a real interaction). This paradigm enables a comparison of real and pseudo interactions to act as a baseline for coordination above chance. Raters were asked to watch the video clips and rate for (i) posture similarity and (ii) simultaneous movement, which is made up of tempo similarity, simultaneous movement and smoothness (Bernieri, Reznick, & Rosenthal, 1988). Using this methodology, Bernieri and colleagues found that an interaction between a mother and her child (14-month old) displayed genuine coordination, above chance, whereas pseudo interactions did not display coordination. Furthermore, mothers interacting with an

unfamiliar child displayed levels of coordination that did not differ from the pseudo interaction condition (Bernieri, Reznick, & Rosenthal, 1988). This methodology was also used to investigate the relationship between interpersonal coordination and rapport in teacher-student interactions (Bernieri, 1988). A strong relationship was found between participants' self-rated rapport and the degree of simultaneous movement rated by independent observers (Bernieri, 1988). However in this study, the degree of behaviour similarity did not differ between real and pseudo interactions and was not associated with rapport. Further to this, Miles and colleagues (Miles, Nind, & Macrae, 2009) found a direct positive relationship between the degree of coordination in walking movements between virtual people and the rating of rapport they received from outside observers. This methodology provides a reliable measure of coordination above chance, and overcomes the time and labour required for microanalysis. It does however rely on human judgement, and could potentially be subjective.

3.5.2.2.3 Movement Energy Analysis techniques

A new advanced technique in the study of interpersonal coordination employs a motion detection system called Movement Energy Analysis (MEA) to black and white video recordings of interaction (Ramseyer & Tschacher, 2008). This system has been mentioned in the previous chapter as it has been employed to detect patterns of change in movement in patients with schizophrenia and their psychiatrist as they take part in a role-play (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010). The MEA technique is based on the premise that each frame in a black and white filmed sequence has a fixed number of pixels that represents a distribution of grey scale values ranging from 0 (black) to 255 (white). The MEA system automatically detects the movements of individuals from video recordings of their interactions. The body part of interest is selected as a 'region of interest' (ROI) and any change in the number of pixels within each ROI is detected frame-by-frame, and the degree of movement change per frame quantified. This method only assesses movement, and takes no account of the direction or purpose. Time series of movement change per frame for each individual in their selected ROI (e.g. head) is then derived. These time series can then be compared using windowed cross-correlation techniques (Boker, Minquan, Rotondo, & King, 2002). Windowing takes the non-stationarity of each time series into account and allows

analysis of the similarity in behaviour change between the individuals at smaller intervals in time. The comparison within each window is lagged, which also provides information on who is producing the behaviour change first (i.e. leading) and who is following. The comparison at each window reveals the degree of similarity of behaviour change between the interacting partners and the time delay between those changes occurring. In a series of experiments, Ramseyer & Tschacher (Ramseyer & Tschacher, 2008; Ramseyer & Tschacher, 2011) employed MEA to record two-way psychotherapy sessions between a patient and their psychiatrist. They wished to establish the presence of interpersonal coordination (Ramseyer & Tschacher, 2008) and its role in quality of the therapeutic relationship and the patient outcomes. A pseudo interaction condition was employed to ensure that behavioural coordination was real and above that occurring due to chance. The findings revealed that patients and their therapist showed coordinated nonverbal movements, which increased in coordination with increasing number of sessions. Furthermore, the higher degree of coordination between patients and their therapist was associated with better patient rated therapeutic relationship, on a session level, and better therapy outcome in the longer term (Ramseyer & Tschacher, 2011).

3.5.2.2.4 Motion capture techniques applied to coordination of limb movements

More recently, research in the field of coordination dynamics has taken a lab-based experimental approach to the investigation of interpersonal coordination. Such studies investigate coordination on a mechanical level, exploring nature and degree of coordination between two coupled oscillators (Kelso, Holt, Rubin, & Kugler, 1981). Coordination dynamics has been applied to inter-limb coordination between two individuals to detect the degree of coordination between their motor movement and how that changes over time (Schmidt, Bienvenu, Fitzpatrick, & Amazeen, 1998). Such experiments typically use a basic paradigm where two individuals sit opposite each other and are asked to coordinate tapping of their index finger, swinging pendulums (Schmidt, Bienvenu, Fitzpatrick, & Amazeen, 1998) or swinging their lower leg (Schmidt, Carello, & Turvey, 1990), with a metronome used to dictate the frequency of the rhythmic movements. These tasks are designed not only to decipher if coordination occurs, but how stable the coordination is at varying movement frequencies. The movement of the particular body part under investigation is recorded, usually using a motion capture

system such as magnetic sensors or optical markers. This enables the precise movement to be recorded in three-dimensional space and time, providing a time series of each individual's movement. The time series are then compared using statistical techniques. One such technique is cross wavelet transform (XWT)(Issartel, Marin, & Cadopi, 2007). A cross-wavelet transform investigates the frequency of movement of both individuals and compares these to see the degree of coordination between their movements (Issartel, Marin, & Cadopi, 2007). Two stable, dominant forms of coordination emerge (1) 'In-phase coordination', seen at 0° , meaning that the two oscillating entities (e.g. individuals tapping fingers) are moving in the same direction and (2) 'Anti-phase coordination' seen at 180° , meaning they are moving in the exact opposite directions. Individuals may be coordinated to any degree in between these two opposing dominant degrees, however other degrees are less stable than the dominant phases of in-phase and anti-phase (Issartel, Marin, & Cadopi, 2007).

Individuals have demonstrated intended interpersonal coordination using such techniques (Schmidt, Bienvenu, Fitzpatrick, & Amazeen, 1998; Schmidt, Carello, & Turvey, 1990). Unintentional interpersonal coordination has also been demonstrated, where individuals were not instructed to coordinate with the movements of the other individual but just instructed to wrist swing the pendulum at a comfortable rate. In this experiment no auditory cues were present and interpersonal coordination arose naturally when individuals within the pairs were able to see each other (Schmidt & O'Brien, 1997). In a similar study conducted by Richardson and colleagues (Richardson, Marsh, & Schmidt, 2005), pairs of individuals were asked to participate in a problem solving task in which they had wrist pendulums attached. As with the previous study, once visual information was present, individuals displayed unintentional interpersonal coordination. In a further study by Richardson and colleagues (2007), individuals were found to unintentionally coordinate their whole bodies in rocking chairs once they were able to visually access their interacting partner. This was seen even when the rocking chairs were unequally matched in weight to change the natural resonance of the chair, thus individuals displayed interpersonal coordination even when experimental situations were put in place to make this more difficult (Richardson, Marsh, Isenhower, Goodman, & Schmidt, 2007). Evidence for the pervasiveness of interpersonal coordination at this level was also given by Issartel et al., (2007) who found unintentional coordination of

individuals arm movements to occur even when they were specifically asked not to coordinate.

3.5.2.2.5 Motion capture techniques applied to social interactions

Clearly, investigating interpersonal coordination in actual interactions is much more complex than the lab-based assessments of coordination on a singular movement. In actual interactions, movements are not restricted or controlled in any way in order to retain the ‘natural’ interaction, and hence the coordination is likely to be much more subtle and less predictable than in the lab-based assessments. However, the analytic techniques used to detect coordination in lab-based studies show the potential for use in detecting the more subtle aspects of interpersonal coordination within actual interaction.

Ashenfelter and colleagues (2009) have used motion capture techniques and windowed cross-correlation analysis to detect interpersonal coordination between head movements of interacting partners as they engage in a two-way role-play. In this study, participants were assigned the role of interviewer or interviewee and asked to hold a mock interview for seven minutes. Participants were told that they were examining magnetic fields being given off by the body during conversation so as they were unaware of the true nature of the study (Ashenfelter, Boker, Waddell, & Vitanov, 2009). Both the head movement angle and speed over time for each individual formed a time series which was then directly compared with that of their interacting partner using windowed cross-correlation analysis method similar to that described in the studies conducted by Ramsyer & Tschacher (2008; 2011). Windows size of two seconds were used, and the similarity of each individual’s head movements within each two-second window was derived, resulting in a time series of similarity of head movements and the temporal displacement of those similar head movements for each two-way interaction. This study found that head movements in natural conversation showed a high degree of non-stationarity. Interpersonal coordination was found to persist for durations of approximately two seconds. In line with the observations of Kendon (1970), coordination was found to fluctuate over the course of the interaction, being high over short intervals and less over longer intervals (Ashenfelter, Boker, Waddell, & Vitanov, 2009).

3.5.3 Function of interpersonal coordination in social interaction

Interpersonal coordination is an essential characteristic of social interaction and is thought to be multifunctional.

3.5.3.1 Rapport

Kendon suggests that coordination itself has a communicative function, in that the level of coordination manifested at any given moment communicates the degree of understanding, agreement or relationship between interacting partners (Kendon, 1970). Indeed, nonverbal coordination is a key component of social rapport (Bernieri & Rosenthal, 1991; Tickle-Degnen & Rosenthal, 1990). Descriptions used to describe good rapport such as ‘in tune’, ‘on the same wavelength’, or ‘in sync’ tend to be manifestations of interpersonal coordination (Tickle-Degnen & Rosenthal, 1990). Evidence presented in the previous section demonstrates that increased coordination between interacting partners is interpreted by those directly involved in the interaction and outside observers as a positive attribute which increases feelings of rapport and togetherness (Bailenson & Yee, 2005; Chartrand & Bargh, 1999; Miles, Nind, & Macrae, 2009; Ramseyer & Tschacher, 2010).

3.5.3.2 Regulating the process managing a conversation

The smooth completion of complex conversational processes such as providing feedback and turn taking relies on coordination between interacting partners, which is not explicitly conveyed. Observational studies have found that the timing of turn taking and feedback processes is not random, but occurs at specific junctures in speakers’ speech (Bavelas, Coates, & Johnson, 2002; Kendon, 1970; Koiso, Horiuchi, Tutiya, Ichikawa, & Den, 1998) Thus, the rhythm of the speech and the syntactic structure are tightly coordinated with the nonverbal behaviours within the interaction. Coordination of nonverbal features such as eye gaze and head movement have been shown to be important in signaling mutual attention, timing of feedback and signaling the start and end of turns and a wish to take the floor (Bavelas & Gerwing, 2007; Kendon, 1970)

Kendon noticed that in multiparty situations, the speaker and direct addressee display a level of coordination not seen between other interacting partners, with a greater degree of mutual gaze, more posture similarity and mirroring of each others movements (Kendon, 1970). Kendon suggested that the unique, coordinated relationship between speaker and addressee serves two main purposes; firstly, to give visual confirmation to the speaker that they are being attended to and that his speech is being directed appropriately; secondly, to increase the bond between the speaker and the recipient, and delineate the direct addressee from other participants. Similarly, Kendon noticed that, when trying to gain the floor, unaddressed individuals would show movements that were temporally coordinated with the speakers' speech seen as 'beating time' with the speech (Kendon, 1970). Again, Kendon suggests two possible functions of this phenomena; firstly, making the speaker aware that they wish to speak next or secondly, facilitating their own timing of when to enter into the conversation (Kendon, 1970). Taken together, Kendon suggested that these observations provide evidence for the role of interpersonal coordination in the complex practical aspects of conversation management. Furthermore, they demonstrate the role of interpersonal coordination in delineating relationships within interactions, and allowing all members of the interaction to know their conversation role at any given point (Kendon, 1970).

Overall, interpersonal coordination is critical to social interaction and is multifunctional, playing a role on many levels of the interaction. At the most basic level, it coordinates the movements of the interacting partners, allowing them to be distinguishable as an interacting unit through smooth meshing of nonverbal behaviour. Secondly, it coordinates nonverbal and verbal behaviours both within and between individuals, allowing individuals to know their role in the interaction at any given time. This coordinates the processes of feedback and turn exchange to allow them to run smoothly, without the need for explicit explanation about when and how these should be conducted. Thirdly, interpersonal coordination has been shown to contribute to the positive social outcomes experienced between interacting partners, such as rapport. All of this happens with varying levels of conscious awareness (Chartrand & Bargh, 1999) and becomes much more salient in interactions involving more than two individuals due to the increased complexity involved with increasing numbers of people.

3.6 Nonverbal behaviours involved in the conversation management processes

For coordination to occur, interacting partners must be able to detect, interpret and display the interactive communicative behaviours, i.e. social cues, such as body movements, posture, gestures, facial expression, eye gaze, and non-verbal vocal behaviours such as speech prosody. Nonverbal behaviours convey specific meanings depending on the conversation role in which they are produced. For the purpose of this thesis, this review will specifically focus on the role of eye gaze, head and head movement of speakers and addressees in the conversation management processes of feedback and turn exchange.

3.6.1 Nonverbal Feedback

At the beginning of this chapter, it was mentioned that the process of feedback between interacting partners drives the interaction forward (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008; Clark & Schaefer, 1989). A listener should provide feedback to the speaker to convey attention, understanding and a wish to continue the interaction (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008). This is frequently conducted via nonverbal means, as it is the most effective way of conveying information regarding the mutual attention or understanding of interacting partners without interrupting the verbal stream. Overall, the process of feedback is achieved through coordination of eye gaze and head movement between interacting partners. Head and hand movements do not occur at random by speakers or listeners during conversation, but are highly coordinated with the rhythm and flow of the speakers' speech.

Eye gaze is asymmetrical between interacting partners and is dependent upon the role of the individual within the interaction. The addressed recipient has been shown to look at the speaker for long intervals, whereas the speaker looks at the recipient for shorter periods (Bavelas, Coates, & Johnson, 2002). Findings suggests that speakers look away from the listener when they are in the early stages of their turn, usually when they are formulating what they will say, and then return their gaze to the addressed recipient when they have completed their speech in order to monitor the attention of their listener (Argyle & Cook, 1976; Kendon, 1976). When a speaker does gaze at the listener, this is thought to mark the beginning of a period of time in which the listener has an

opportunity to provide feedback to the listener (Bavelas, Coates, & Johnson, 2002). This may be called a ‘gaze window’ (Bavelas, Coates, & Johnson, 2002), which tends to coincide with phonemic junctures (Dittmann & Llewellyn, 1969; Kendon, 1967) or hesitant phases of speech (Rosenfeld, 1977), thus coordinating the timing of speakers’ speech with the feedback request. During this window, the listener should be looking at the speaker (Bavelas, Coates, & Johnson, 2002), and mutual eye gaze between the speaker and listener conveys that the listener is attending to the speaker’s speech but may not convey anything about the level of understanding of the listener.

Microanalysis of video recorded dyadic conversations reveals that a speaker may use head nodding (up-and-down head movement) during this period of mutual eye gaze to request feedback from the listener (McClave, 2000). This observational study found that speakers’ nodding was largely beyond conscious control, and was recognized and responded to by listeners within a fraction of a second of the speakers’ request (McClave, 2000). The listener may provide feedback nonverbally in the form of head nodding, which can act as a substitute for verbal messages (Boholm & Allwood, 2010). Such nonverbal feedback informs the speaker that they have the listeners’ attention, and conveys the listeners’ level of understanding without interrupting the verbal stream. The gaze-feedback process aids the regulation of speakers’ speech during long turns.

Experimental studies have identified that listener feedback has a direct impact on the speakers’ ability to speak (Bavelas, Coates, & Johnson, 2000). People speaking to distracted listeners who provided less feedback were found to tell stories with poorer quality compared to those who had attentive listeners (Bavelas, Coates, & Johnson, 2000). A lack of appropriate feedback from the listener during the gaze window has been shown to result in a speaker employing techniques to try to gain the listeners attention and emphasis and clarity to their speech, such as repeating and repairing their speech (Goodwin, 1980), using exaggerated head movements (McClave, 2000) or using hand gesture (Bavelas, Kenwood, Johnson, & Phillips, 2002; Holler & Beattie, 2003). Indeed, the frequency of speakers’ gestures is seen to increase under conditions where the speaker is concerned about their listeners’ attention or comprehension, or in difficult or complex communicative situations (Bavelas, Kenwood, Johnson, & Phillips, 2002; Holler & Beattie, 2003). Speakers adapt their gestures for the listener (Gerwing &

Bavelas, 2004). As with head movement, the timing of speakers' gestures are highly coordinated with the rhythm of the speakers' speech (Woodall & Burgoon, 1981). An experimental study revealed that gestures that are 'out-of-synch' with the speakers' speech were distracting for the listener, and interferes with their comprehension (Woodall & Burgoon, 1981).

3.6.2 Turn Exchange

The third feature of the feedback loop is to convey a wish to continue the conversation, either by indicating that the speaker should continue their turn of speech or by taking a speech turn (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008). The key behaviours involved in this process are presented below.

A pivotal feature of turn exchange is mutual gaze between the speaker and the addressee who will take the next turn (Jokinen, Nishida, & Yamamoto, 2009; Kendon, 1967; Vertegaal, Weevers, Sohn, & Cheung, 2003). Head orientation may be a better indicator of where the attention is focused rather than eye gaze in multiparty interactions, as bolder head movements are easier to detect when interacting partners are further apart (Jokinen, Nishida, & Yamamoto, 2010; Loomis, Kelly, Pusch, Bailenson, & Beall, 2008). The speaker may display turn ending cues, such as leaning back and dropping the pitch and loudness of their speech (Kendon, 1970). Speakers may also decide that they do not wish to end their turn. In the case of turn holding, where a speaker is under pressure to yield their turn but they wish to continue holding the floor, the speaker may employ hand gestures and gaze aversion as cues to other participants that they have not completed their turn (Duncan & Niederehe, 1974). The use of hand gesture at phonemic junctures in conversation, i.e. points where a turn change would naturally occur, greatly reduced the attempts of other interactants to take the floor (Duncan & Niederehe, 1974).

In requesting a turn, an interactant firstly must establish mutual gaze with the speaker, delineating themselves as the direct addressee and the next in person to speak. They display a shift in their posture, moving their head forward and towards the speaker and displaying head nodding (Jokinen, Nishida, & Yamamoto, 2010; Wiemann & Knapp, 1975). Kendon (1970) noticed that the head nod of the listener is coordinated with the

rhythm of the speakers' speech. This may function to gain the attention of other interacting partners, inhibiting them from competing for the floor (Wiemann & Knapp, 1975). Similarly, hand gestures such as raising a finger or the whole hand may also be used in order to gain attention and make it clear to other interacting partners of their intention to take the next turn (Jokinen, Nishida, & Yamamoto, 2010). Once a turn has been gained, the next speaker begins their turn. As they do so, they lift their head and gaze at the current speaker, then just before they begin to speak they move their gaze away (Argyle & Cook, 1976) and shift their posture (Cassell, Nakano, Bickmore, Sidner, & Rich, 2001; Schefflen, 1973).

Overall, these brief descriptions of the behaviours and dynamics involved in the conversation management processes of feedback and turn exchange demonstrate the key role of nonverbal behaviour within these processes. The nonverbal exchange between interacting partners is critical to the continuation of a social interaction. The ability to detect and interpret such nonverbal cues becomes even more important under multiparty conditions, where the conversation management processes are more demanding and complex. Difficulty communicating on this nonverbal level would result in problematic interaction. The exchange of nonverbal cues involved in such these processes will be examined in patients' interactions in the current study.

3.7 Chapter summary

The purpose of this chapter was to provide an overview of normative social interaction. This chapter has demonstrated that face-to-face social interaction is a highly coordinated, cooperative act between interacting partners, with behaviours of all parties influencing the behaviours of all others within the interaction. Two critical determinates of successful social interaction have been presented within this chapter (i) interpersonal coordination between interacting partners and (ii) feedback between interacting partners. Both processes rely on the exchange of nonverbal cues between interacting partners in order for them to occur. Nonverbal exchanges become more relevant, complex and demanding with the addition of more interacting partners.

Patients with schizophrenia demonstrate deficits interpreting nonverbal cues when completing social cognitive tests. The current study will investigate if social interactions involving a patient with a diagnosis of schizophrenia display atypical patterns of interactionally salient nonverbal behaviours. The nonverbal behaviour of patients' social interactions will be scrutinized on three levels:

1. Investigating interpersonal coordination between interacting partners in two and three- way interactions (chapters 4 & 5)
2. Investigating the participation of interacting partners in the conversation roles of speaker, addressee and unaddressed recipient within the three-way interaction (chapter 6)
3. Investigating the production of nonverbal cues (i.e. nodding and gesture) by interacting partners when actively participating in the three-way interaction (i.e. as speaker or addressed recipient) (chapter 7)

The relationship between these nonverbal behaviours and patients' clinical and social features will be investigated.

Part II : Interpersonal Coordination

Chapter 4: Is nonverbal interpersonal coordination reduced in social interactions involving a patient with a diagnosis of schizophrenia?

4.1 Introduction

The first empirical report of this thesis addresses **research question 1, (parts a and b)**. This chapter is concerned with exploring the nonverbal coordination between interacting partners in patients' two and three-way interactions.

As demonstrated in the literature review, interpersonal coordination plays an important role in successful social interaction. The ability to coordinate with others requires the detection and responsiveness to nonverbal social cues, a skill that patients with schizophrenia display difficulty with when assessed using social cognitive tests. Furthermore, interpersonal coordination plays a key role in social rapport, which psychiatrists have reported to be problematic in patients' interactions. Taken together, these characteristics highlight coordination as potentially problematic in patients' social interactions and a likely contributor to their social deficits. However, there has been no robust empirical investigation of interpersonal coordination in patients with a diagnosis of schizophrenia.

As reviewed in chapters 2 and 3, Condon & Ogston (1966) investigated one aspect of interpersonal coordination (i.e. temporal coordination) in patients with schizophrenia as they engaged in a two-way conversation with their clinician. This study, although descriptively rich, was limited by the small sample size (i.e. 3 patients), lack of information on symptoms, and the time and labour intensive nature of the emic-level hand coding of speech and behaviour.

The primary aim of this chapter is to experimentally assess if interpersonal coordination is reduced in patients' social interactions. As mentioned in the literature review, difficulties in interpersonal coordination may be masked in interactions involving two people and may only become apparent under more complex multiparty conditions where the demand for coordination is greater. Hence, this chapter assessed both two-way and three-way interactions.

Motion capture equipment was employed to record the precise movements of patients and healthy participant partners in 3-Dimensions over the course of their social encounter. All interacting partners had not previously met and healthy participants were unaware of the patients' diagnosis. The motion capture data was analysed, using methods detailed below (section 4.2.6.5 *Measuring interpersonal coordination*), to derive an index of coordination between head movements of interacting partners. Head movement was chosen specifically, due to its pivotal role in conversation management processes.

The following hypotheses will be tested:

1. Interpersonal coordination is not reduced in patients' two-way interactions,
2. Interpersonal coordination is reduced in patients' three-way interactions.

4.1.1 Patterns of interpersonal coordination over time

The second aim of this chapter is to identify the patterns of coordination over the course of patients' two and three-way interaction. Analysing patterns over time allows coordination to be scrutinized at a more fine-grained level. As discussed in chapter 3, interactions have a baseline level of coordination between individuals, which is modulated over the course of the interaction depending upon the demands moment-to-moment (Kendon, 1970). Taking a mean measure of coordination over the whole interaction will mask such fluctuations. Previous studies of head movement coordination have found that coordination is sustained between partners for short periods of approximately 2 seconds (Boker, Minquan, Rotondo, & King, 2002). Hence, to look at each variation would be too detailed to make any meaningful inferences about the pattern of coordination over time. In order to address this, in the current analysis, each interaction is divided into ten sections. A measure of mean coordination for each section will be derived to provide a pattern of coordination over time. This pattern can then be used to identify trends in the coordination of the interacting pairs both in the two and three-way interactions.

Three-way interactions specifically provide an opportunity to examine, not only the coordination of pairs directly involving a patient (i.e. patient-healthy participant pairs P-

HP), but also the impact of the patient on the coordination between their two healthy participant partners (i.e. healthy participant pairs HPp-HPp).

The following question will be addressed:

3. What is the pattern of coordination over the course of patients' three-way interactions?

4.2 Methods

4.2.1 Study design

This study consisted of two interaction experiments: a two-way interaction and a three-way interaction. The same 20 patients participated in both the two-way and three-way interactions.

4.2.1.1 Two-way interaction experiment

This experiment involved two conditions; (1) an experimental patient condition involving 20 two-way interactions each containing one patient with a diagnosis of schizophrenia (P) and one healthy participant (HPp), (2) a control condition involving 20 two-way interactions each containing two healthy participants (Control).

4.2.1.2 Three-way interaction experiment

This experiment involved two conditions; (1) an experimental patient condition involving 20 three-way interactions, each containing one patient with a diagnosis of schizophrenia (P) and two non-psychiatric healthy participants (HPp), (2) a control condition involving 20 three-way interactions each containing three non-psychiatric healthy participants (Control).

4.2.2 Study participants

Schizophrenia Patients: 20 patients with a diagnosis of schizophrenia (6 Male, 14 Female) were recruited at routine psychiatric outpatient clinics on the basis of a clinical diagnosis of schizophrenia. The researcher attended the psychiatric clinics and

approached those patients who were deemed suitable by their psychiatrist. 25% of patients who were approached agreed to participate. Diagnosis was confirmed using the structured clinical interview for diagnostic symptoms (SCID-IV) (Michael, Spitzer, Gibbon, & Williams, 2002). Patients presenting with motor side effects from anti-psychotic medication (e.g. muscle stiffness and involuntary muscle spasms) were excluded from the study. This was assessed using the Abnormal Involuntary Movement Scale (AIMS) (Guy, 1976). Patients who were not fluent English speakers were also excluded, as this may be problematic for social interactions. All patients were between the ages of 18 and 65 years of age.

At the time of recruitment, three patients were medication free, two were taking older typical antipsychotic medication (Trifluoperazine or Flupentixol) and the remaining fifteen were taking newer atypical antipsychotic medication (Olanzapine, Clozapine, Risperidone, Aripiprazole or Amisulpride). To allow for comparisons between patients, medication dose for each patient was transformed into Chlorpromazine equivalents (CPZE). Standard dose CPZE=200-500mg/day, low dose CPZE=50-200 mg/day (Barbui, Saraceno, Liberati, & Garattini, 1996). The dose of each medication taken by patients within this study as an equivalent of 100mg/day of Chlorpromazine is displayed in table 1.

Table 1. Chlorpromazine equivalents for antipsychotic medication

Medication	N	Dose (mg/day) equivalent to Chlorpromazine 100 mg/day
Typical Antipsychotics		
¹ Trifluoperazine	1	5
² Flupentixol Depot	1	16-40 (mg/fortnightly)
Atypical Antipsychotics		
³ Olanzapine	7	5
¹ Clozapine	3	50
³ Risperidone	1	2
³ Aripiprazole	4	7.5

References: 1: Lehman and Steinwachs (1998), 2: Atkins, Burgess, Bottomley & Riccio (1997), 3:Woods (2003)

Healthy participants: One hundred non-psychiatric healthy participants (56 Male, 44 Female) were recruited from non-academic staff at Queen Mary University of London, and through advertising on local community websites. The recruitment of university students was specifically avoided in an attempt to match the healthy participants to the patients in terms of age and level of educational attainment. Although a high number of people responded to the advertisement and approximately 80% of responders agreed to take part, there was a high rate of people who did not attend on the day of the experiment (approximately 50%). Therefore, of those who responded to the advertisement approximately 40% actually participated in the study. Participants with a diagnosis of psychosis or affective disorders in themselves or any first-degree relatives, participants with any formal clinical training as psychiatrists or clinical psychologists and those who were not fluent English speakers were excluded from the study. All participants were aged between 18 and 65.

Participants were unfamiliar with their interacting partners and had not met prior to the study. Healthy participants were informed that the study was an investigation of three-way social interaction and were unaware that a patient was present during the interaction, or that there was any psychiatric element to the research.⁷

4.2.3 Assessment measures & equipment

4.2.3.1 Assessments of sociodemographic information

Participants completed a questionnaire regarding their sociodemographic information including their age, gender, ethnicity, first language, age at leaving full time education or training, their current employment and marital status and the number of children they have.

⁷ This ruse was helped by the fact that all aspects of the study took place in the computer science department and not in the psychiatric department.

4.2.3.2 Clinical assessments

The Structured Clinical Interview for Diagnostic symptoms research version, patient edition (SCID-1/P) (DSM-IV) (Michael, Spitzer, Gibbon, & Williams, 2002) evaluated patients' diagnosis. This assessed patients' symptoms over the course of their illness, examining the onset and duration of each specific symptom, building up a symptom profile for each patient. Patients were then classified into their specific schizophrenia types (paranoid type, catatonic type, disorganized type, undifferentiated type or residual type).

The positive and negative syndrome scale (PANSS) (Kay, Friszbein, & Opler, 1987) assessed patients' symptom severity at the time of the study. PANSS was used to rate patients' positive, negative and general symptoms on a 7-point scale of severity (1=absent, 2=minimum, 3=mild, 4=moderate, 5=moderate severe, 6=severe, 7=extreme). Positive symptoms represent a change in the patients' behaviour or thoughts and include sensory hallucinations and delusional beliefs (e.g., paranoid or persecutory delusions, with no external evidence to support the belief). Negative symptoms represent a withdrawal or reduction in functioning, including blunted affect, avolition and alogia. Positive and negative subscale scores ranged from 7 (absent) – 49 (extreme), general symptoms scores ranged from 16 (absent) - 112 (extreme).

The Beck Anxiety Inventory (BAI) (Beck, Epstein, Brown, & Steer, 1988) rated participants' level of anxiety. The BAI is a 21-item self-report questionnaire measuring common symptoms of anxiety such as 'fear of losing control' and 'nervousness'. Thirteen items assessed physiological symptoms, five describe cognitive aspects and three represent both somatic and cognitive symptoms. Participants rated how much they have been bothered by each symptom in the past week on a 4-point scale, ranging from 0-not at all to 3-severely, I could barely stand it. Total scores range from 0 (no symptoms of anxiety) to 63 (severe anxiety). **The Abnormal Involuntary Movement Scale** (AIMS) (Guy, 1976) was administered to patients to test for the presence of abnormal motor movements. The patients' psychiatrist or the researcher used the first 7 items of the AIMS to test for involuntary movements of the patients' face, arms, legs,

neck, shoulders and hips. Movements are rated on a 5-points scale (0-none, 1- minimal may be extreme normal, 2- mild, 3-moderate and 4-Severe). Patients with a score of 2 (mild) or above on any item were excluded from the study.

4.2.4 3-Dimension motion capture equipment

All interactions were recorded in the Augmented Human Interaction (AHI) lab at Queen Mary, University of London. The AHI lab was fitted with Vicon motion capture equipment. The Vicon system tracks movement in 3-Dimensional (3-D) space. Vicon is an optical based motion capture system, meaning that the markers are not active but simply pieces of reflective material. The system consisted of 12 infrared cameras (figure 1) and the Vicon software iQ.



Figure 1. Infrared cameras in the Augmented Human Interaction (AHI) laboratory

The cameras tracked the reflective markers, which were placed in specific positions on the body of the participants using Velcro (see section 4.2.5: *Experimental procedure* for detailed description). The infrared cameras detected markers as a 2-Dimensional (2-D) image at a rate of 60 frames per second. These images were transferred to the Vicon iQ software where they were combined to enable reconstruction of the precise 3-Dimensional (3-D) positions of participants' markers at each frame of the interaction. Movements were recorded in the vertical (up-and-down) horizontal (side-to-side movement) and the depth (forward-and-back movement) axes (figure 2).

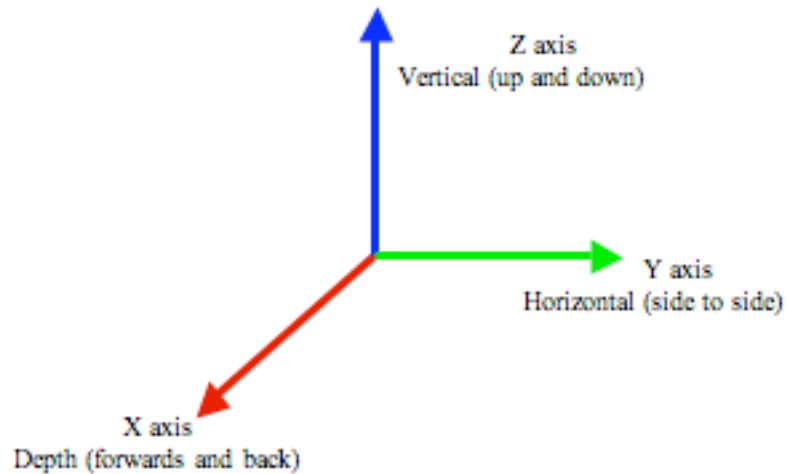


Figure 2. Three dimensions of movement: Vertical, horizontal and depth

4.2.5 Experimental procedure

All procedures were approved by the NHS Research Ethics Committee (Reference number: 07/H0711/90). All participants were provided with a study information sheet and given an opportunity to ask questions about the study prior to giving their written informed consent to participate. A copy of the patient study information sheet and consent form can be found in appendix A. Healthy participants' study information sheet and consent form are in appendix B.

Patients' clinical assessments were administered during an interview with the researcher, which took place on a separate day from the interaction task, but occurred within the same week so as to capture the patients' symptom profile at the time of the interaction as accurately as possible. Clinical interviews with patients took approximately 2 hours.

On the day of the interaction, participants were fitted with the motion capture suits, consisting of a black Lycra top, a baseball cap and 27 reflective markers attached to the top and the cap using Velcro. Markers were attached in an upper body skeleton formation recommended by Vicon consisting of; four markers on the head (i.e. baseball cap), four on the waist, two on the chest, three on the back, one on each shoulder, one on each upper arm, one on each elbow, one on each forearm, two on each wrist (one inner wrist and one outer) and one on the back of each hand (figure 3).



Figure 3. Participants' three-way interaction - participants wearing Lycra tops, baseball caps and reflective markers attached with Velcro.

The body movement of each participant was calibrated to identify the range of motion of each individual. This process required individuals to stand in the centre of the interaction space (figure 3) and perform a series of movements as instructed by the researcher. These movements included, bending their arms at the elbow, rotating their head and bending at the waist. This process took approximately 30 seconds.

4.2.5.1 Two-way interaction –London Olympics discussion

Two participants were seated on stools in the interaction lab (figure 3) and the researcher asked them to discuss their views on the Olympics coming to London in 2012. Other discussion topics were piloted for this study, however as this research was conducted in east London near the site of the Olympics it was topical and was found to generate a lively discussion between participants. Interactions ended when the interaction came to a natural termination and the participants stopped talking or, failing this, the interaction was terminated at approximately 500 seconds (8 minutes 20 seconds).

4.2.5.2 Three-way interaction - Balloon task

Participants were seated on three stools in the interaction space (Figure 3). The researcher read aloud the balloon task scenario to the seated group. The Balloon Task is

an interactive decision-making task. Participants were provided with a fictional moral dilemma and, as a group, are asked to reach agreement on the outcome of the dilemma. The dilemma states; there are four people in a hot air balloon that is losing height and is moments away from crashing, killing all passengers on board. The only way for the passengers to survive is for one of them to jump to their certain death to save the remaining three. The passengers in the balloon are: 1. Dr Nick Rivera: A cancer research scientist on the brink of discovering a cure to the most common types of cancer, 2. Mrs. Suzie Durkins: A primary school teacher who is seven months pregnant with her second child, 3. Mr. Tom Durkins: Devoted husband to Susie, who is the balloon pilot and the only person on board with any flying experience and 4. Carla Jenkins: A nine-year old child prodigy tipped to become the next Mozart.

Participants were told that their task was to debate the reasons for and against each individual being saved, and reach a mutual agreement on which of the four individuals should jump from the balloon. Although many interaction tasks were piloted for this study, the balloon task was chosen as it required no prior knowledge from the participants, proved highly engaging, and generated a good range of verbal and non-verbal interaction as participants debated their perspectives and argued for and against each individual. The group was provided with an opportunity to ask questions before the researcher left the interaction space and the task began. Interactions ended when participants reached a joint decision on who should jump from the balloon. Groups that failed to reach an agreed decision had their interaction terminated at approximately 450 seconds (7mins 30 seconds). Alongside the motion capture recordings, interactions were audio-visually recorded using two traditional 2-D video camera to provide a reference video with speech.

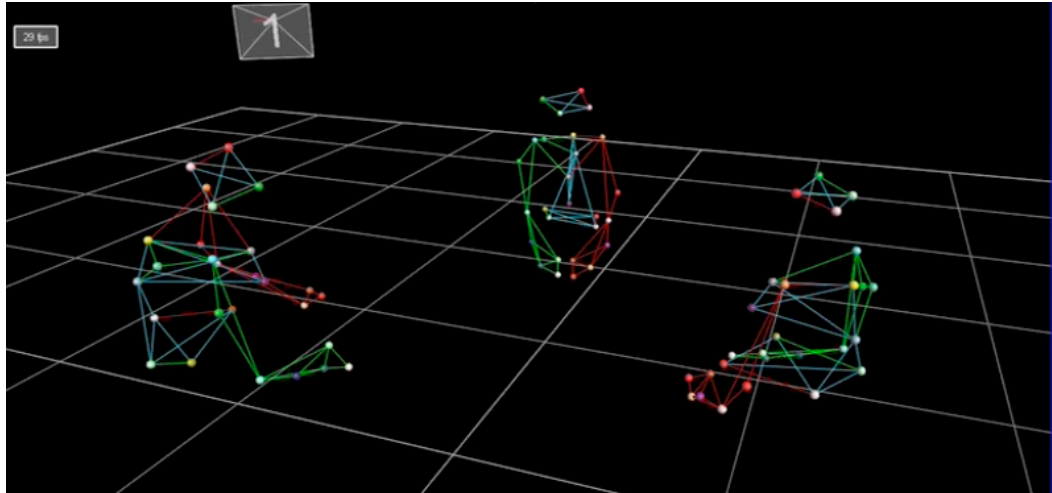


Figure 4. 3-D wire-frame representation of a three-way interaction

4.2.6 Data Analysis

4.2.6.1 Reconstructing 3-D data and dealing with missing markers

Once the interaction was motion captured, the Vicon iQ software reconstructed a 3-Dimensional wire-frame representation of the precise spatial and temporal movements of each participant involved in the interaction (figure 4). Although every effort was made to ensure that each participant, and each of their 27 markers, was visible by the cameras in the interaction space, every capture had markers that were unlabelled or missing completely during sections of the interaction. This occurred due to temporary occlusion of the markers, which is unavoidable when capturing natural social interaction where movements are not restricted. A simple movement such as a folding arms may occlude markers on one or both forearms, wrists and hands from the cameras view, resulting in unlabeled or missing markers for this section of the interaction. The primary cause for occlusion in the seated arrangement used in this study was movement of the arms. Therefore, the parts of the body that suffered most from missing data and those which are occluded most often, were the wrists, hands, elbows and front waist markers. The markers that were rarely missing were the head, shoulders, the back torso markers and the upper arm markers.

4.2.6.1.1 Manual labeling of missing markers

When the data was reconstructed, in Vicon iQ, markers that were captured but were unlabeled appeared as white markers unattached to the 3-D wire-frame. The identity of unlabelled markers could be deciphered by looking at their spatial position in relation to the other markers in the 3-D wire-frame. This was a simple but time intensive process taking approximately five hours to label a seven-minute three-way interaction with three upper-body skeletons, and approximately three hours to label a similar two-way interaction. Thus, the entire data set involving 40 three-way interactions and 40 two-way interactions took approximately 300 hours to label.

4.2.6.1.2 Post processing of labeled data

After labeling, approximately 10% of the markers in each 7-minute capture were missing. These were retrieved using pipeline operations in Vicon iQ. Two forms of pipeline operations were used; Firstly, ‘splines’ were used to fill smaller gaps in data points of 100 frames or less. Splines took the 3-D coordinates of the missing marker before the gap and after the gap and used these to predict the 3-D coordinates of the marker during the gap. It then added this predicted data point into the reconstruction. Secondly, when gaps remained in the reconstruction after the splines had been implemented a second pipeline operation called ‘rigid body’ was performed. The ‘Rigid body’ operation imported a rigid template of the upper body model, which was mapped onto participants’ markers in the reconstruction. Similar to the spline operation, the rigid body predicted 3-D coordinates of the missing markers, however it did so by calculating where it should be in relation to the other markers of that body e.g. the head is a rigid body, therefore if the precise 3-D coordinates of 3 of the markers on that head was known the fourth was predicted and inserted into the reconstruction. A copy of the reconstruction was saved prior to the pipeline and at each stage of the pipeline operations.

4.2.6.2 Exporting the 3-D data

The data from each interaction group was exported from Vicon iQ in a trc file format. Within the Vicon software, each marker was assigned a name, indicating which participant the marker was attached to and where it was positioned on the body of that participant (e.g. p1LUPA referred to Participant 1 left upper arm). The markers were referenced by name in the TRC file. The trc file consisted of a header section providing the file name, frame rate, the total number of frames and the identity of each marker within each of their three axes and a motion section providing the precise 3-D coordinates of each marker in mm. A break down of the number of coordinates retrieved for one 7-minute three-way interaction is displayed in table 2. The trc file was then exported into the mathematical software MATLAB for mathematical analysis.

Table 2. Motion capture data for one three-way interaction

	One Interaction Group		
Participant number	1	2	3
Markers	27	27	27
3-D coordinates per frame	81	81	81
3-D coordinates per second (60fps)	4,860	4,860	4,860
3D coordinates per 7min interaction	2,187,000	2,187,000	2,187,000
Total coordinates per three-way group	6,561,000		

4.2.6.3 Normalizing the participants in 3-D space

Once the interaction had been imported into MATLAB, the movement data of each participant was normalized to ensure uniform data and allow direct comparison of participants. This was achieved by anchoring the participant using their four waist and two shoulder markers. As the head is a rigid body, all four head markers functioned as a unit, therefore the spatial-temporal data from any one of the head markers provided all head movement data. The front left head marker was chosen as the representative marker of head movement. The normalized raw head movement data from each participant in each axis (vertical horizontal and depth) was then derived (figure 5).

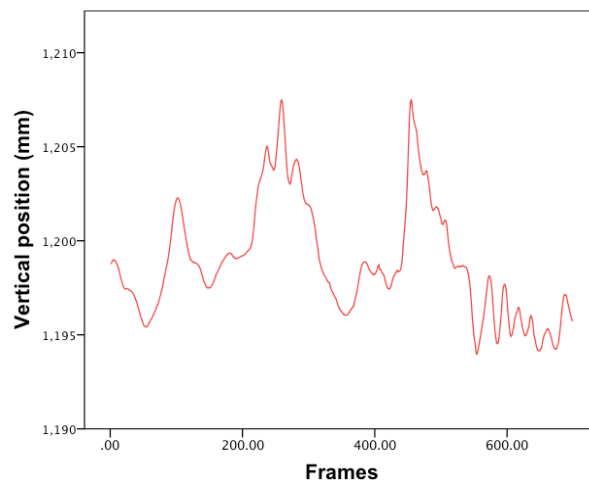


Figure 5. Raw motion data of a participant’s vertical head movement – in millimeters in the first 700 frames of their interaction.

4.2.6.4 *Measuring individual head movement*

In order to obtain a measure of individual head movement that could be compared between participants, the mean head movement speed (mm/frame) of the front left head marker of each participant was calculated as; the mean change in position of the front left head marker in millimeters per frame. This was calculated for the vertical (up and down), horizontal (side to side) and depth axes individually (forwards and back) and the mean head movement speed across all three axes was calculated for each participant.

4.2.6.5 *Measuring interpersonal coordination*

The head movement of each participant was directly compared with that of their interacting partners, using a windowed cross correlation. This provided two measures of interpersonal coordination:

- (i) **Correlation** (r) degree of similarity between head movements,
- (ii) **Delay** (seconds) the time between the similar head movements occurring.

A MATLAB script to run the cross-correlation analyses was developed by a programmer within the department of computer science at Queen Mary, University of London (Dr Chris Frauenberger). Within each cross-correlation window, local stationarity is assumed, i.e. we assume that the dynamics between the interacting partners do not change for the duration of the window, and that the degree of correlation

within that window is representative of the interaction at that point. Therefore, the window size chosen should represent a period of time within which interaction between interacting partners remains relatively stable. Previous studies investigating head movement coordination in two-way interactions found interpersonal coordination to persist for short periods of approximately two seconds (Ashenfelter, Boker, Waddell, & Vitanov, 2009). For this reason, a window of 2 seconds was chosen in the current study. Each window was overlapped by 50% to minimize the chance of correlated movements being undetected.

The cross correlations were performed within each axis of movement individually to limit the detection of similar movements to only those occurring within the same axis. Within each window, correlations were detected using frame by lagged frame comparison method. This determined the average correlation of all compared frames at each temporal delay within a window from -2 to +2 seconds. Significant correlations were identified as those more than one standard deviation from the mean correlation coefficient. The most significant positive correlation and the most significant negative correlation were selected from each window. This formed a time series of the significant correlations and their associated delay within each window over time. This is displayed in figure 6. The blue line represents the positive correlations and the red line represents the negative correlations.

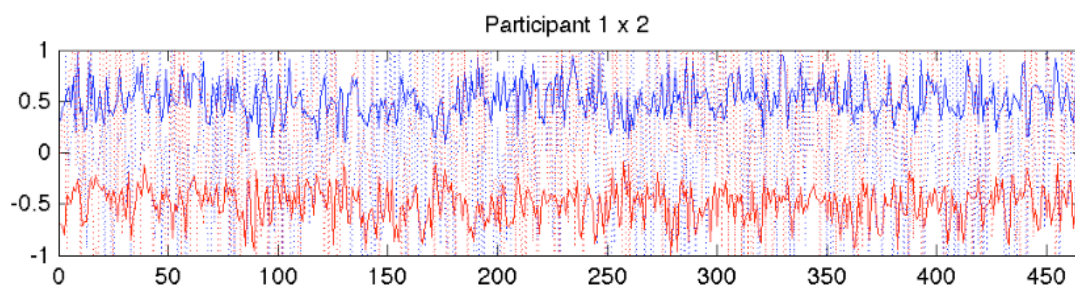


Figure 6. Cross-correlation time series of participants' coordinated head movements

The most significant correlation (i.e. greatest r value irrespective of whether it is a positive or negative correlation) within each window was selected, alongside its associated delay, as representing the degree of coordination between the interacting partners within that two-second window of the interaction.

4.2.6.6 Preparation of interpersonal coordination data

In line with previous studies investigating correlated head movement in two-way interactions, there was no interactionally meaningful distinction made between positive and negative head movement correlations. Both were treated equally as an index of movement coordination. The distribution of r in each axis is displayed in figure 7. It can be seen that there are no differences in distribution of r for positive and negative correlations. Therefore, for the purpose of analysis, and in line with the practice of previous studies (Ashenfelter, Boker, Waddell, & Vitanov, 2009; Boker, Minquan, Rotondo, & King, 2002; Ramseyer & Tschacher, 2008), all negative correlations were transformed to positive values prior to analysis. All correlations occurring at a delay of zero seconds were removed from the analysis as no temporal delay was applied to these correlations; therefore they did not represent interpersonal responsiveness between individuals.

The sign of the delay value indicated the identity of the person that produced the correlated movement first (i.e. the leader) and who produced it second (i.e. the follower). It would be inappropriate to conduct analysis on delay values that are negative, therefore, prior to statistical analysis the sign was removed (i.e. all delay values are positive) and the identity of the leader and follower were retained.

Within each axis, the chosen r and delay values from each 2-second window together formed a time series displaying, the strength of the correlation (r), its temporal delay (sec) and the identity of the leader and follower for that correlated movement. This data was imported into the statistical package SPSS for inferential statistical analysis. In order to retain the maximum amount of information, and eliminate data replication from overlapping cross-correlation windows, every second window was removed from the data prior to analysis.

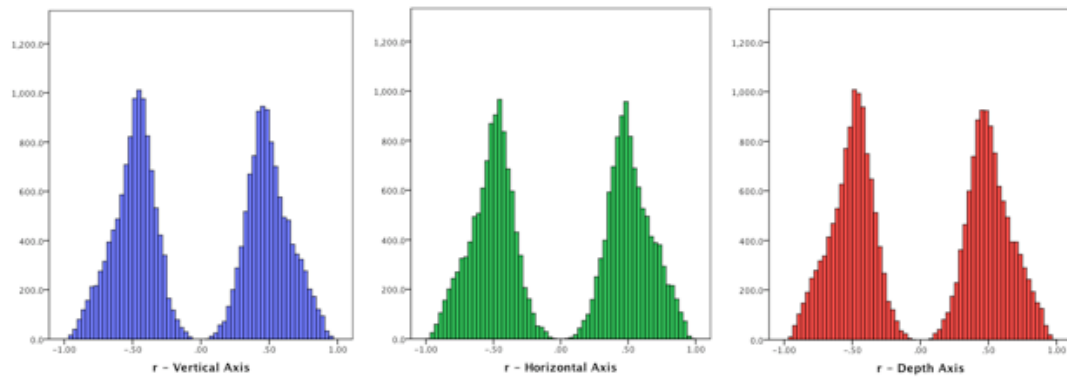


Figure 7. Distribution of r in the vertical (blue) horizontal (green) and depth (red) axes with original sign

4.2.7 Statistical Analysis

All statistical analysis were conducted in SPSS with p-values of $p < .05$ considered significant, and p-values between $p = .05$ and $p < .10$ noted as a trend.

4.2.7.1 Sociodemographic characteristics

Socio-demographic information was compared between (i) patients and healthy participants and (ii) patient condition and control condition. Gender, ethnicity and first language (i.e. native English speakers) were compared between using a Pearson's χ^2 test. Age and age leaving full-time education and training is compared using an independent samples t-test.

4.2.7.2 Comparison of interaction length by condition

An independent samples t-test compared the mean length of interactions (seconds) in the patient condition and the control condition.

4.2.7.3 Comparison of patient and healthy participants' head movement

Previous studies have found healthy participants show reduced head movement when interacting with a patient in a two-way interaction (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010). In order to determine the difference in individual head movement between patients and healthy participants, and to eliminate the possible confounding impact of the patient on the head movement of their healthy participant

partners, an independent samples t-test compared mean head movement speed (mm/frame) between patients and control group healthy participants only.

4.2.7.4 Association between patients' medication dose and head movement

Seventeen patients were taking antipsychotic medication at the time of recruitment. Previous studies have found that antipsychotic medication, even newer antipsychotic medication, which the majority of the patients in this study were taking, may have an impact on movement (Leucht, Pitschel-Walz, Abraham, & Kissling, 1999). In order to investigate this relationship bivariate correlation analyses assessed the association between patients' medication dose (CPZE mg/day) and their mean head speed (mm/frame) in their two and three-way interactions.

4.2.7.5 Comparison of interpersonal coordination between conditions

A bivariate correlation assessed the relationship between r and delay. Differences in coordination between conditions were assessed using generalized linear analysis of variance models (GLM). This analysis was chosen as it can incorporate the relatedness between pairs within the same interaction, i.e. in the three-way interactions, and non-parametric data (i.e. delay).

In each model the dependent variable was the coordination (r or delay) and the independent variable was condition (patient or control). All models analyzing r used a linear response model and those analyzing delay used a gamma response model, to account for the different data distributions.

In the **two-way comparison** variables adjusted for were: patients' symptoms (PANSS positive, negative and general), patients' antipsychotic medication dose (CPZE), medication type (medication free, atypical antipsychotic medication or typical antipsychotic medication) and length of the interaction (seconds). These were included as covariates.

In the **three-way comparison**, alongside adjusting for patients' symptoms, medication dose (CPZE), medication type and interaction length, the relatedness between pairs that were interacting within the same three-way group was also adjusted for. This was achieved by taking the ID number for each pair (Pair-ID) and nesting it within the number of the group they interacted in (Group-ID). This was entered into the model as a random factor. Within patients' three-way interactions, differences in coordination (r and delay) between the two pair types were compared. GLM models were identical to those used to compare conditions in the three-way interaction. However, the dependent variable in these models was pair type (i.e. patient-healthy participant pair (P-HPp) or healthy participant pair (HPp-HPp)).

4.2.7.6 Patterns of coordination over time

Patterns of coordination over time was analysed for two-way and three-way interactions separately. Each interaction was divided into ten sections (interaction length (seconds) /10) the mean r of each pair, in each section, was calculated. In order to assess the relationship between r and time, separate trend analyses were performed on each condition in the two-way interaction, and each pair type in the three-way interaction (patient-healthy participant (P-HPp), healthy participants in the patient group (HPp-HPp), and healthy participants in the control group (controls)). In each analysis, r was the dependent variable and the independent variable was time (in sections).

4.3 Results

4.3.1 Patients' clinical characteristics

Patients' clinical characteristics are displayed in table 3. Three patients had no previous admissions to psychiatric hospitals. Fifteen patients had between one and six previous admissions, and the remaining two patients had 15 or more. On average, patients were taking doses of medication that were lower than the standard dose of 200-500mg/day chlorpromazine equivalents (Barbui, Saraceno, Liberati, & Garattini, 1996). Patients' symptoms scores were also relatively low with patients displaying, on average, moderate positive and negative symptoms and only mild negative symptoms. Patients showed very little variance in their negative symptoms.

Table 3. Patients' clinical characteristics

Clinical Variables (n=20)	Min	Max	M	SD
Years diagnosed	2	46	15.00	10.26
Number of previous admissions	0	20	3.85	5.01
Previous admissions (weeks)	0	60	19.59	18.45
Medication dose (CPZE) (mg/day)	0	400	167.87	109.29
PANSS Positive	7	37	15.80	6.76
PANSS Negative	7	19	9.95	3.36
PANSS General	16	59	28.41	10.42

4.3.2 Sociodemographic characteristics

4.3.2.1 Individual level characteristics

Patients: Ten patients lived alone and ten with their family or a partner. 16 patients were single, and had no children; four patients had partners and children. 19 patients were living in independent housing that they either owned or rented. One patient was living in supported housing. 12 patients had someone they call a close friend, however the remaining eight did not. Three patients were in regular employment while the remaining 17 were unemployed.

Healthy participants: 19 healthy participants lived alone and the remaining 81 lived with their family, partner or friends. 78 were single, the remaining 22 were married or had partners. 84 healthy participants had no children while 16 did have children. 98 healthy participants lived in independent housing, either owned or rented, while two lived in supported housing. 21 healthy participants had no one they called a close friend, while the remaining 79 did. 53 healthy participants were in regular employment and the remaining 47 were unemployed.

The sociodemographic information by participant type is displayed in table 4(a). The patient sample was significantly older and had more females than the healthy participant sample. Patients and healthy participants did not differ on ethnicity or age leaving education or training. Sociodemographic information by condition is displayed in table

4(b). Participants in the patient condition were significantly older and displayed a trend for having more native English speakers.

Table 4(a) Sociodemographic information by participant type

Variables	Patients (n=20) M (SD)	Healthy participants (n=100) M (SD)	χ^2	<i>t</i>	<i>df</i>	<i>p</i>
% Female	65.00	45.00	2.67	-	1	.10 \square
% Caucasian	60.00	56.60	0.15	-	1	.70
% Native English speakers	85.00	86.00	0.01			.91
Age	41.50 (8.64)	31.10 (9.60)	-	-4.51	118	<.01**
Age leaving education	19.37 (3.78)	21.10 (5.60)	-	1.29	107	.19

Significance level: **= $p < .01$ *= $p < .05$ $\square = p < .10$

Table 4(b) Sociodemographic information by condition

Variables	Patient condition (n=60) M (SD)	Control condition (n=60) M (SD)	χ^2	<i>t</i>	<i>df</i>	<i>p</i>
% Female	53.30	43.30	1.20	-	1	.27
% Caucasian	55.60	47.10	0.76	-	1	.38
%Native English speakers	91.70	80.00	3.36			.07 \square
Age	34.92 (9.88)	30.82 (10.01)	-	2.26	118	.03*
Age leaving education	20.81 (4.49)	21.02 (6.39)	-	-0.20	110	.84

Significance level: **= $p < .01$ *= $p < .05$ $\square = p < .10$

4.3.2.2 Interaction level distribution of gender and language

Two-way Interactions: In the patient condition, 9 interactions were mixed gender, 5 involved only males and 6 only females. In the control condition, 11 interactions were mixed gender, 6 involved only males and 3 only females.

All two-way interactions involved at least one native English speaker. In the patient condition, 4 participants were non-native English speakers (3 patients born in the

Philippines, Kenya and Italy. 1 healthy participant born in India). In the control condition, 7 participants were non-native English speakers born in china, the Democratic Republic of Congo, Finland, Germany and two from India.

Three-way Interactions: In the patient condition 15 groups involved a mix of genders (8 groups = 1 male and 2 females, 7 groups = 2 males and 1 female), 3 involved only females and 2 involved only males. In the control condition, 16 groups involved a mix of genders (4 groups=1 male and 2 females, 11 groups=2 males and 1 female), 2 involved only males and 2 involved only females.

All three-way interactions involved at least two native English speakers. In the patient condition, 5 participants were non-native English speakers (3 patients born in the Phillipines, Kenya and Italy. 2 healthy participants born in Japan and India). In the control condition, 10 participants were non-native English speakers born in china, the Democratic Republic of Congo, Finland, Germany, Poland, Argentina, two from Italy and two from India.

4.3.3 Comparison of interaction length by condition

Patients’ two-way interactions showed a trend for being shorter than control two-way interactions. However, the length of the three-way interactions did not differ between conditions (table 5).

Table 5. Interaction length (seconds) by condition

Interaction Length	Patient Condition M (SD)	Control Condition M (SD)	<i>t</i>	<i>df</i>	<i>p</i>
Two-way (sec)	289.14 (89.56)	346.76 (102.06)	-1.87	38	.07 α
Three-way (sec)	315.83 (116.00)	335.29 (118.90)	-0.51	38	.61

Significance level: **= $p < .01$ *= $p < .05$ $\alpha = p < .10$

4.3.4 Comparison of patient and healthy participants’ head movement

The mean head movement speed (mm/frame) for patients and control group healthy participants did not differ in either two-way or three way interactions (table 6).

Table 6. Head movement by participant type

Interaction	Patients	Controls	<i>T</i>	<i>df</i>	<i>p</i>
	M (SD)	M (SD)			
Two-way	.381 (.21)	.435 (.15)	-1.12	58	.27
Three-way	.304 (.11)	.348 (.16)	-1.19	78	.24

Significance level: **= $p < .01$ *= $p < .05$ $\alpha = p < .10$

4.3.5 Association between patients' medication dose and head movement

There was no association between patients' antipsychotic medication dose (CPZE mg/day) and their head movement speed (mm/frame) in the two-way interaction ($r(19) = .006, p = .98$) or the three-way interaction ($r(19) = .311, p = .19$).

4.3.6 Comparison of interpersonal coordination between conditions

The relationship between r and delay are displayed in figure 8. There was a high association between r and delay ($r(120) = -.809, p < .01$), with higher correlated head movements occurring after shorter delay (figure 8).

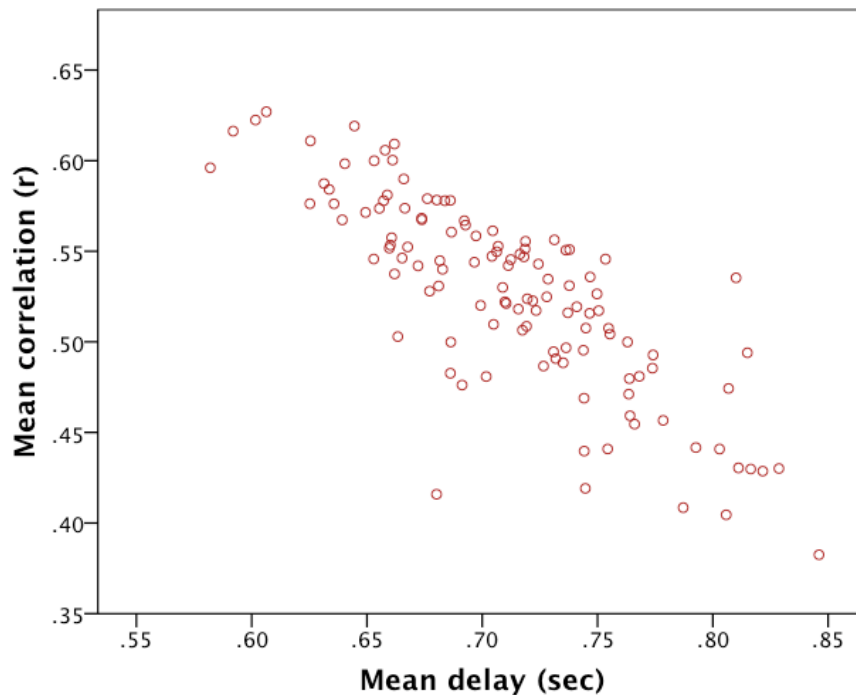


Figure 8. Relationship between head movement r and delay

Description of unadjusted means: The unadjusted mean r and delay for each condition in the two and three way interactions are displayed graphically in figure 9 (two-way interaction) and figure 10 (three-way interaction).

Taking these graphs together it appears that overall, both patient and control groups display more coordination (i.e. higher r and shorter delay) in the three-way interactions compared to the two-way. Furthermore, it can be seen that the mean r value across all groups and conditions is approx $r=.50$, which is in line with values of head movement correlation reported in previous studies (Ashenfelter, Boker, Waddell, & Vitanov, 2009).

In the two-way interaction, patient groups appear to be *more* coordinated (i.e. higher r) than control groups. Whereas, in the three-way interaction, patient groups appear to be less correlated (i.e. lower r) than control groups, but correlating after a shorter delay.

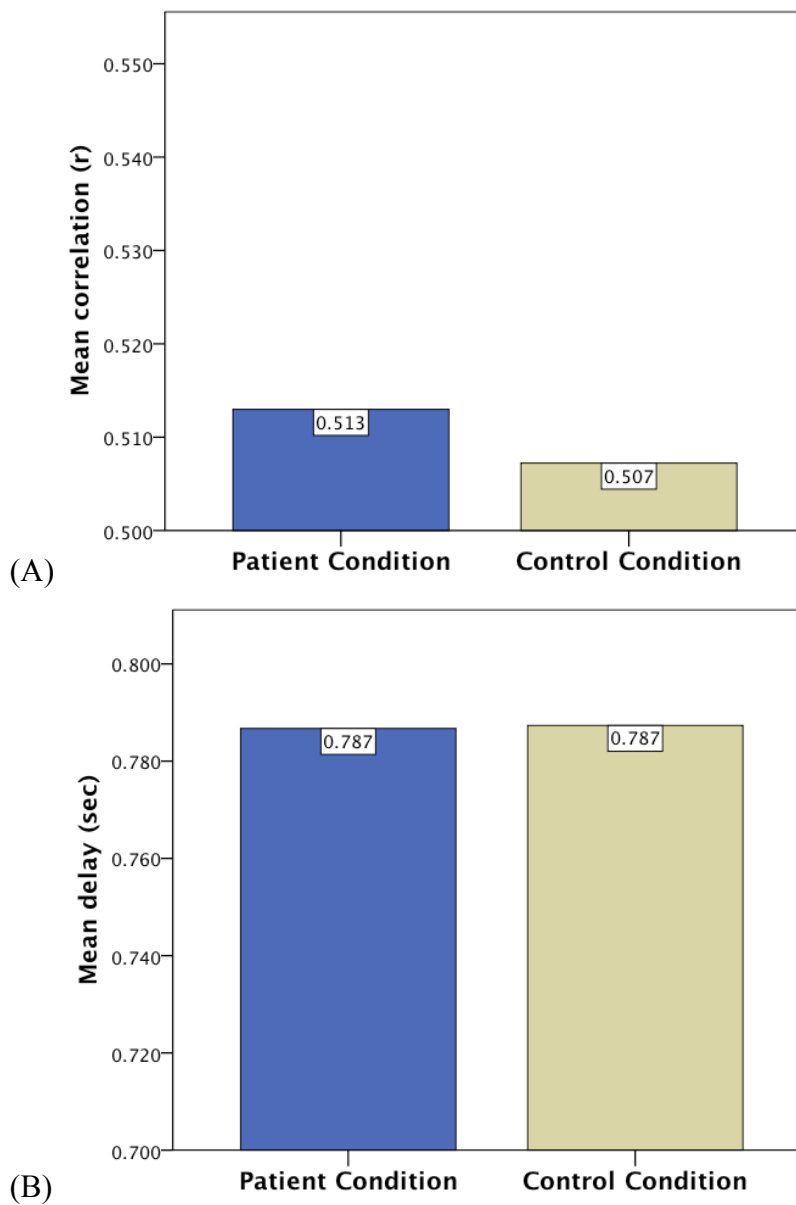


Figure 9. Two-way interaction: Unadjusted mean r (A) and delay (B) by condition

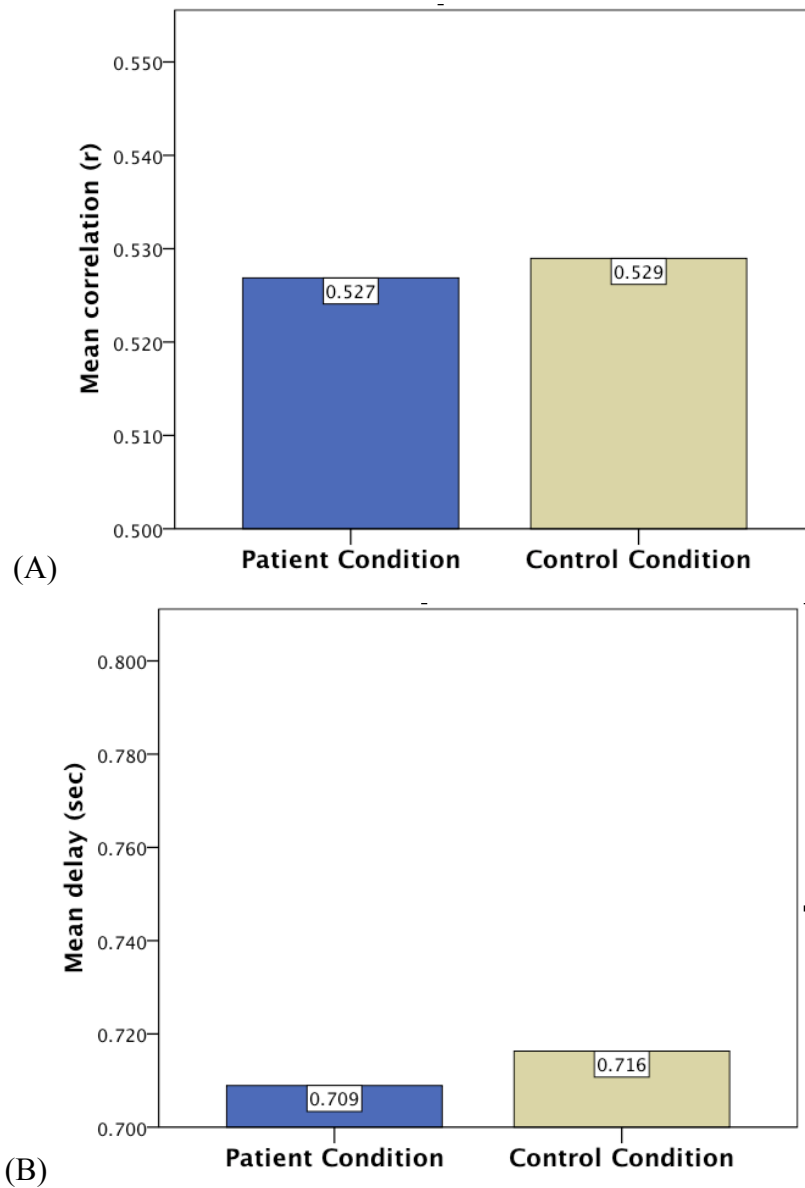


Figure 10. Three-way interaction: Unadjusted mean r (A) and delay (B) by condition

Comparisons of adjusted means: As patients and healthy participants showed significant differences in age and gender, these variables were also adjusted for the in analysis alongside patients' symptoms, medication dose and interaction length. The adjusted patient and control group means and standard errors for r and delay are displayed in table 7, alongside the comparisons between the patient and control conditions. The adjusted mean coordination values for pairs within the three-way patient group (i.e. patient-healthy participant pairs (P-HPp) and healthy participant pairs (HPp-HPp)) are displayed in table 8 alongside their comparisons.

The results revealed that patient and control two-way interactions did not differ in their degree of coordination (r or delay). However, patients' three-way interactions displayed reduced coordination, as the head movements between interacting partners were significantly less correlated than those of the control group comparisons. Within the patients' three-way interactions, coordination did not differ between pairs involving a patient and pairs involving only healthy participants.

Table 7. Pair-wise comparison of adjusted mean coordination by condition

Interaction		Patient M (SE)	Control M (SE)	Difference (P-C)	SE	X ²	df	p
Two-way	r	.513 (.004)	.507 (.003)	-.006	.006	0.84	1	.36
	Delay	.509 (.008)	.535 (.009)	.026	.017	2.43	1	.12
Three-way	r	.478 (.006)	.575 (.006)	-.097	.013	59.45	1	<.01**
	Delay	.724 (.023)	.694 (.022)	.031	.045	0.48	1	.49

Significance level: **= $p < .01$ *= $p < .05$ $\alpha = p < .100$

Table 8. Pair-wise comparison of adjusted mean coordination by pair type within the patients' three-way interaction.

Interaction		P-HPp M (SE)	HPp-HPp M (SE)	Difference (P-C)	SE	X ²	df	p
Patients	r	.436 (.023)	.481 (.009)	-.045	.026	2.48	1	.12
Three-way	Delay	.739 (.024)	.701 (.012)	.039	.035	1.26	1	.26

Significance level: **= $p < .01$ *= $p < .05$ $\alpha = p < .10$

4.3.7 Patterns of coordination over time

Two-way interaction: The average two-way interaction lasted approximately 317.89 seconds (SD=99.87 seconds). Therefore the average length of each ten section was 31.79 seconds.

Description: The mean coordination over time for the two-way interactions are displayed in figure 11. During the first to the seventh sections (the first 3 minutes 40 seconds approximately) patient pairs appear to be more coordinated than the pairs in the control group. From the seventh section onwards, coordination in both the patient and control conditions is similar and becomes increasingly more coordinated until the end of the interaction.

Trend analysis: The patient condition shows a quadratic relationship between r and time ($F(1,199)=2.51$, $p=.10\alpha$), relating this to figure 11, it means that at the start of the patients' interaction there is an initial decrease in coordination from the start of the interaction to the seventh section (3 minutes 40 seconds approximately), followed by an increase in coordination towards the end of the interaction. The control condition shows a linear relationship with time ($F(1,199)=4.42$, $p=.03^*$).

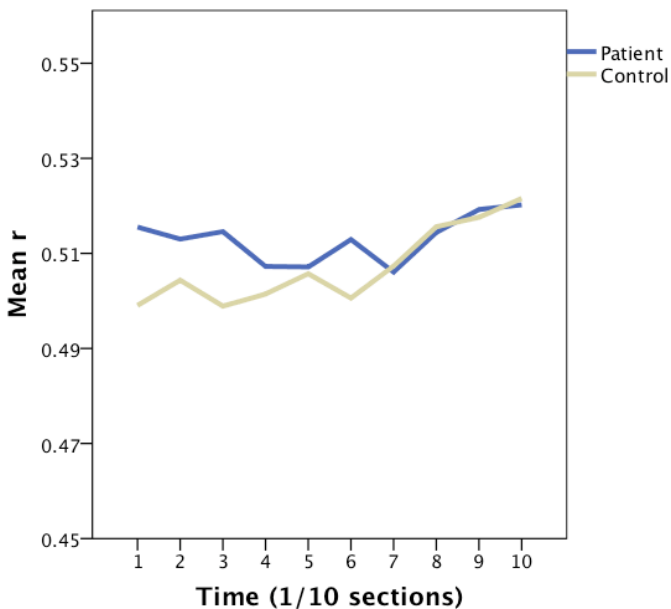


Figure 11. Relationship between coordination and time in two-way interaction by condition

Three-way interaction: The average three-way interaction lasted 325.55 seconds (SD=115.25 seconds), therefore the average length of each of the ten sections was 32.56 seconds.

Description: The mean r over time for each pair type (i.e. Patient healthy participant pair (P-HPp), healthy participants interacting with a patient (HPp-HPp) and control pairs) is displayed in figure 12. In the first section, pairs involving a patient were the least coordinated. Healthy participant pairs in the patient group (HPp-HPp) showed coordination similar to that seen in the control group. In the second section, all pairs within the patient group showed reduced coordination. Over the course of the interaction, pairs involving a patient showed a gradual increase in coordination, peaking in section eight before showing a sharp reduction towards the end of the interaction. A similar pattern is seen by the patients' healthy participant partners. However, they remained somewhat more coordinated than pairs involving a patient for the whole interaction.

Trend analysis: Pairs involving a patient showed a linear relationship with r ($F(1,399)=2.40$, $p=.10$), meaning that the head movements of pairs involving a patient became more coordinated (i.e. displayed a higher r) over the course of the interaction. If we relate this to figure 12, it can be seen that this linear relationship refers to the time between the second and eighth sections of the interaction (i.e. between 1 minute 5 seconds and 4 minutes 22 seconds approximately). No pattern of coordination over time emerged for healthy participant pairs in the patient group ($F(1,199)=1.36$, $p=.25$), or pairs in the control group ($F(1,599)=1.29$, $p=.26$).

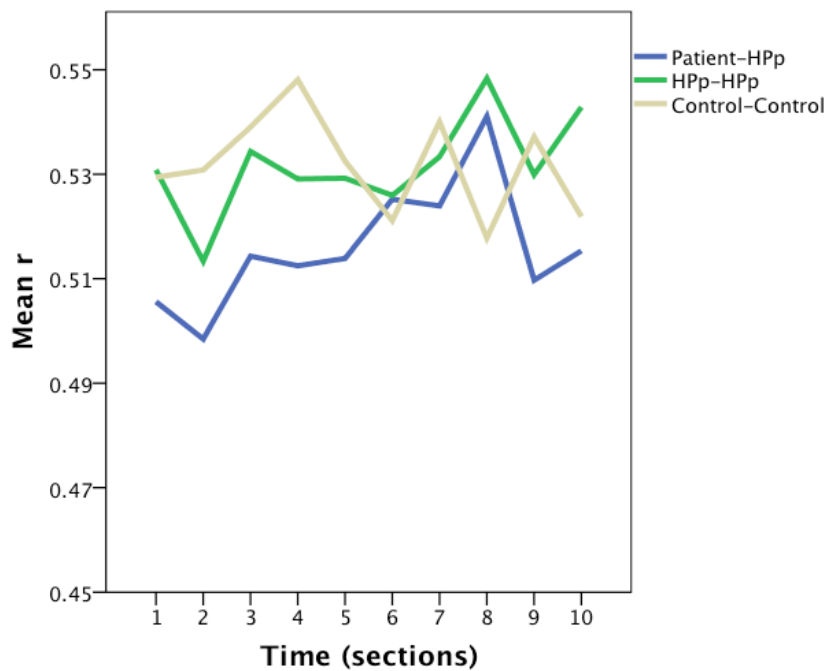


Figure 12. Relationship between coordination and time in three-way interaction by pair type

4.4 Discussion

The findings supported the first and second hypotheses. Compared to control groups interpersonal coordination was not reduced in patients' two-way interactions but was reduced (i.e. less correlated head movement) in patients' three-way interactions. In patients' three-way interactions, coordination did not differ between pairs involving a patient and healthy participant pairs.

In relation to the exploration of patterns of coordination over time, patients' two-way interactions showed a different pattern to controls. Patient groups displayed a pattern of declining coordination in the first part of the interaction followed by a period of increasing coordination over time towards the end of the interaction. However, control interactions showed increased coordination over time.

In the three-way interactions, patterns of coordination over time differed across the three pair types. Pairs involving a patient became increasingly coordinated over the course of the interaction. Healthy participant pairs in the patient group showed no association

between coordination and time. Control group pairs also showed no association between coordination and time.

The findings must be considered in the context of the strengths and limitations of this study and the analysis used within this chapter.

4.4.1 Study strengths

This study had a number of strengths. Firstly, all interacting partners were unfamiliar to each other and healthy participants were unaware that they were interacting with a patient with a diagnosis of schizophrenia. This design enabled the potentially confounding features of familiarity between interacting partners and prior knowledge of the patients' diagnosis and history to be eliminated. Furthermore, the majority of studies investigating patients' social interactions previously have focused on the clinical interaction between a patient and their psychiatrist. The current study provides a new perspective analysing how patients interact outside of a clinical context. A second strength of this study was the addition of the three-way interaction. Again, traditional studies of patients' interactions predominantly assess two-way interactions. Recording three-way interactions enabled coordination to be assessed under more complex conversation management conditions where the demand for coordination between the interacting partners is greater. Furthermore, recording patients' three-way interactions provides the unique opportunity to investigate the systemic impact of the presence of the patient on the coordination between the other two interacting partners within the interaction. This could not be achieved by two-way interaction, nor could it be achieved by a four-way interaction as this has the potential to break into two two-way interactions. A third strength is the use of motion capture equipment to record the interactions. This recorded the precise movement of interacting partners, which could then be directly compared for similarity in each direction of movement. This eliminated the need for hand coding of behaviours, which is time and labour intensive and relies on human judgement.

The analysis in this chapter used a conservative measure of coordinated behaviour. Coordination was only detected between head movements occurring in the same direction. This was the first controlled experimental study of interpersonal coordination in patients' social interactions and as such, it was deemed better to have a more precise and conservative index of coordination at this stage. As the findings using this conservative estimate point to coordination being a promising line of enquiry in schizophrenia, future studies could begin to explore this area by slowly broadening the scope of the coordination measure. Another strength of this analysis is that alongside looking at the mean coordination, it also looks at the pattern of coordination over the course of the interaction. This allowed interpretations to be made about how the coordination patterns unfold and how patients and their partners adapt over time.

4.4.2 Study limitations

This study also had some important limitations. Firstly, although attempts were made to match patients and healthy participants on gender, ethnicity, age and age leaving full time education and training, it was not possible to systematically balance the patient and healthy participant groups on each of these features. The patient sample was comprised of more females and was older than the healthy participant sample. This imbalance was a result of the high non-attendance rates by healthy participants, which reduced the pool of healthy participants available for recruitment. Previous studies have found micro-level differences in head movement between males and females during conversation (Ashenfelter, Boker, Waddell, & Vitanov, 2009). Furthermore, variations in interpersonal coordination have been predicted by gender pairing of the interacting partners (La France & Ickes, 1981). In order to limit the impact of the gender imbalance, and account for the difference in age between participant types, these variables were adjusted for in the analyses.

A further limiting feature was the difference in tasks used in the two and three-way interactions. The two-way interaction was a discussion, whereas the three-way interaction required the group to come to a joint decision. It would have been ideal to capture spontaneous interaction between participants rather than giving them a topic to discuss. However, in reality, placing two or three people together in a room does not

necessarily mean that they will begin a conversation. Many topics were piloted for this study. The prerequisites for the choice of topic were that it required no, or limited, prior knowledge and was engaging enough to generate a discussion for at least five minutes. The tasks that were chosen achieved both of these, where others had failed. However, it is possible that the type of task chosen had an impact on the coordination between the interacting partners. Kendon (1970) and Scheflen (1964) suggested that coordination could signify the level of shared mental states or agreement between individuals. Although there may be agreement or disagreement between interacting partners in both tasks, perhaps the need to reach a joint decision in the three-way task had a greater influence on the interpersonal coordination between participants. However, it could be argued that interpersonal coordination functions on a more mechanical level, acting to coordinate partners, enabling the negotiation of feedback and turn exchange. Thus, it would be expected that these building blocks of any social exchange would remain the same irrespective of the content of the interaction. In order to tease out any influence of task, future studies could reverse the tasks in the two and three-way conditions to see if the pattern of coordination detected in this study remained the same.

The setting of the social interactions could also be considered a limitation. Interactions took place in the human interaction lab, with participants wearing motion capture suits, consisting of Lycra tops and reflective markers. This was essential in order to capture movements of participants in 3-D. However, it is possible that patients with schizophrenia, particularly those with symptoms of paranoia, may have experienced more discomfort or anxiety with this process than the healthy participants. The relationship between patients' interpersonal coordination and their symptoms of anxiety will be assessed in the next chapter (chapter 5).

Although steps were taken to limit the impact of patients' possible effects from antipsychotic medication by excluding patients with obvious motor side effects, it is unclear if medication had a less obvious impact on patients' coordination. This topic will be revisited in more detail the next chapter (chapter 5). However, future studies would benefit from using a comparison group of unmediated patients (e.g. first episode patients) to unpick the precise impact of patients' medication on their coordination.

The analysis used in this chapter was limited by the inability to combine the two indices of coordination (i.e. correlation and delay), even though they were highly related. As motion capture techniques are only beginning to be used for the study of social interaction, the analytic techniques used to explore data of this kind are still in the early stages of development. Furthermore, specific statistical analysis methods used to assess this type of data do not exist. As such, the analysis used in the current study followed those used in previous analysis of head movement coordination (Ashenfelter, Boker, Waddell, & Vitanov, 2009; Boker, Minquan, Rotondo, & King, 2002) and was deemed the most appropriate at the time.

4.4.3 Interpretation of the findings

Reduced interpersonal coordination in patients' three-way interaction was detected while controlling for patients' symptoms and medication. Furthermore, patients did not differ from control participants on head movement speed, suggesting that it is interpersonal coordination specifically that is reduced rather than a general motor deficit.

Interpersonal coordination was reduced in patients' three-way interactions and not in their two-way interactions. Two-way interactions are the simplest form of face-to-face interaction. The basic speaker-hearer model is in place and as such, conversation management processes are limited in their complexity. Under such circumstances, the reliance on interpersonal coordination may be less; therefore difficulties coordinating may be masked. This appears to be the case in the current analysis.

Patterns of coordination over time in the two-way interactions differed between patient and control groups (figure 11). Pairs in the control condition became increasingly more coordinated over the course of the interaction. Whereas, pairs in the patient condition, although beginning the interaction more coordinated than controls, showed a steady decline in coordination over the first half of the interaction and an increase in coordination over the second half. This last quarter of the interaction saw patient and control pairs displaying the same degree and pattern of coordination.

So why did patient pairs display *more* coordination than controls at the start of the interaction? One explanation could be derived from The Interaction Adaptation Theory

(IAT) (Burgoon, Stern, & Dillman, 1995). This predicts that, in interaction, behaviour that deviates from expectancies will result in compensatory behaviour by their interacting partners. In the case of patients' two-way interactions, healthy participants detect unexpected behaviour (i.e. reduced coordination) in the patient and overcompensate for this by displaying increased coordination with the patient. As the interaction progresses the need for compensatory behaviour reduces as the healthy participant becomes more attuned to the behaviour of the patient. An alternative explanation is that the processes of conversation management (i.e. turn exchange) are more difficult to achieve when a patient is present, hence greater coordination between the partners is needed. Once again, as the interaction progresses, the partners become more attuned to each other and the need for coordination reduces. The increase in coordination in the final minutes of the interaction is in line with that seen in control condition, which suggests that over the course of a patients' two-way interaction, their coordination pattern adapts to what would be expected in control groups.

Coordination patterns in the three-way interactions also differed between pair types (figure 12). Pairs in the control group displayed periodic rise and fall of coordination over the course of the interaction. Pairs involving a patient showed an overall increase in coordination over time, followed by a sharp reduction then slight rise in the final quarter. Healthy participant pairs in the patient group started the interaction displaying levels of coordination similar to control pairs, and over time displayed a pattern that almost mirrored that of the pairs involving a patient. However they remained somewhat more coordinated throughout.

So what does this pattern of coordination tell us? Control pairs in the three-way interactions appear to display more coordination than pairs in the two-way interactions. However, pairs involving a patient did not show this, suggesting that coordination in the pair involving a patient is more difficult. As with the two-way interactions, pairs involving a patient begin the interaction with an atypical degree of coordination. During the first 30 seconds, the impact of the patient is limited to those pairs directly involving a patient. In the following 30 seconds, there is a substantial reduction in coordination in all pairs within the patient group, suggesting that it is at this point that the presence of the

patient exerts a systemic impact on the coordination between all interacting partners in that group.

Following this, the patient pair displays adaptation towards the coordination patterns normally seen in healthy participants' interactions. This may be due to overcompensation by the healthy participants to the patients' reduced coordination, displaying increasingly more coordination over time. However, as this increased coordination is attributable to both partners in the pair, it indicates that patients are able to detect and respond to their healthy participants' coordination cues thus allowing them to become more coordinated over time.

This pattern of increasing coordination ends with a steep reduction in the final quarter of the interaction. There are two possible explanations for the reduction; Firstly, as the dip is followed by a smaller peak, this pattern could reflect a change in the pairs' pattern of coordination that displayed by the control pairs. This would follow the trend seen in the two-way interactions of patient pairs moving from atypical patterns towards the pattern displayed in the control group. However, the coordination values in the three-way interaction are much lower in the patient pairs. A second explanation is that the degree of adaptation both by patients and healthy participants may be more attentionally demanding. Perhaps this is difficult to sustain over longer periods of time, in which case healthy participants divert their attention away from the patient at this stage. This will be queried in the next chapter.

Overall, it appears that pairs involving a patient begin the interaction with atypical patterns of coordination and over the course of the interaction, coordination in the patient pair becomes more closely aligned to level of coordination and pattern (in two-way at least) displayed by pairs in the control groups. As discussed in chapter 2 of the literature review, previous studies investigating nonverbal facial expressions (Krause, Steimer, Sanger-Alt, & Wagner, 1989) and head movement (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010) of patients and their partners during interaction have found that healthy participants adapt their behaviour to match the reduced style of the patient (i.e. partners display less facial expressions and head movement). These studies did not investigate the change over time but looked at the

overall rate of expressions and movement throughout the course of the interaction. This chapter has revealed that although, overall, healthy participants are seen to adapt to the reduced coordination of the patient, over time patients adapt to the increasingly more coordinated movements of the healthy participants.

4.5 Conclusion

In conclusion, this chapter has demonstrated that interpersonal coordination is reduced in patients' three-way interactions. The reduction in coordination is systemic between all interacting partners. Atypical patterns of coordination between patients and their partners are more prominent at the start of the interaction. As the interaction progresses, patients and their partners show adaptation towards more typical coordination levels. However, it is unclear if this pattern of adaptation can be sustained over longer periods or when there are more than two people interacting.

These findings demonstrate the ability of the patient to adapt their coordination pattern to align with the healthy participants they are interacting with. This would indicate that patients have the ability to detect and respond to the coordination cues of their healthy participant partners, although it may happen at a different pace and take some encouragement in the form of overcompensation by the healthy participants initially. Overall, it would appear that, in interactions involving a patient, coordination is difficult to negotiate as the interaction begins and may require more effort from the patients' interacting partners in order for this to occur. The more interacting partners that are present in the interaction, the more difficult this is to achieve and possibly sustain.

These findings raise some important questions; firstly, do patients' symptoms influence the difficulty they experience with coordination? Secondly, if interpersonal coordination is fundamental to successful social interaction, how does this pattern of reduced coordination impact patients' social interactions, rapport with interacting partners and longer term social functioning? Thirdly, if patients demonstrate adaptation towards the coordination levels of their interacting partners, thus interpreting and responding to social cues, is this associated with their social cognitive abilities as measured by social cognitive tests? The relationships between patients' coordination and their clinical

features social cognition, social functioning and rapport will be explored in the next chapter.

Chapter 5: Is interpersonal coordination associated with patients' clinical features, social cognition and social functioning?

5.1 Introduction

The previous chapter demonstrated that interpersonal coordination is reduced in patients' three-way interactions. This chapter follows on from chapter 4 and addresses **research question 1 (part c)**, exploring the relationship between interpersonal coordination in patients' three-way interactions and patients' clinical features, social cognition, social functioning and rapport.

5.1.1 Association between coordination and patients' clinical features

Although we now know that interpersonal coordination is impaired in patients' three – way interactions, adjusting for symptoms and medication, the influence of symptoms and medication on coordination is unknown.

5.1.1.1 Symptoms

As discussed in the literature review, Condon & Ogston's (Condon & Ogston, 1966) study failed to provide detail on the type or severity of patients' symptoms. A comment was made that one patient in the study was considered '*much improved*' by their psychiatrist and they displayed more coordination. Thus, suggesting that coordination, as assessed by Condon & Ogston at least, was influenced by patients' symptom severity. Performance on social cognitive assessments is found to be poorer in patients with more negative symptoms (Strauss, Jetha, Ross, Duke, & Allen, 2010) and those in the acute phase of the disorder (Mueser et al., 1996). Therefore, it would be expected that if patients' symptoms influence their ability to detect and respond to social cues in social cognitive assessments, it would have a similar effect on their ability to respond to the nonverbal social cues needed to coordinate. Thus, patients with more severe symptoms should display poorer coordination. This hypothesis will be assessed.

The findings of the previous chapter revealed that the presence of a patient in the three-way interaction systemically reduced the coordination between all interacting partners.

This supports the theory of interaction as a system, thus a change in any part of the interaction influences all other parts of the interaction (Watzlawick, Bavelas, & Jackson, 1967). Following this, it would be expected that if patients' symptoms influence the coordination of the patient, this, in turn, would impact the coordination of their partners. Thus, it would be expected that patients' symptoms would also be associated with changes in the coordination of their interacting partners.

5.1.1.2 Antipsychotic medication

Although the analysis of chapter four revealed that medication dose was not associated with patients' head movement, it is unclear if patients' medication had a more direct impact on their coordination specifically. A recent study suggested that an older typical antipsychotic drug, Haloperidol, caused shrinkage in the part of the brain that controls movement and coordination (Maxmen, 2010). Although no patients in the current study were taking Haloperidol, two were taking similar older antipsychotic medication, and fifteen were taking newer atypical antipsychotic medication. Three patients were medication free. Although the number of patients in each medication group is small in the current study, this chapter will investigate if there is an impact of medication type on patients' coordination specifically.

5.1.2 Association between patients' coordination and social cognition

Throughout the literature review it has been argued that although patients display poor performance on detecting and responding to social cues when completing social cognitive assessments (Penn, Sanna, & Roberts, 2007). Such tests are removed from real life, therefore it is unclear if this difficulty persists during their social interactions with others. The findings of chapter 4 revealed that over time, patients displayed adaptation to the coordination patterns of their healthy participant partners. Hence, this demonstrates the patients' ability to interpret and respond to nonverbal cues during their actual interactions. As such it would be expected that patients' coordination patterns would be associated with their performance on assessments of social cognition.

5.1.3 Association between patients' coordination, rapport and social functioning

As discussed in the literature review interpersonal coordination is thought to play a key role in successful social interaction and in the feeling of rapport (Chartrand & Bargh, 1999; Miles, Nind, & Macrae, 2009). Hence, it would be expected that reduced coordination between interacting partners in the patients' interactions would result in their healthy participant partners experiencing poorer rapport with the patient. Furthermore, if patients' interactions are less successful, this could lead to longer-term difficulties with their social interactions, resulting in difficulties with interpersonal relationships and overall poorer social functioning.

The following four hypotheses will be tested:

1. Patients' reduced coordination will be associated with higher symptoms, poorer performance on assessments of social cognition, poorer social functioning and lower ratings of rapport.
2. Patients taking antipsychotic medication will show less coordination than patients who are medication free.
3. Patients' higher symptom scores will be associated with reduced coordination in their healthy participant partners.
4. Healthy participants' reduced coordination will be associated with them experiencing less rapport with their patient partners

5.2 Methods

5.2.1 Participants

Twenty patients with a diagnosis of schizophrenia and one hundred non-psychiatric healthy participants took part in the study. See chapter 4 for a detailed description of the participants.

5.2.2 Assessments of executive functioning and IQ

Executive functioning was assessed using the **Brixton Spatial Anticipation Test** (BSAT) and the **Hayling Sentence Completion Test** (HSCT) (Burgess & Shallice, 1997). The BSAT assessed participants' ability to detect, follow and adapt to changing patterns. The

HSCT assessed participants' ability to generate or suppress an appropriate response. Scores ranged from 1 (impaired) to 10 (Not impaired).

The Standard Progressive Matrices of Raven (SPMR) (Raven & Court, 1992) was administered as a non-verbal assessment of IQ designed to cover a wide range of mental ability irrespective of age, sex, language ability and education. In each test participants were presented with 4 sets of 12 patterns and asked to identify the missing item that completed each pattern. Participants were given 47 minutes to complete the task. Scores range from 0 (poor) to 60 (excellent). **The Mill Hill Vocabulary scale (MHV)** (Raven & Court, 1992) was administered as a Verbal assessment of IQ. It consists of 88 words divided into two sets of 44. Participants were asked to select the correct synonym for each word from a list of six alternatives provided. Scores range from 0 (poor) to 34 (excellent).

5.2.3 Social cognitive assessments

A shortened version of the **Social Cue Recognition Test (SCRT)** (Corrigan & Green, 1993) assessed participants' ability to read abstract and concrete social cues. Participants watched four short (60 seconds) vignettes of interactions, two with high emotive content such as a discussion about suicide, and two with low emotive content such as a discussion about a party. Participants were presented with thirty-six true/false questions based on the vignettes. The questions ranged in levels of abstraction from concrete cues such as 'Norman and Peg were carrying books in their arms' to more abstract cues such as 'Norman felt irritated that he was wasting his time'. Performance on this task was rated by a non-parametric index of cue sensitivity (A'), based on the correct hit rate and false positive rate. Higher (A') scores indicate greater sensitivity to social cues.

A shortened version of the **Profile of Nonverbal Sensitivity (PONS)** test, 'the face and body PONS' (Rosenthal, Hall, DiMatteo, Rogers, & Archer, 1979) evaluated nonverbal social perception. Participants watched forty, two-second clips of non-verbal scenes portrayed by a Caucasian female. In each scene the nonverbal behaviour of either the face, body (neck to knee including the hands) or both was presented. After watching each clip participants choose one of two descriptions that best fit the scene they have just

viewed (e.g. “expressing jealous anger” or “admiring nature”). A correct answer scored 1 and an incorrect answer scored zero. Total scores ranged from 0-40, with higher scores indicating greater sensitivity to nonverbal social cues.

Participants’ Theory of Mind (ToM) was assessed using three assessments: (i) **The hinting task** (Corcoran, Mercer, & Frith, 1995), which required participants to listen to 10 short stories involving two people and decipher what one person means when they give a verbal hint to the other. A score of 2 was given if the meaning is deciphered after the first telling of the story, if participants did not know the meaning a clue was provided. If they answer correctly after the clue a score of 1 was given. Participants who did not know the meaning after the clue got a score of zero. Total scores range from 0 (poor)- 20 (excellent). (ii) First order theory of mind was assessed using **The Sally Anne Task** (Baron-Cohen, Leslie, & Frith, 1985) and (iii) Second order theory of mind was assessed using **The Ice-cream Van Task** (Baron-Cohen, 1989). In both the Sally Anne Task and the Ice-cream Van Task, participants were read aloud a story by the researcher and asked to infer the thoughts of the individuals that had just been discussed. Scores on both tasks ranged from 0 (impaired)-1 (excellent).

5.2.4 Social functioning assessments

The Manchester short assessment of quality of life (MANSA) (Priebe, Huxley, Knight, & Evans, 1999) assessed participants’ subjective quality of life. The MANSA consists of 12 self report items which asks participants to rate their quality of life over 12 life domains including physical health, mental health, employment, finances, accommodation, living situation, relationships with family, social relationships, sexual relationships, leisure activities, personal safety and life in general. Each item was rated on a 7 point Likert scale from (1-couldn't be worse, 2-displeased, 3-mostly dissatisfied, 4-mixed, 5-mostly satisfied, 6 –pleased and 7-couldn't be better). Total scores were taken as a mean of all 12 items ranges from 1-7 with higher scores indicating greater satisfaction with life.

The objectives social outcomes index (SIX) (Priebe, Watzke, Hansson, & Burns, 2008) was employed to evaluate participants’ real world social functioning. This is a self-report questionnaire assessing participants’ accommodation (0-homeless, 1-supported

housing, 2-independent housing), employment (0-unemployed, 1-voluntary/supported employment, 2-regular employment), living situation (0-living alone, 1-living with family/partner) and friendships (0-not met a friend in the past week, 1-has met 1/more friend(s) in the past week). Scores range from 0 (poor) – 6 (excellent).

The Social Network Schedule (SNS) (Dunn, O'Driscoll, Dayson, Wills, & Leff, 1990) was administered to patients only to assess the size and quality of their social networks. Patients were asked to recall what they did on a specific day recalling all the individuals they met that day. Through discussion about this day and their daily activities over a course of a week, a picture of the patients' social network is built up. Each contact within the patients' social network was then systematically scored in terms of where they know the individual from (i.e. in /out of residential setting), their relationship with the patient (e.g. relative, work mate, neighbour, etc.), how often they meet up (e.g., daily, weekly, fortnightly, ect..) the type of interaction that they have (i.e. active verbal exchange, intermediate exchange such as saying hello in passing, or passive interaction with no verbal exchange), and the patients' views on their relationship (e.g. do they upset the patient, would the patient confide in them and would they consider them a friend). The number of contacts in the patients' social network was counted (SNS-Size) and the quality of their network was scored (SNS-Quality) ranging from 6 (poor) to 26 (excellent).

5.2.5 Assessment of rapport

Each individual was asked to answer the following question regarding the level of rapport they felt with each of their interacting partners: 'How much rapport/connection did you feel with individual X'. Rating was on a 10-point scale of 1 (I felt no rapport/connection with them) -10 (I felt a strong rapport/ connection with them). This item was taken from a rapport assessment used by Drolet and Morris (2000).

5.2.6 Procedure for administering the assessment tools

On completion of the interaction task, each participant was asked to complete the Manchester short assessment of quality of life (MANSA), the objective social outcomes Index (SIX), the Standard Progressive Matrices Raven spatial test of IQ (SPMR) and the

Mill Hill Vocabulary scale of IQ (MHV). Participants completed these assessments as they sat separately at three desks in the interaction space. In order to complete the social cognitive tests, a projector was set up in the room and the videos for the SCRT and PONS were played for the individuals as they were seated at their desks. Although all three participants watched the short video clips at the same time, they were asked not to speak to each other during this task and completed their assessments using a pen and paper individually.

All participants took part in a short one-to-one interview with the researcher, during which, they completed the tests of executive functioning; Brixton Spatial Anticipation Task, (BAST) and the Hayling Sentence Completion Task (HSCT). Participants also completed the three assessments of theory of mind (the hinting task, the Ice-Cream Van (ICV) task and the Sally Anne (SA) task) and the rapport questionnaire.

5.2.7 Data Analysis

5.2.7.1 Preparation of interpersonal coordination data

The coordination data (r and delay) corresponds to a ‘pair’ of individuals. Therefore, in order to compare coordinated movement with the assessment scores on an individual basis the coordination when following (i.e. producing the correlated movement second) was derived for each individual. The coordination when following was used as this provides a measure of an individual’s coordination when responding to the head movement of another, thus allowing associations to be made between an individual’s responsiveness to others with their own assessment performance. For the remainder of this chapter, an individual’s coordination refers to their mean r and delay when they are following the movements of their interacting partners. Healthy participants in the patient groups interact with one patient and one healthy participant, therefore for these participants two measures of coordination was derived; coordination when following the patient (i.e. following in the P-HPp pair) and coordination when following the other healthy participant (i.e. following in the HPp-HPp pair).

5.2.7.2 Dealing with missing assessment data

Some participants did not complete all of the assessments. This was for a number of reasons; firstly, assessments of rapport, anxiety (BAI) and IQ (SPMR and MHV) were not conducted for the first ten groups recruited. These assessments were only introduced in the final thirty groups. Secondly, a number of healthy participants who participated in the interaction tasks did not complete the full set of questionnaires due to limitations on their time. Importantly all patients did complete the full set of questionnaires.

Missing values were imputed using a multiple imputation (MI) method conducted in SPSS 19. Traditional ad-hoc deletion or replacement methods were avoided as they may cause lowered sample sizes or biased results due to deletion of missing values or artificially reduce the variance of the variable due to data replacement using mean values (Wayman, 2003). The MI method has been shown to perform better than such ad-hoc measures (Schafer & Graham, 2002). It has been shown to produce unbiased parameter estimates which reflect the uncertainty associated with estimating missing data and is capable of handling variables that deviate from normality or have a high rate of missing data (Wayman, 2003). In this study the MI method used a fully conditional specification model, using 5 imputations as recommended by SPSS. The missing values were modeled using the relationship between the existing variables, thus preserving the characteristics of the dataset including means, variances, correlations and data parameters whilst retaining the sample size (McCleary, 2002). The MI method provided a full data set that was then analysed in the usual manner using the SPSS 19 software. The results reported below correspond with those recommended by Sterne et al. (2009) and are inline with the STROBE initiative to strengthen observational studies (von Elm et al., 2007). The percentages and frequencies of missing data can be found in Appendix C.

Although the mean rapport score for each individual was imputed using MI, the rapport score that individuals gave to their partner was not. Rapport score is unlike other measures in the study, in that it relates to two individuals; the rater and the rated. The MI method cannot calculate scores between cases, therefore the decision was taken to be

conservative with this data. All statistical analysis assessing healthy participants' rapport score to the patient will only included cases that are complete in the original data set.

5.2.8 Statistical Analysis

All statistical analysis were conducted in SPSS with p-values of $p < .05$ considered significant, and p-values between $p = .05$ and $p < .1$ noted as a trend

5.2.8.1 Comparison of patient and healthy participants' anxiety, cognitive and social features

An independent samples t-test compared patients and healthy participants' scores on measures of anxiety (BAI), executive functioning (BSAT & HSCT), IQ (SPMR and MHV), social cognition (SCRT, PONS, Hinting task, 1st and 2nd Order ToM Tasks), quality of life (MANSA), and social functioning (SIX) and rapport.

5.2.8.2 Investigating the impact of antipsychotic medication on patients' coordination.

In order to unpick the impact of antipsychotic medication on patients' coordination, the mean r and delay displayed by patients on each medication type (i.e. (i) medication free, (ii) taking newer atypical antipsychotic medication, (iii) taking older typical antipsychotic medication) was compared with two separate generalized linear analysis of variance models (GLM) using a Bonferroni pair-wise comparison.

In each model the dependent variable was the coordination (r or delay) and the independent variable was medication type (medication free or atypical antipsychotic medication or typical antipsychotic medication). Patients' symptoms (PANSS positive, negative and general), medication dose (CPZE), age, gender and the length of the interaction (seconds) were adjusted for by including them as covariates in the analysis. The model analyzing r used a linear response model and the delay model used a gamma response model, to account for the different data distributions.

5.2.8.3 Association between patients' coordination and clinical, cognitive and social features

Bivariate correlations assessed the relationship between patients' coordination (r and delay) and their scores on PANSS symptoms (PANSS positive, PANSS negative, PANSS general), medication dose (CPZE), symptoms of anxiety (BAI), executive functioning (Brixton Spatial Anticipation Test, Hayling Sentence Completion Task), IQ (Standard Progressive Matrices of Ravens and Mill Hill Vocabulary test), social cognitive assessments (Social Cue Recognition Test, Profile of Nonverbal Sensitivity test, the hinting task, and the 1st and 2nd order Theory of Mind tests), quality of life (MANSA), social functioning (SIX), social networks (SNS) and their rapport score.

5.2.8.4 Association between patients' symptoms, rapport and their partners' coordination

Bivariate correlations assessed the relationship between healthy participants' coordination (r and delay), both in the patient pair (P-HPp) and in the healthy participant pair (HPp-HPp), and patients' symptoms (PANSS positive, PANSS negative, PANSS general) and the rapport score they give to the patient .

A multiple linear regression model was used to further analyse significant correlations ($p < .1$) across all associations.

5.3 Results

5.3.1 Comparison of patient and healthy participants' anxiety, cognitive and social features

The comparison of patient and healthy participants' performance on measures of anxiety, cognitive and social measures are displayed in table 9. Patients displayed more symptoms of anxiety and poorer scores on executive functioning (BSAT and HSCT), sensitivity to nonverbal social cues (PONS), the hinting task and the second order theory of mind task (Ice Cream Van Task). Patients also had poorer social functioning (SIX) and poorer quality of life (MANSA). Patients did not differ from healthy participant scores on IQ (SPMR and MHV), recognition of social cues (SCRT) or first order theory of mind (Sally Anne Task) or rapport rating from their partners.

Table 9. Mean scores on clinical, cognitive and social measures by participant type

Variables	Patients M (SE)	Healthy Participants M (SE)	<i>t</i>	<i>df</i>	<i>p</i>
Anxiety (BAI)	37.11 (4.54)	28.75 (1.17)	-2.02	119	.07□
Executive functioning: Brixton (BSAT)	3.07 (0.51)	5.10 (0.22)	3.65	119	<.01**
Executive functioning: Hayling (HSCT)	3.79 (0.43)	4.91 (0.18)	2.52	119	<.01**
IQ: Spatial (SPMR)	46.67(3.09)	45.89 (1.30)	-0.26	119	.75
IQ: Verbal (MHV)	17.23 (1.53)	18.04 (6.30)	0.45	119	.66
Abstract social cue recognition (SCRT)	1.19 (0.11)	1.18 (0.03)	-0.12	119	.90
Concrete social cue recognition (SCRT)	1.18 (0.09)	1.19 (0.02)	0.24	119	.82
Sensitivity to nonverbal cues (PONS)	26.45 (0.71)	28.09 (0.30)	2.47	119	<.01**
Theory of Mind: Hinting Task	18.23 (0.51)	19.87 (0.10)	4.80	119	<.01**
Theory of Mind: 1 st Order (SA Task)	1.00 (0.08)	1.00 (0.01)	0.13	119	.90
Theory of Mind: 2 nd Order (ICV task)	0.80 (0.12)	0.96 (0.36)	1.82	119	.07□
Quality of Life (MANSA)	4.31 (0.18)	5.14 (0.12)	3.22	119	<.01**
Social Functioning (SIX)	3.40 (0.28)	4.55 (0.13)	3.89	119	<.01**
Social Network: Size	6.10 (2.57)	-	-	-	-
Social Network: Quality	18.70 (1.72)	-	-	-	-
Rapport	6.58 (0.52)	6.89 (0.15)	0.79	119	.43

Key: BAI=Beck Anxiety Inventory; BAST=Brixton Spatial Anticipation Task; HSCT=Hayling Sentence Completion Task; SPMR=Standard Progressive Matrices Raven's; MHV=Mill Hill Vocabulary Test; SCRT_Abstract= Social Cue Recognition Test Abstract cue detection score; SCRT_Concrete= Social Cue Recognition Test Concrete cue detection score; PONS=Profile of Nonverbal Sensitivity test; MANSA=Manchester short assessment of subjective social outcomes; SIX=Objective social outcomes index. Significance levels **= p<.01 *= p<.05 □=p<.10.

5.3.2 Investigating the impact of antipsychotic medication on patients' coordination

Description of unadjusted means: Figure 13 displays the unadjusted mean *r* and delay displayed by patients on each medication type. Control participants who have been added to the graph to provide context. It can be seen that patients who are medication free are the most coordinated (i.e. highest *r* and shortest delay), whereas patients taking older typical antipsychotic medication are the least coordinated (i.e. lowest *r* and longest delay).

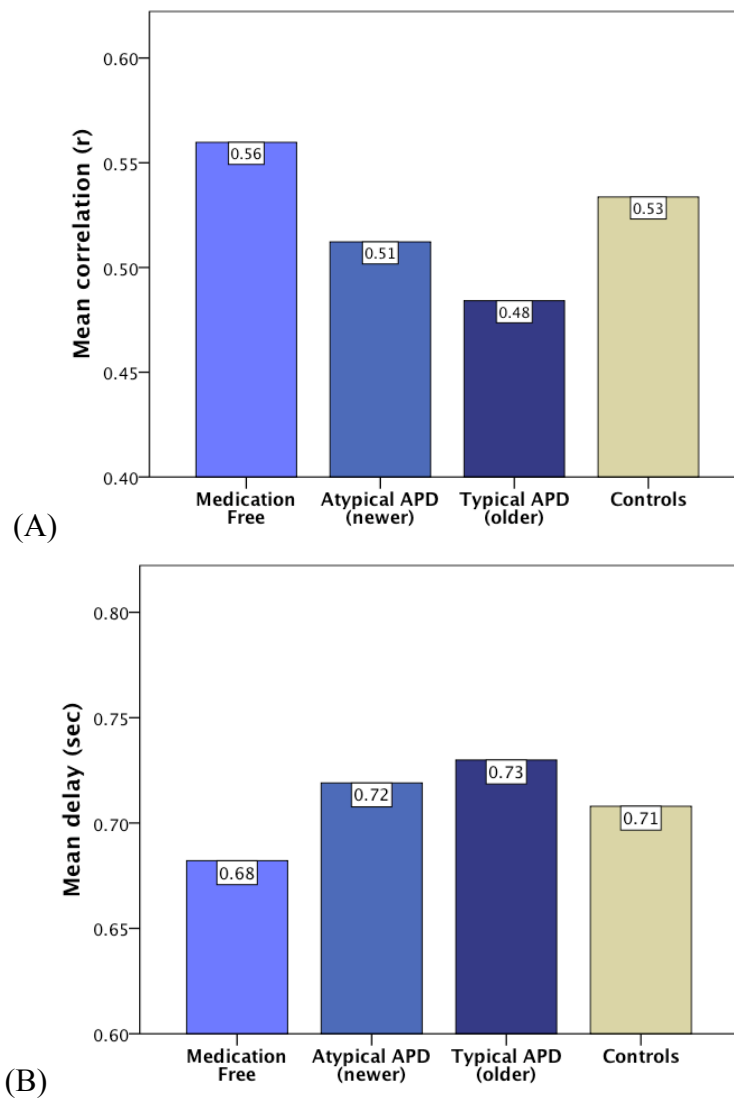


Figure 13. Mean r (A) and delay (B) displayed by patients' medication type.

Comparison of adjusted means: The mean coordination after adjusting for patients' symptoms and medication dose are displayed in table 10 with the pair-wise comparisons in table 11. The results revealed that medication free patients were significantly more coordinated (i.e. higher r and shorter delay) than patients taking any antipsychotic medication. There was no significant difference between patients on older typical antipsychotic medication and newer atypical antipsychotic medication.

Table 10. Adjusted mean r and delay by medication type

Coordination	Medication type	Mean (SE)	95% Wald Confidence Interval	
R	Med Free	0.64 (0.03)	0.58	0.71
	Atypical AP	0.49 (0.01)	0.47	0.51
	Typical AP	0.46 (0.03)	0.41	0.51
Delay	Med Free	0.59 (0.03)	0.54	0.65
	Atypical AP	0.74 (0.01)	0.72	0.76
	Typical AP	0.75 (0.03)	0.69	0.80

Table 11. Pair-wise comparison r and delay by medication type

Coordination	Medication type 1	Medication type 2	Difference (M1-M2)	SE	df	p
R	Med Free	Atypical	0.15	0.04	1	<.01**
	Med Free	Typical	0.18	0.04	1	<.01**
	Atypical	Typical	0.04	0.03	1	.53
Delay	Med Free	Atypical	-0.14	0.03	1	<.01**
	Med Free	Typical	-0.15	0.04	1	<.01**
	Atypical	Typical	-0.01	0.03	1	1.00

Significance levels: **= p<.01 * = p<.05 □ = p<.10

Overall Test Results: *r* : $\chi^2=18.86$, *df*=2, *p*=<.01** Delay : $\chi^2=19.10$, *df*=2, *p*=<.01**

5.3.3 Association between patients' coordination and clinical, cognitive and social features

The relationship between patients' coordination and their clinical, cognitive and social features are displayed in table 12. Patients displaying less coordination (i.e. greater delay) received lower rapport scores from their healthy participant partners. However, no association was seen between patients' coordination and their positive, negative or general symptoms, their medication dose, their symptoms of anxiety, or their performance on assessments of executive functioning, IQ or social cognition. Furthermore, patients' coordination was not associated with their quality of life, their real world measures of social functioning or their social networks.

Table 12. Correlation of patients' coordination with their clinical, cognitive and social features

Variables	N	Correlation r (p)	Delay Rho (p)
Positive symptoms	20	-.196 (.41)	.151 (.53)
Negative symptoms	20	-.253 (.28)	.158 (.50)
General symptoms	20	-.139 (.56)	.014 (.96)
Medication dose (CPZE)	20	-.136 (.14)	.102 (.27)
Anxiety symptoms (BAI)	20	-.051 (.87)	.039 (.88)
Executive functioning: Brixton (BSAT)	20	.315 (.20)	-.214 (.37)
Executive functioning: Hayling (HSCT)	20	-.181 (.46)	.219 (.36)
IQ: Spatial (SPMR)	20	.241 (.34)	-.093 (.74)
IQ: Verbal (MHV)	20	.094 (.73)	-.141 (.59)
Abstract social cue recognition (SCRT-A)	20	.297 (.21)	-.200 (.41)
Concrete social cue recognition (SCRT-C)	20	-.120 (.62)	.045 (.86)
Sensitivity to nonverbal social cues (PONS)	20	.048 (.85)	-.046 (.86)
Theory of Mind: Hinting Task	20	.173 (.47)	.225 (.37)
Theory of Mind: 1 st Order (Sally Anne Task)	20	.208 (.38)	-.071 (.79)
Theory of Mind: 2 nd Order (ICV task)	20	.190 (.43)	-.176 (.49)
Quality of Life (MANSAs)	20	.219 (.36)	-.156 (.52)
Social Functioning (SIX)	20	-.110 (.65)	.028 (.91)
Social Network: Size (SNS-Size)	20	-.108 (.66)	.180 (.45)
Social Network: Quality (SNS- Quality)	20	.306 (.19)	-.314 (.18)
Rapport	20	.218 (.36)	-.509 (.02)*

Significance levels **= p<.01 *= p<.05 α =p<.10

5.3.4 Association between patients' symptoms, rapport and their partners' coordination

Table 13 displays the association between healthy participants' coordination and patients' symptoms and rapport. Increased patients' positive and general symptoms were associated with reduced healthy participant coordination (i.e. reduced r and greater delay). Reduced coordination (i.e. greater delay) between healthy participants was also associated with lower patient rapport scores.

Table 14 displays the multiple regression analysis exploring the relationship healthy participants' coordination (i.e. delay) and patients' symptoms and coordination. Although patients' general symptoms were correlated with healthy participants'

coordination they were not included in the regression analysis due to their high correlation with positive symptoms ($r(20)=.83, p<.01$). The analysis revealed that patients' increased positive symptoms predict reduced coordination (i.e. greater delay) between their healthy participant partners.

Table 15 displays the multiple regression analysis exploring the predictors of patients' rapport score. This revealed that both increased patients' negative symptoms and reduced healthy participants' coordination independently predict poorer patient rapport.

Table 13. Association of healthy participants' coordination, patients' symptoms and rapport

	Coordinating with patient			Coordinating with other HP		
	n	Correlation	Delay	n	Correlation	Delay
		r (p)	Rho (p)		r (p)	Rho (p)
Patients' positive symptoms	40	-.212 (.19)	.049 (.77)	40	-.265(.10) α	.391(.01)**
Patients' negative symptoms	40	-.233 (.15)	.193 (.23)	40	.165 (.31)	-.087 (.59)
Patients' general symptoms	40	-.170 (.29)	-.035(.83)	40	-.062 (.71)	.273 (.09) α
Rapport score to patient	40	-.284 (.11)	.213 (.27)	40	.169 (.41)	-.399 (.04)*

Significance levels **= $p<.01$ *= $p<.05$ α = $p<.10$

Table 14. Predictors of coordination between healthy participants in the patient group

Variable	β	t	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Healthy participant pair coordination (delay)					
Patients' positive symptoms	.356	2.36	.03*	.967	1.04
Patients' coordination (r)	-.240	-1.34	.19	.686	1.46
Patients' coordination (delay)	.231	1.30	.20	.705	1.42

Model: Adjusted $R^2=.136, F(3,39)=3.05, p<.04*$

Table 15. Predictors of patients' rapport

Variable	β	t	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Patient rapport score					
Patients' positive symptoms	.267	1.64	.12	.807	1.24
Patients' negative symptoms	-.607	-3.71	<.01**	.799	1.25
Patients' coordination (delay)	-.176	-1.16	.26	.934	1.07
Healthy participant pair (delay)	-.429	-2.86	<.01**	.948	1.25
Model: Adjusted R^2 =.465, $F(4,25)$ =6.44, p <.01**					

5.4 Discussion

The findings partially supported the first hypothesis, as patients' reduced coordination was associated with others experiencing less rapport with them. However, no association was found between patients' coordination and their symptoms, performance on social cognitive assessments, or social functioning. The findings did support hypothesis two, patients who were medication free were more coordinated than patients taking antipsychotic medication. The findings also supported hypothesis three and four; patients' increased positive symptoms predicted reduced coordination between their healthy participant partners. In turn, healthy participants who were less coordinated reported less rapport with the patient. Independent of this, patients with more negative symptoms also received poorer rapport ratings.

5.4.1 Coordination and patients' symptoms

The findings revealed that the presence of a patient with more positive symptoms, such as hallucinations and delusional beliefs, in the three-way interaction reduced the coordination between the two healthy participants within that interaction. This finding was surprising, as it was expected that patients' symptoms would impact on the patients' own coordination with others. However, this was not the case. Positive symptoms are those that may be unusual to others such as delusional beliefs, disordered thoughts or sensory hallucinations. In the current study, three patients presented with moderate

positive symptoms, while the remaining seventeen showed only mild positive symptoms. This would suggest that the impact of patients' symptoms on their partners' coordination is seen even when patients are not very symptomatic. Although the verbal content of the interaction was not analysed in the current study, healthy participants did not report anything unusual about their interacting partners and were unaware that a patient was present. Thus, it would appear that healthy participants were detecting something on a nonverbal level. Perhaps the reduced coordination between the healthy participants is indicative of the healthy participants investing more attention or effort into their interaction with the patient where they are detecting a problem or difficulty, resulting in the coordination between the healthy participants being compromised.

5.4.2 The influence of antipsychotic medication on coordination

Patients who were medication free were more coordinated than the patients who were taking typical or atypical antipsychotic medication after controlling for medication dose and symptoms. This finding adds weight to those of Maxmen (2010), which found older typical antipsychotic medication (Haloperidol) to shrink the part of the brain that controlled coordination. The finding of this study must be taken in the context of its limitations. As this investigation was not the focus of this thesis and conducted post hoc, no medication inclusion criteria was defined in the initial recruitment stage. As such, the number of patients taking typical antipsychotic medication, or no medication, was very small. However, the graphical representation of mean coordination for each medication type (figure 13) show a gradual increase in coordination from the least coordinated taking typical medication to the most coordinated being medication free. The medication free patients in the current study appear to have levels of coordination equal to or surpassing that of the control participants. As only three patients were medication free in the current sample it would be inappropriate to make any inferences about this pattern.

No association was found between medication dose and coordination. However, the power to detect a relationship here may have been limited due to the low variation in medication dose, with all taking less than the standard dose of medication per day.

Future investigations with larger sample sizes in each medication type would be required to investigate the precise influence of patients' antipsychotic medication on their coordination. However, a large percentage of patients who have a diagnosis of

schizophrenia will be taking antipsychotic medication. As such, the coordination they display during interactions while taking this medication will be typical of the coordination they display in their encounters with others, which is precisely what was being measured in this study.

5.4.3 Coordination and patients' rapport

Patients and healthy participants were not seen to differ on the rating of rapport they received from their interacting partners. However, in line with predictions, reduced interpersonal coordination between patients and their healthy participant partners was associated with healthy participants experiencing less rapport with the patient. These findings correspond to those of previous studies finding interpersonal coordination to play a key role in interpersonal rapport in two-way interactions (Bailenson & Yee, 2005; Chartrand & Bargh, 1999; Miles, Nind, & Macrae, 2009; Ramseyer & Tschacher, 2010). The results of the current study build on these findings revealing that in three-way interactions reduced coordination between patients' healthy participant partners was also associated with healthy participants experiencing less rapport with the patient. This demonstrates that reduced interpersonal coordination between any interacting partners in a patient's three-way interaction is detrimental to others' experience of rapport with the patient. Perhaps the reduced interpersonal coordination between healthy participants in the patient interaction is indicative of the increased demands of interacting with the patient, requiring healthy participants to invest more attention and effort towards the patient, thus away from each other. As such, the coordination between the healthy participants is compromised, and the relationship with the patient may feel more difficult or less connected and lack rapport.

Patients with more negative symptoms, such as affective disturbances and social withdrawal, were also rated as having poorer rapport. This finding is in line with predictions and supports experimental evidence of the Praecox feeling, which found patients' negative symptoms, such as affective disturbances, to be highly correlated with psychiatrists' experience of a lack of rapport with the patient (Grube, 2006). The finding is particularly interesting given that the patients in this study had very low levels

of negative symptoms. This suggests that even when negative symptoms are mild they impact the healthy participants' experience of rapport with the patient.

5.4.4 Patients' coordination and social cognition

Although patients' performance on assessments of social cue recognition did not differ from those of control participants, patients did have poorer performance on assessments of sensitivity to nonverbal social cues and theory of mind. The findings of this chapter revealed that contrary to predictions, there was no association between patients' coordination and their performance on any assessment of social cognition. It must be kept in mind that this exploratory study included only 20 patients and the variance on these assessments was quite low. As such, this analysis may have lacked the power to detect an effect if one had been present. However, the ability to detect and respond to nonverbal social cues in a social cognitive assessment is somewhat removed from the act of engaging in a social encounter with others. The process of coordination may occur without the conscious awareness of those involved. The act of completing a social cognitive assessment is always a conscious process. Perhaps such assessments are measuring the more conscious component of patients' social cognitive processes, assessing what patients *would do or would think* when they were given the time to process the information and come to a conclusion. Whereas, interpersonal coordination is a measure of what patients *actually do* in the moment-to-moment interaction where processing time is limited. Future studies would benefit from larger sample sizes to enable a more robust analysis of associations between patients' coordination and their performance on measures of social cognition.

5.4.5 Patients' coordination and social functioning

Patients did display poorer social functioning and poorer quality of life than the healthy participants in the study. However, patients' coordination was not associated with any measure of their social functioning including the size and quality of their social networks, their quality of life and their real world social functioning attainments. This finding was unexpected as it was predicted that as interpersonal coordination is a crucial component of successful social interaction, reduced coordination would be associated with poorer social functioning.

There are a number of possible explanations for this finding; Firstly, patients displayed very little variance on their performance of measures of real world social functioning and quality of life, therefore, perhaps this study had insufficient power to detect an association if one was present. Patients' scores for quality of social network was somewhat more varied and, although not significant, showed an approach towards a trend in the direction that would be expected (i.e. better quality of friends associated with more coordination). This suggests that perhaps a study with a larger sample size may have detected an association between these variables. Secondly, as discussed in chapter 4, a conservative measure of head movement interpersonal coordination was used in this analysis. Social interactions involve more than just head movement, and more than just coordination within the same directions. Indeed interpersonal coordination occurs on many levels between interacting partners. For this exploratory study, a conservative measure was needed to see if coordination occurs on this most basic level. However, perhaps a less restrictive measure of coordination, including coordination of head movement across all axes, then moving on to coordination of body movements, arms and hands would provide a more encompassing measure of coordination as it happens in interaction and as such, a better predictor of patients' social functioning.

5.5 Conclusion

In conclusion, this chapter has demonstrated that reduced coordination between interacting partners in patients' interactions results poorer patient rapport. This is intensified by patients' increased symptom severity. Taking these findings together with those of chapter four they reveal that the undisclosed presence of a patient in a three-way interaction reduces interpersonal coordination between all interacting partners, which results in others' experiencing less rapport with the patient. This pattern is intensified when patients are more symptomatic.

One interpretation of the findings is that patients demand greater attention from others during interaction, which results in reduced coordination between interacting partners and comes at the expense of attention towards the other healthy participant. This claim

will be assessed in the next chapter by exploring the distribution of conversation role in patients' interactions to see if patients are more likely to be focus of their healthy participant partners' attention (i.e. in the active pair as speaker or primary recipient).

Part III: Interaction Participation

Chapter 6: What is the pattern of participation of patients and their partners in three-way interactions?

6.1 Introduction

This chapter will address **research question 2 (parts a and b)**. This chapter differs from the other empirical chapters in this thesis in that it is not concerned with nonverbal behaviour per se⁸. Instead it is moving from the global analysis of interpersonal coordination in chapters 4 and 5, to a more focused look on the dynamics of patients' interactions. Specifically, this chapter explores how often patients and their interacting partners take the conversation roles of speaker, addressed recipient or unaddressed recipient during a three-way interaction.

6.2 Conversation role in three-way interactions

As discussed in chapter 3, in a three-way interaction there is, for the most part, a speaker, an addressed recipient, who is delineated by the speakers' gaze and who the speech is being directed towards, and an unaddressed recipient (Goffman, 1981). The unaddressed recipient is a ratified member of the interaction, but they are outside of the speaker – addressee 'active pair' (i.e. individuals with the active roles in the interaction at that point in time). The active pair has a particular relationship sharing mutual gaze, and displaying greater coordination (Kendon, 1970). The unaddressed recipient is excluded from this relationship.

⁸ Although, nonverbal movement was not the focus of this chapter, conversation role was determined using a hybrid method of analysis combining hand coding of speaker identity with the nonverbal head angles from the motion capture data. This process is described in detail in this chapter.

So what pattern of conversation role participation would we expect to see in patients' three-way interactions? The analysis of chapter 4 revealed that patients' interactions are less coordinated. Patients and their healthy participant partners show a pattern of adaptation over time towards increased coordination. This pattern of adaptation may be more difficult, requiring more effort and attention from both the patient and the healthy participant partners to sustain it. As such, it would be expected that healthy participants would spend more time interacting with each other rather than with the patient. This would result in the patient spending less time actively involved in the interaction and more time as an unaddressed recipient. This hypothesis will be examined in this chapter.

Over time, it would be expected that patients would become gradually more involved in the active pair, as they become more coordinated with their interacting partners. In chapter 4 it was seen that this increasing pattern descends in the final quarter of the interaction. One explanation postulated for this was that healthy participants were unable to sustain the adaptation pattern with the patient and simply turn their attention to the other interacting partner. If this is the case, the patient should show a reduction in the amount of time they spend in the active pair at this stage of the interaction. This will be explored in the current study.

6.2.1 Relationship between patients' interaction participation and their clinical and social features

Patients' positive and negative symptoms are disparate. Patients' negative symptoms such as social and emotional withdrawal and lack of spontaneity would suggest that they would be less likely to actively participate in the three-way interaction, and hence spend more time in the role of unaddressed recipient during a three-way interaction. However, patients' positive symptoms, such as excitement and grandiosity may make patients more likely to participate in the active pair. Indeed, the findings from chapter 5 suggested that patients with more positive symptoms might be demanding more attention from their healthy participant partners. If this is the case it would be expected that patients displaying more positive symptoms would be found more often in the active pair (i.e. speaker or primary recipient) in the three-way interaction.

As discussed in the literature review, patients with schizophrenia are one of the most socially excluded groups in society. They tend to have smaller social networks and less satisfactory relationships than patients with other psychiatric disorders (Erickson, Beiser, Iacono, Fleming, & Lin, 1989). Perhaps patients' level of active participation in their three-way interactions is associated with aspects of their social participation in life, such as the size of their social networks. If this were the case it would be expected that patients who spend less time actively involved in the interaction would display poorer social functioning.

In this chapter the identity of the speaker in the interactions will be derived from hand coding traditional 2-D video. However, the identity of the addressed and unaddressed recipients will be approximated from the speakers' head angle using the 3-D motion capture data. As we are approximating gaze from head angle and not hand coding it directly from the video, the terms primary and secondary recipient will replace addressed and unaddressed recipient respectively. The percentage of time participants spend in each of these roles during the interaction will be measured.

The following hypotheses will be tested:

1. Patients will spend less time in the active pair (i.e. speaker and primary recipient) compared to control participants.
2. Patients' partners will spend more time in the active pair compared to control § participants
3. Patients' participation in the interaction will be mediated by their symptoms.
4. Patients spending less time in the active pair will be associated with poorer social functioning.

The patterns of participation in the active pair over time will also be explored within this chapter.

6.3 Method

6.3.1 Participants

The data analysis and results are based on 38 groups (19 patient groups and 19 control groups). Due to technical difficulties importing the TRC file into the Python programme, two groups were not included in this analysis (Group 11=Control group & Group 18=Patient group)

6.3.2 Assessment measures

Patients' symptoms were assessed using the positive and negative syndrome scale (PANSS). A detailed description of the measure is provided in chapter 4 (section: *4.2.3.2 Clinical assessments*). Patients' social functioning was assessed using the objectives social outcomes index (SIX), the Manchester short assessment quality of life (MANSA) and the social network schedule (SNS). Descriptions of these measures are provided in chapter 5 (section *5.2.4 Social functioning assessments*).

6.3.3 Data analysis

6.3.3.1 Assigning conversation role - Hand coding the identity of the speaker

Although speech was not transcribed, the identity of the speaker in each frame of the interaction was determined through observation of the 2D video in the annotation tool ELAN (Crasborn & Sloetjes, 2008). The 2D video was synchronized with the 3-D motion capture data and ELAN's waveform viewer was used to ensure accuracy and precision in the speech coding (figure 14). The identity of the speaker(s) was hand-annotated by the author. All verbal contributions were classed as speech including statements of verbal feedback such as "uh hmm". The annotated ELAN file was created for each interaction and exported as an xml file.

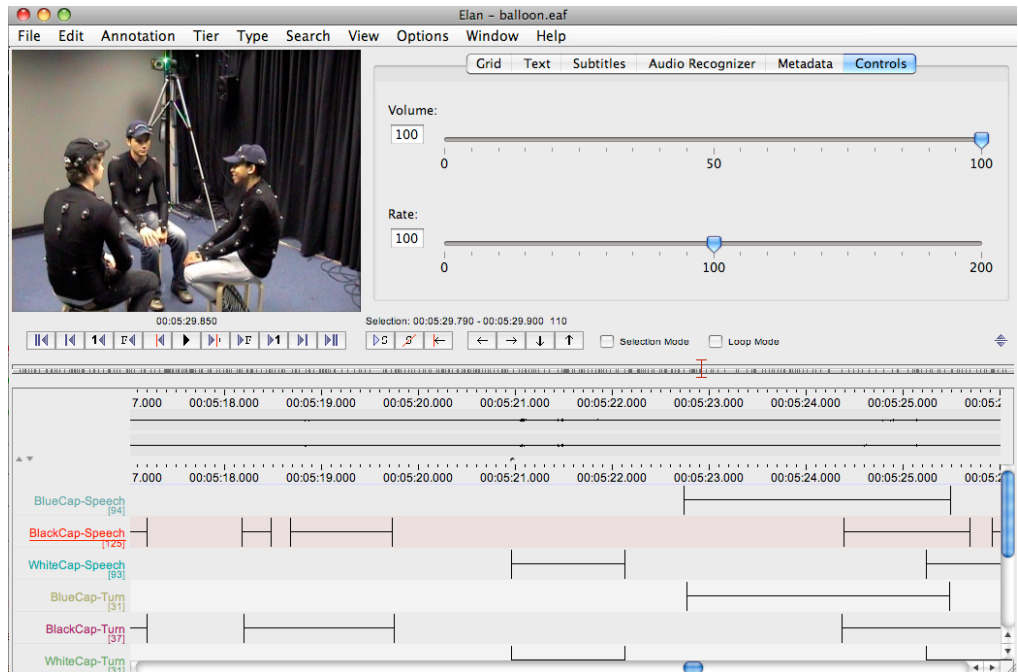


Figure 14. ELAN speaker identity annotation for a three-way conversation

6.3.3.2 *Assigning conversation role – Indexing primary and secondary recipients*

The identification of primary and secondary recipient roles was based on the head orientation of the speaker. Head orientation was used as it has been shown to be a good indicator of the direction of gaze and attention in multiparty dialogue (Jokinen, Nishida, & Yamamoto, 2010; Loomis, Kelly, Pusch, Bailenson, & Beall, 2008). A Python programme developed by Battersby et al., (2010) was used to calculate the speakers' head orientation from the 3-D coordinates of the four head markers attached to their baseball cap. The Python software incorporated both the ELAN .xml file and the 3-D motion capture trc file. The two files were temporally aligned so as the speech and motion capture information could be matched.

For each frame of data the speakers' head orientation was calculated. The orientation of the speakers' head was compared to a centre line falling between the speakers' two interacting partners, bisecting the interaction space (figure 15). Head orientations falling within two degrees of the centre line were excluded. If the head orientation was greater than 2 degrees from the centre line the participant that the speaker was orientated

towards was identified as the primary recipient and the other participant, by default, was identified as the secondary recipient. Therefore for each frame of data, the identity of the speaker (based on hand annotated speech) and the primary and secondary recipients (based on speaker head orientation) could be derived. For the purpose of the data analysis, frames with more than one speaker were excluded from the analysis.

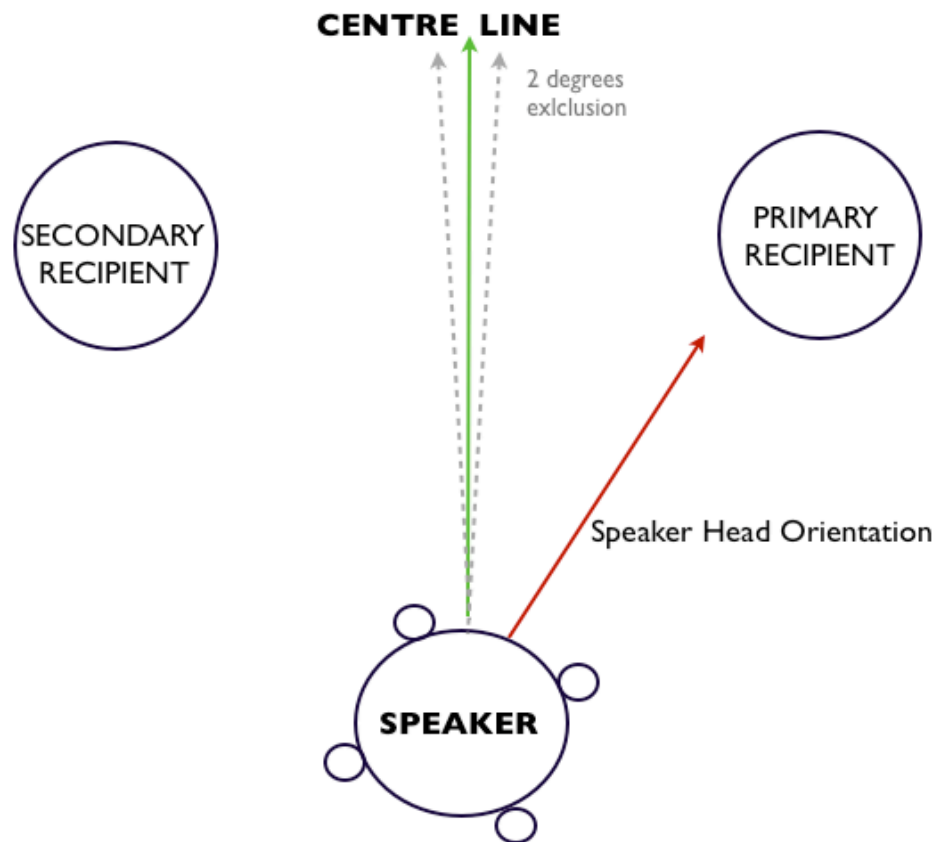


Figure 15. Assignment of primary and secondary recipient conversation role

6.3.3.3 Calculating the participation in each conversation role

To gain an index of the proportion of time each individual spends as speaker, primary recipient and secondary recipient during their three-way interaction, the number of frames spent in each role was taken as a percentage of the total number of frames in their three-way interaction.

6.3.4 Statistical Analysis

All statistical analysis were conducted in SPSS with p-values of $p < .05$ considered significant, and p-values between $p = .05$ and $p < .1$ noted as a trend.

6.3.4.1 Three-way interaction information

A Chi² compared patient and control group three-way interactions on the percentage of frames with no speakers, percentage of frames with one speaker and percentage of frames with overlapping speech (i.e. 2 or more speakers).

6.3.4.2 Comparison of time spent in each conversation role

Percentage of time spent as speaker, primary and secondary recipient were compared between participant types using three generalized estimating equations (GEE). The GEE models were chosen as they allow the relatedness between individuals who belong to the same three-way group to be taken into account, and they also allow for comparison between individuals within the same condition (i.e. Patients and healthy participants in the patient group). Differences between the three pair types were assessed using a Bonferroni pair-wise comparison.

In order to describe the relationships between individuals and groups, Group ID was entered as subject variable and individual_ID was entered as the within subjects variable. The dependent variable in each model was conversation role (i.e. speaker, primary recipient or secondary recipient), the independent variable was participant type (Patient, Healthy participant in the patient group (HPp) and control participant). In order to adjust for the group each participant belonged to, Group ID was entered as a fixed factor. Other variables adjusted for in the model by adding as covariates were; medication dose (CPZE), medication type, PANSS symptom scores (positive, negative and general), age and sex. An exchangeable correlation matrix was chosen to describe the data as it accounted for the relatedness and possible correlation between individuals within each three-way group. All models used a normal distribution.

6.3.4.3 Pattern of interaction participation over time

In order to gain an index of how the pattern of interaction participation unfolds over time in patients' three-way interactions, each interaction was divided into ten sections (see

chapter 4 - *Patterns of coordination over time*). Within each section the mean percentage of time spent in each of the three conversation roles (i.e. speaker, primary recipient and secondary recipient) was calculated for each participant. The mean percentage of time in the active pair (i.e. percentage as speaker + percentage as primary recipient) was plotted over time for each participant type (i.e. patients, healthy participants in the patient group (HPp) and participants in the control group). Trend analyses were performed on each participant type to assess the relationship between participation in the active pair and time. In each analysis, percentage of time in the active pair was the dependent variable and the independent variable was time (in ten sections).

For a more focused look at the patients' pattern of participation within the active pair, the percentage of time patients spend in the role of speaker and primary recipient were plotted separately. Two separate trend analyses assessed the relationship between patients' percentage of time in the role of speaker or primary recipient (dependent variable) and time (independent variable).

6.3.4.4 Relationship between conversation role and patients' clinical and social features

A Pearson's correlation assessed the association between the percentage of time patients spent in each conversation role (speaker, primary and secondary recipient) and patients' PANSS symptom scores (PANSS positive, PANSS negative, PANSS general), their quality of life scores (MANSA), their scores on assessments of real world social functioning (SIX) and their social networks (SNS- size and quality).

Significant associations with p-values of $p < .1$ or less were further analysed in SPSS using a multiple linear regression.

6.4 Results

6.4.1 Three-way interaction information

Table 16 displays the mean percentage of time patient and control interactions spent with each of the three speaker combinations (no speaker, one speaker or two or more

speakers). Compared to control groups, patients' interactions had fewer frames with overlapping speech.

Table 16. Mean percentage of time in each speaker combination by condition

Number of Speakers	Patient condition M (SD)	Control condition M (SD)	Z	n	p
None	25.75 (9.44)	23.32 (7.41)	-1.35	57	.18
One	67.93 (8.23)	67.61 (6.29)	-0.12	57	.89
Two +	6.31 (2.42)	9.06 (4.94)	-2.99	57	<.01**

Significance levels **= $p < .01$ *= $p < .05$ □= $p < .10$

6.4.2 Comparison of time spent in each conversation role

Description of unadjusted means: Figure 16 graphically displays the mean percentage of time each participant type spent in each conversation role. From this graph it appears that patients spend less time speaking and more time in the role of secondary recipient, compared to the control participants. Whereas, patients' healthy participant partners appear to speak more and spend less time as primary recipients. It would be inappropriate to compare these values without adjusting for the group participants belonged to and their age and gender, patients' symptoms and medication dose.

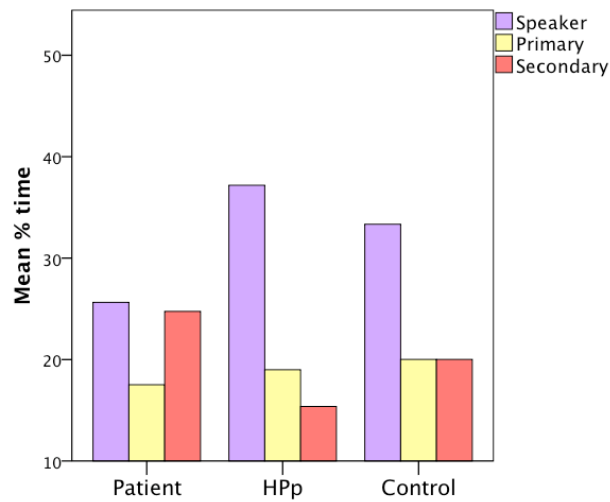


Figure 16. Percentage of time spent in each conversation role by participant type

Comparison of adjusted means: The adjusted mean percentages of time spent in each conversation role are displayed in table 17 with the pair-wise comparisons displayed in table 18. Compared to control group participants, patients spend less time in the role of speaker and more time in the role of primary recipient. They do not differ in the time spent in the role of secondary recipient. Compared to control participants, healthy participants in the patient group spend more time speaking and less time in the role of primary or secondary recipient. Within the patient group, patients spend less time speaking and more time in the role of primary recipient

Table 17. Adjusted mean percentage of time participants spend in conversation roles

Conversation role	Participant type	Mean (SE)	95% Wald Confidence Interval	
Speaker	Patient	10.35 (2.16)	6.11	14.58
	HPp	47.26 (3.88)	39.65	54.86
	Control	38.04 (1.22)	35.65	40.43
Primary	Patient	36.28 (6.41)	23.71	48.84
	HPp	8.91 (1.99)	4.99	12.82
	Control	20.48 (1.17)	18.19	22.77
Secondary	Patient	19.59 (5.84)	8.15	31.04
	HPp	9.44 (1.84)	5.84	13.05
	Control	25.68 (1.09)	23.55	27.83

Table 18. Pair-wise comparison of time spent in conversation roles by participant type

Conversation role	Participant type 1	Participant type 2	Difference (P1-P2)	SE	df	p
Speaker	Control	Patient	27.69	3.09	1	<.01**
	Control	HPp	-9.23	3.78	1	<.05*
	Patient	HPp	-36.91	5.89	1	<.01**
Primary	Control	Patient	-15.79	7.41	1	.09□
	Control	HPp	11.57	1.79	1	<.01**
	Patient	HPp	27.37	8.21	1	<.01**
Secondary	Control	Patient	6.09	6.76	1	1.00
	Control	HPp	16.25	1.71	1	<.01**
	Patient	HPp	10.16	7.47	1	.52

Overall Test Results: Speaker: $\chi^2=48.62$, $df=2$, $p=<.01^{**}$ Primary: $\chi^2=41.82$, $df=2$, $p=<.01^{**}$ Secondary: $\chi^2=106.42$, $df=2$, $p=<.01^{**}$

6.4.3 Pattern of interaction participation over time

Description: Figure 17 displays the mean percentage of time each participant type spends in the active pair. The average duration of each section in figure 17 is 32.56 seconds. It can be seen that during the first 32 second section patients spend the least amount of time in the active pair. In the second section patients are more involved in the active pair, which is mirrored by a slight dip in the participation of their interacting partners (i.e. patient replaces a healthy participant in the active pair). As the interaction progresses, patients appear to become more involved in the active pair and, by default, the healthy participants show a slight decrease in their active pair participation.

Patients' participation in the active pair is broken down further in figure 18, which displays the percentage of time patients spend in the role of speaker and primary recipient over the interaction. This shows that patients speak less at the start of the interaction and are more likely to be in the role of primary recipient. However, as the interaction progresses patients spend more time as speaker and less time as primary recipient. This pattern reverses again in the final quarter of the interaction.

Trend analysis: The trend analysis revealed that healthy participants in the patient group showed a linear relationship between participation in the active pair and time ($F(1,399)=2.88$, $p=.09$). Relating this to the graph (figure 17) it shows that healthy participants spend less time in the active pair over the course of the interaction. Patients showed no association between their participation in the active pair and time ($F(1,199)=0.71$, $p=.40$). Control participants also did not show a relationship between the participation in the active pair and time ($F(1,599)=0.15$, $p=.79$).

Focusing on the patients' percentage of time in the roles of speaker and primary recipient specifically, the trend analysis revealed a linear relationship between patients' percentage of time speaking and time ($F(1,199)=3.06$, $p=.08$). Relating this to the graph in figure 18, it can be seen that patients spent more time speaking as the interaction progresses, and this trend is most notably seen in time sections 1-6 (i.e. first 3 minutes 15 sec approx). Percentage of time spent in primary recipient role showed no association with time ($F(1,199)=0.38$, $p=.54$).

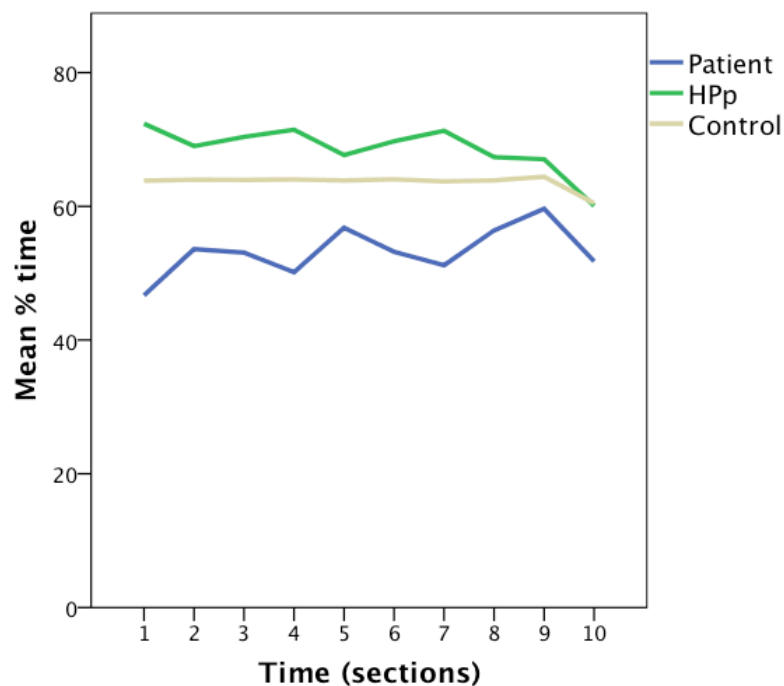


Figure 17. Unadjusted mean percentage of time spent in the active pair over time.

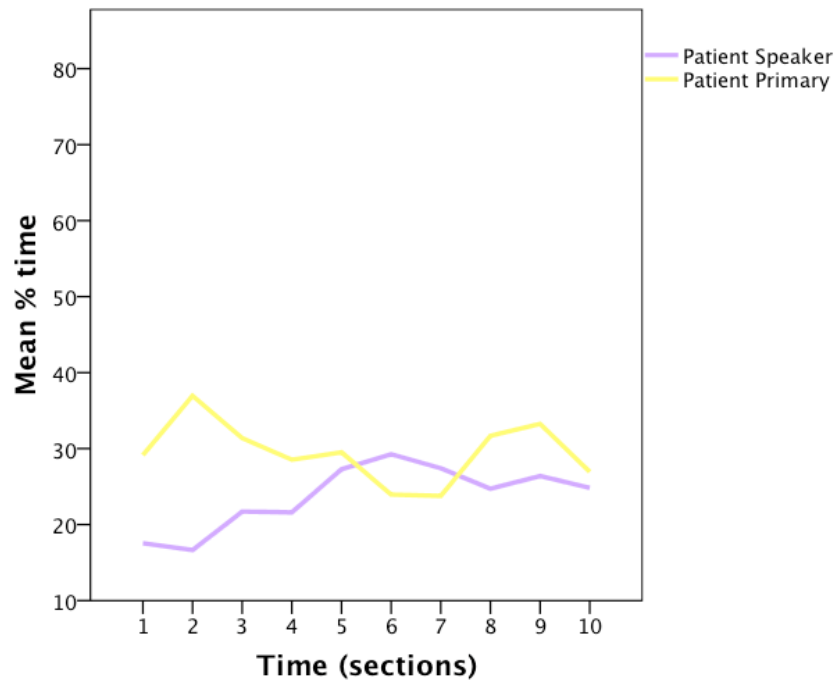


Figure 18. Unadjusted mean percentage of patients spent as speakers and primary recipients over time

6.4.4 Relationship between conversation role and patients' clinical and social features

Patients who spent more time speaking had higher positive symptom scores and lower negative symptom scores (table 19).

Multiple regression analyses revealed that patients who spent less time speaking had more negative symptoms and less positive symptoms (table 20).

Patients having fewer positive symptoms and spending less time actively involved in the interaction (i.e. more time as secondary recipient) predicted better quality of life (table 21).

Table 19. Relationship between patients' time spent in each conversation role and their symptoms and social functioning

	N	Speaker R (p)	Primary r (p)	Secondary R (p)
Positive Symptoms (PANSS_pos)	19	.382 (.10)□	-.238 (.33)	.109 (.66)
Negative Symptoms (PANSS_neg)	19	-.393 (.10)□	.209 (.39)	.054 (.83)
General Symptoms (PANSS_gen)	19	.311 (.20)	-.179 (.46)	.024 (.92)
Quality of Life (MANSA)	19	-.526 (.02)*	-.024 (.95)	.449 (.05)*
Social Functioning (SIX)	19	-.334 (.16)	.235 (.34)	-.060 (.81)
Social Network: Size (SNS-Size)	19	-.347 (.15)	.378 (.12)	.009 (.97)
Social Network: Quality (SNS- Quality)	19	-.280 (.25)	.173 (.49)	.220 (.37)

Key: PANSS=Positive And Negative Symptom Scale; SNS=Social Network Schedule; MANSA=Manchester short assessment of subjective social outcomes; SIX=Objective social outcomes index. Significance levels **= p<.01 *= p<.05 □=p<.10

Table 20. Predictors of patients' time speaking

Variable	β	t	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Patients' percentage of time speaking					
Patients' positive symptoms	.538	2.71	<.01**	.918	1.09
Patients' negative symptoms	-.547	-2.75	<.01**	.918	1.09
Model: Adjusted R ² =.348, F(2,18)=5.806, p<.01**					

Table 21. Predictors of patients' Quality of Life (MANSA)

Variable	β	T	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Patients' Quality of Life score (MANSA)					
Patients' time spent in secondary	.464	2.32	.03*	.991	1.01
Patients' positive symptoms	-.468	-2.25	.04*	.911	1.09
Patients' negative symptoms	-.019	-0.09	.93	.916	1.09
Model: Adjusted R ² =.287, F(3,18)=3.42, p<.01**					

6.5 Discussion

The findings did not support hypothesis one. The amount of time spent in the active pair did not differ between patients and control participants. However, within the active pair, patients did spend less time in the role of speaker and more time in the role of primary recipient, compared to control participants. Hypothesis two was supported, as patients' partners spent more time in the active pair than control group participants. Hypothesis three was supported as patients with more negative symptoms spoke less and patients with more positive symptoms spoke more. The findings did not support hypothesis four, as patients who spent *less* time in the active pair reported a better quality of life.

Analysis of patterns over time revealed that healthy participants showed a trend for less participation in the active pair. Furthermore, patients showed a trend towards speaking more as the interaction progressed.

6.5.1 Chapter strengths and limitations

A key strength of this study is that it measured the participation of participants in the interaction on three levels; firstly, the percentage of time spent in the active pair, secondly within the active pair, the percentage of time in the roles of speaker and primary recipient and thirdly, the pattern of participation in the active pair over time. By doing so this enabled a more comprehensive picture of the participation of patients and their partners in their three-way interactions. A limiting feature of this study is that head angle is used to approximate conversation role rather than observer rated measures. However, in interactions involving more than two people, head angle is thought to be a good predictor of who the speaker is looking at than eye gaze (Jokinen, Nishida, & Yamamoto, 2010; Loomis, Kelly, Pusch, Bailenson, & Beall, 2008). Furthermore, as both patient and control interactions were subject to the same method of measurement, any errors will be equal between the conditions.

6.5.2 Interpretation of the findings

The results revealed that although patients were no less likely to participate in the active pair, they spent more time as a primary recipient when participating. This suggests that

even though patients' partners were unaware of the patients' diagnosis, they were more likely to direct their speech towards the patient (i.e. patient as primary recipient) than towards the other interacting partner. This finding corroborates the results of a previous small study (six patient-clinician interactions) examining patients' two-way clinical interactions, which revealed that psychiatrists spend a greater proportion of the interaction looking towards the patient compared to when they are interacting with non-patient controls (Fairbanks, McGuire, & Harris, 1982). In the current findings this pattern is seen in the absence of an awareness of the patients' diagnosis or any overtly unusual behaviour by the patient. Thus, it appears that others are detecting something unusual in the behaviour of the patient, which demands their increased attention.

This explanation also accounts for the unpredicted association between patients' poor social functioning and greater time spent in the active pair. The term 'active-pair' is somewhat misleading. The speaker is essentially the *active* participant within this pair, whereas the primary recipient is *passively* involved as the focus of the speakers' gaze. The current analysis takes no account of the head orientation of the primary recipient and as such cannot determine if they are reciprocating the speakers' gaze. Thus, the features of the patient that healthy participants are detecting and responding to makes the patient more likely to be the target of their attention, in the passive role of primary recipient. When the healthy participants' detection of such features is less pronounced, the patient is less likely to be given the same degree of attention, therefore they spend less time in the active pair. This anomalous feature of the patients' behaviour influences their social interaction, at least in terms of their participation and others' behaviour, therefore it is feasible that it plays a role in patients' longer term social functioning. This suggests that the feature that makes patients more likely to be in the active pair also predicts poorer social functioning.

Patients' increased positive symptoms also predicted patients' poorer quality of life. Thus, it would appear that the relationship between patients' active participation in the interaction and their social functioning is mediated by their symptoms. Patients with more negative symptoms spent less time in the role of speaker and patients with more positive symptoms spent more. As discussed in chapter 5, the patients in the current sample had very few positive and negative symptoms therefore this suggests that

patients' symptoms influence their participation in the three-way interaction, even when symptoms are mild.

6.5.2.1 Patterns of participation over time

Investigating the patterns of patients' participation in the interaction over time revealed that although patients did not display a direct relationship between their active pair participation and time, the healthy participants did spend less time in the active pair as the interaction progressed. This would suggest that the patient did become more involved in the active pair over time. During the second 30-second (approx) section of the interaction, patients spend more time in the active pair, specifically in the role of primary recipient. This suggests that, as was seen with interpersonal coordination in chapter 4, at this point in the interaction healthy participants are detecting something in the patient making the patient more likely to be the focus of their partners' attention (i.e. primary recipient). As the interaction progresses, patients spend increasingly more time speaking. Patients' time speaking reduces in the last quarter of the interaction and they become more likely to be a primary recipient. Again, this pattern is similar to that seen in the pattern of coordination over time in chapter 4, with pairs involving a patient reverting to more atypical coordination patterns in the final quarter of the interaction.

So what is happening in the final quarter of the interaction? In chapter 4 it was suggested that the return to atypical patterns in the final quarter may be indicative of patients' partners being unable to sustain the interaction with the patient. The results of this chapter demonstrate that patients do not show less participation in the active pair in the final quarter of the interaction. Therefore, healthy participants are not merely focusing their attention away from the patient and towards each other, as was suggested in chapter 4. An alternative suggestion is that it is the patients themselves who are unable to sustain the pattern of adaptation. Over the course of the interaction it is the patients who move from a more atypical display of behaviour to what would be expected in control interactions. Perhaps this more typical pattern is not a natural pattern for the patient (i.e. greater coordination or more time speaking) and they find it difficult to maintain over longer periods of time.

6.6 Conclusion

In conclusion, the findings of this chapter build on those of previous chapters demonstrating that healthy participants interacting with a patient give more attention to the patient than the other healthy participant, even though they are unaware of their diagnosis. Patients' participation in the active pair is mediated by their positive and negative symptoms. However, independent of symptoms, patients who spend more time actively involved in a three-way interaction have a poorer quality of life.

The findings of this chapter reiterate those of chapters 4 and 5, suggesting that healthy participants are detecting and responding to a feature of the patients' behaviour. Over time this response becomes less pronounced and the patients' patterns of participation becomes less atypical. In order to understand the nonverbal communication between patients and their partners on a more descriptive level, the nonverbal cues produced by patients and their partners when actively involved in the three-way interaction need to be examined. This will be the focus of the next chapter.

Part IV: Nonverbal cues

Chapter 7: Are the nonverbal cues of nodding and gesture atypical in patients' three-way interactions?

7.1 Introduction

The final empirical chapter in this thesis will address research question 3 (parts a-d). This chapter is concerned with how patients and their partners use the nonverbal cues of head nodding and hand gesture when they are actively participating in a three-way interaction (i.e. in the roles of speaker or primary recipient).

The previous empirical chapters (chapters 4-6) have revealed that patients and their interacting partners display atypical nonverbal patterns in their three-way interactions. The nonverbal behaviour of the healthy participants changes in the presence of the patient; they show reduced interpersonal coordination (chapter 4) and, when speaking, they direct their attention more towards the patient than others (chapter 6). This occurs while the healthy participants are unaware that a patient is present and in the absence of patients displaying any overt symptoms or the healthy participants reporting anything unusual about their partners' behaviour. Thus, it would appear that the healthy participants are detecting and responding to nonverbal anomalies in the patient, which they may not even be consciously aware of. The aim of this chapter is to use a more focused analysis to investigate how patients and their healthy participant partners use nonverbal hand and head cues when they are actively participating in the interaction (i.e. part of the active pair).

Specifically, this chapter will focus on the cues of head nodding and hand gesture. Nodding and gesture were chosen as they are employed in the conversational management processes of feedback and turn exchange. Furthermore, they convey specific meanings depending on the conversation role they are produced in. For example, in the active pair, head nodding may be used by speakers to request feedback from the primary recipient (McClave, 2000) and by primary recipients to provide feedback to the speaker (Boholm & Allwood, 2010). Hand gesture can be used to add clarity or emphasis to speakers' speech or to gain the attention of their primary recipient

(Bavelas, Kenwood, Johnson, & Phillips, 2002). Gesture may also be used by primary recipients to indicate a wish to take the floor (Jokinen, Nishida, & Yamamoto, 2010).

Uncovering how the patient and healthy participants use these nonverbal cues in the role of speaker and primary recipient will provide information on their nonverbal communication and the potential functional impacts any anomalous patterns may have. So what would we expect to see in patients' three-way interactions? As discussed in chapter two, previous studies investigating the nonverbal behaviour of patients and their partners have found that patients display less head and hand movement during their two-way clinical interactions (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010; Troisi, Spalletta, & Pasini, 1998). Their clinician partners display reduced movement in line with that seen in the patient (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010). The current analysis differs from these in that patients are interacting with healthy participant partners who are not clinically trained and unaware of the patients' diagnosis. The findings of previous chapters within this thesis have found that patients display atypical patterns of interpersonal coordination, which is detected by their healthy participant partners, although not necessarily on a conscious level. Patients' partners respond by adapting their own behaviour to compensate for that of the patients. Thus, it would be expected that patients will display less nonverbal cues and their healthy participant partners will adapt their behaviour to compensate for this pattern.

7.1.1 Nonverbal cues and patients' symptoms

The findings from studies trying to identify a relationship between patients' nonverbal behaviour and their symptoms are mixed. Some studies found that patients with negative symptoms display less nonverbal behaviour (Brüne et al., 2008), while others report no relationship (Troisi, Spalletta, & Pasini, 1998). Such studies have only investigated the direct association between patients' symptoms and their own nonverbal behaviour. As discussed in the literature review, subtle changes in the behaviour of one interacting partner may have a more observable impact on their interacting partners. Indeed, the findings of chapter 5 revealed that although patients' symptom severity was not associated with their own coordination, it was associated with reduced coordination

between the patients' healthy participant partners. Thus, patients' symptoms may influence the nonverbal behaviour of their partners. The relationship between patients' symptoms and the nodding and gesture of patients and their interacting partners will be assessed in the current chapter.

7.1.2 Nonverbal cues and patients' social functioning and social cognition

As reviewed in chapter 2, few studies explored the links between patients' social functioning and their nonverbal behaviour. Those that have link a reduction in facial expression with poorer social and occupational functioning (Troisi, Pompili, Binello, & Sterpone, 2007). The nonverbal cues under investigation in this chapter (i.e. nodding and gesture) are among those employed in the nonverbal exchange of feedback. As we saw in chapter 3, the feedback process is crucial in driving the interaction forwards, and anomalies in feedback between speakers and their primary recipients results in interactions that are more problematic (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008; Bavelas & Chovil, 2000). Although feedback is not specifically being assessed in this chapter, it would be expected that if patients produce atypical patterns of nonverbal cues employed in the process of feedback (i.e. nodding and gesture), this would have a negative impact on their social interactions. This, in turn, may be detrimental to their longer term social functioning. Furthermore, it would be expected that atypical patterns of such nonverbal cues may be associated with difficulty reading and interpreting the nonverbal cues of others. Therefore, they should be associated with patients' social cognitive abilities.

In the current chapter, participants' head nodding and hand gesture will be approximated from the 3-D motion capture data of their three-way interactions. The following hypotheses will be assessed:

1. In the active pair (i.e. speaker or addressed recipient), patients will show less nodding and gesture compared to control group participants.
2. Patients' reduced nodding and gesture will be associated with higher negative symptom scores, poorer performance on assessments of social cognition and poorer social functioning.

3. The atypical patterns displayed by patients will be detected by their healthy participant partners and visible in adaptations in their nonverbal cues.
4. The severity of patients' symptoms will be associated with their partners' production of nonverbal cues.

In line with previous chapters in this thesis, the pattern of nodding and gesture over time will be explored within this chapter.

7.2 Method

7.2.1 Participants

As with chapter 6, the following analysis will be performed on 38 groups (19, patient groups and 19 control groups) as groups 11 (control group) and 18 (patient group) were excluded due to technical difficulties importing files into the Python programme.

7.2.2 Assessment measures

Patients' symptoms were assessed using the positive and negative syndrome scale (PANSS). Symptoms of anxiety were measured using the Beck Anxiety Inventory (BAI). A detailed description of these measures is provided in chapter 4 (section: 4.2.3.2 *Clinical assessments*).

Participants' social perception was assessed using the social cue recognition test (SCRT) and the profile of nonverbal sensitivity test (PONS). Participants' theory of mind was assessed using the hinting task, the Sally Anne task and the ice-cream van task (ICV). Patients' social functioning was assessed using the objectives social outcomes index (SIX), the Manchester short assessment quality of life (MANSA) and the social network schedule (SNS). Descriptions of these measures is provided in chapter 5 (section 5.2.3 *Social cognitive assessments* & 5.2.4 *Social functioning assessments*).

7.2.3 Data analysis

As this analysis aimed to capture only hand and head movement in the specific conversation roles, only frames where there was one speaker were selected for analysis. Frames with no speaker or overlapping speech were removed prior to data analysis.

7.2.3.1 Measuring head movement - Indexing head nodding

As with previous chapters, in order to gain a baseline measure of head movement, the mean head movement speed (mm/frame) was calculated as the mean change in position of the front left head marker in millimeters per frame. For the purpose of this study, only head movement speed in the vertical axis was derived as this has been used to approximate nodding (Battersby & Healey, 2010). The purpose of this measure was to identify points at which individuals were producing a vertical head movement that approximates the nodding of the head. Movement of the front left head marker in the vertical axis was used as an index of head movement. A Python programme developed by Stuart Battersby (Battersby & Healey, 2010) used a two-stage process to approximate head nodding. In stage one, vertical movement of the front left head marker of each participant was interpreted as a signal over time, displaying the frequencies of movement over the course of the interaction. Low frequency movements (1Hz and below) such as those occurring due to body sway or posture shift, and high frequency movements (4Hz and above) such as those occurring due to tremor or camera error, were eliminated. Head movements that fell between these frequencies were retained. These frequencies are in accordance with those described as the parameters of normal head movement in the *British Journal of Ophthalmology* (Gresty, Leech, Sanders, & Eggars, 1976) and fall within the range of ordinary head movement as described by Hadar et al., (1983). The second stage involves applying peak and trough detection to the retained data to identify change in movement direction (i.e. top and bottom of a head nod). Movements with 7 frames of data between the top and bottom of the nod that have a head speed value greater than .3mm/frame are considered to be a head nod. These parameters are based on the findings of a previous study identifying speakers' head movement (Cerrato & Svanfeldt, 2005). Such movements will be referred to as 'head nodding' during the remainder of this thesis, with the caveat that this is restricted to

movements identified purely from the motion data and not through any observational techniques.

7.2.3.2 Measuring hand movement – Indexing hand gesture

A measure of hand movement was derived directly from the 3-D motion capture data. The 3D data from the hand markers indicated hand movement. Examination of the hand movement data revealed that participants moved at least one of their hands, to varying degrees, almost constantly throughout the interaction. Therefore, coding hand movement as a binary variable (hand moving or hand not moving) produced a ceiling effect in those individuals with all their 3-D data present, and gave misleading results in those individuals with missing hand data through occlusion of the hand markers (for more detail see section 4.5.4 *Reconstructing the motion capture data and dealing with missing markers*). Therefore, in order to allow for comparison of hand movement between individuals, the change in position (in millimeters) of the fastest moving hand marker was recorded between each interaction frame. A mean speed of the fastest moving hand (mm/frame) for each individual was calculated. In order to gain an index of hand gesture, the mean hand movement speed and its standard deviation for each individual was calculated. Hand movements occurring at speeds greater than 1 standard deviation from the mean individual hand speed (mm/frame) were coded as a gesture. As with the head nodding, such movements will be referred to as hand gestures for the remainder of this study, with the caveat that this is restricted to movements identified purely from the motion data and not through any observational techniques.

7.2.4 Statistical Analysis

All statistical analysis were conducted in SPSS with p-values of $p < .05$ considered significant, and p-values between $p = .05$ and $p < .1$ noted as a trend.

7.2.4.1 Comparison of patients' and healthy participants' hand and head movement

In order to determine the difference in individual head and hand movement between patients and healthy participants, and to take into account the possible impact of the patient on the head movement of their healthy participant partners, an independent

samples t-test compared mean head and hand movement speed (mm/frame) between patients and participants in the control group.

7.2.4.2 Association of medication dose and patients' movement

As with previous chapters, bivariate correlation analyses assessed the relationship between antipsychotic medication dosage (CPZE) (mg/day) and patients' head movement speed (mm/frame) and hand movement speed (mm/frame).

7.2.4.3 Comparison of nodding and gesture by participant type

The percentage of nodding and gesture in the speaker and primary recipient roles were compared between participant types using four separate generalized estimating equation (GEE) models. As with the models in chapter 6, this was used as it takes into account the relatedness between individuals who belong to the same three-way group. Differences between the three pair types were assessed using a Bonferroni pair-wise comparison. In each model, the subject variable is Group_ID and the within subjects variable is individual_ID.

In each model, the dependent variable was nonverbal cue in each conversation role (i.e. speaker nodding, speaker gesture, primary nodding and primary gesture) and the independent variable was participant type (patient, healthy participant in the patient group and control participants). The model was adjusted for group number, medication dose (CPZE), medication type, PANSS symptom scores (positive, negative and general), age and sex. An exchangeable correlation matrix was used to account for the relatedness between individuals within each group. The models used a gamma distribution to deal with the positive skew in the distribution of the data.

7.2.4.4 Patterns of nodding and gesture over time

Each three-way interaction was divided into 10 sections as described in chapter 4 (section 4.2.7.6 *Patterns of coordination over time*). The mean percentage of nodding and gesture within the roles of speaker and primary recipient were calculated for each

participant. In order to assess the relationship between time (in sections) and participants' production of nonverbal cues within each conversation role, separate trend analyses were performed for each participant type (i.e. speaker nodding, speaker gesture, primary recipient nodding, primary recipient gesture). In each, the dependent variable was nonverbal cues in a conversation role (e.g. percentage of speaker nodding) and the independent variable was time (in sections).

7.2.4.5 Relationship between nonverbal behaviour and patients' clinical and social features

A Spearman's correlation assessed the association between patients' nodding and gestures as speaker and primary recipient and their symptom scores (PANSS positive, PANSS negative and PANSS general), scores on assessments of anxiety (BAI), their scores on social cognitive assessments (Social Cue Recognition Test, Profile of Nonverbal Sensitivity test, the hinting task, and the 1st and 2nd order Theory of Mind tests), their quality of life scores (MANSA), their scores on assessments of real world social functioning (SIX) and their social networks (SNS- size and quality). A Spearman's correlation assessed the association between the nodding and gesture of patients' partners as speakers and primary recipients and patients' symptoms (PANSS positive, PANSS negative and PANSS general).

Significant correlations $p < .1$ will be further investigated using multiple linear regression analyses.

7.3 Results

7.3.1 Comparison of patients and healthy participants' hand and head movement

Table 22 displays the mean head and hand movement speed (mm/frame) for patients and control group healthy participants. Patients and healthy participants did not differ on their speed of hand or head movement

Table 22. Head and hand movement speed by participant type

Movement speed	Patient M (SD)	Controls M (SD)	t	df	p
Head (mm/frame)	.216 (.09)	.234 (.11)	-.659	74	.51
Hand (mm/frame)	1.01 (.58)	1.09 (.77)	-.461	74	.65

7.3.2 Association of medication on patients' individual movement

Antipsychotic medication dose (CPZE) was not associated with patients' head movement speed ($r(19)=.311$, $p=.20$) or hand movement speed ($r(19)=.245$, $p=.31$).

7.3.3 Comparison of nodding and gesture by participant type

Description of unadjusted means: The unadjusted mean percentage of nodding and gesture by conversation role and participant type are displayed in figure 19. Looking at the graphs it appears that patients nodded and gestured less when speaking compared to control participants. Healthy participants interacting with a patient appear to gesture less when speaking, but nod and gesture more in the role of primary recipient when compared to the control participants.

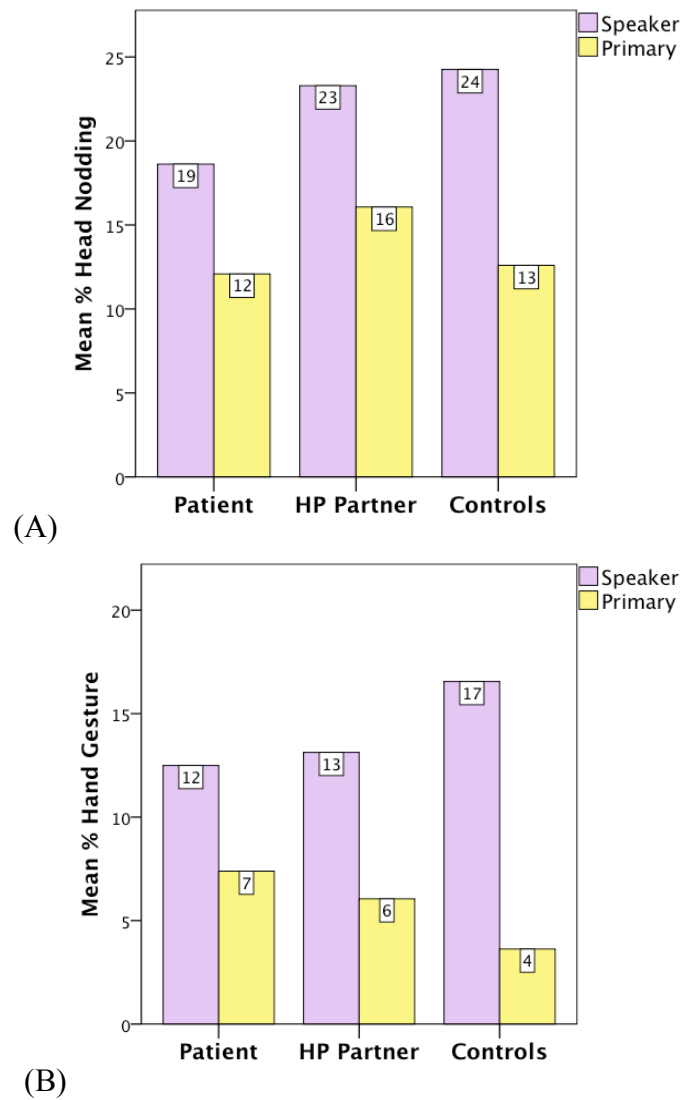


Figure 19. Mean percentage of nodding (A) and gesture (B) by conversation role and participant type

Comparison of adjusted means: The adjusted mean values of nodding by participant type are displayed in table 23 with the pair-wise comparisons in table 24. The adjusted mean values for participant gesture are displayed in table 25 with the pair-wise comparisons in table 26.

Compared to control participants, patients showed less nonverbal cues when speaking (nodding and gesture) and in the role of primary recipient (nodding). Patients' healthy participant partners displayed more nonverbal cues (nodding and gesture) in the role of primary recipient compared to control participants.

Table 23. Adjusted means of percentage of nodding by conversation role and participant type

Conversation role	Participant	Mean	S.E	95% Wald Confidence Interval	
				Lower	Upper
Speaker	Patient	-21.82	7.32	-36.17	7.48
	HPp	30.13	2.07	26.07	34.19
	Control	33.18	1.31	30.62	35.74
Primary recipient	Patient	4.37	1.70	1.03	7.12
	HPp	23.04	2.83	17.49	28.56
	Control	9.86	0.67	8.55	11.17

Table 24. Pair-wise comparison of nodding by conversation role and participant type

Conversation role	P 1	P 2	(P1-P2)	SE	df	P	95% Wald CI	
							Lower	Upper
Speaker	Control	Patient	55.00	8.52	1	<.01**	34.61	75.39
	Control	HPp	3.05	1.58	1	.16	-0.74	6.83
	Patient	HPp	-51.95	9.25	1	<.01**	-74.09	-29.81
Primary	Control	Patient	5.48	2.29	1	<.05*	-0.17	10.98
	Control	HPp	-13.18	2.55	1	<.01**	-19.29	-7.06
	Patient	HPp	-18.66	4.42	1	<.01**	-29.25	-8.08

Overall Test Results: Speaker Nodding: $\chi^2=64.96$, $df=2$, $p=<.01^{**}$ Primary Nodding: $\chi^2=28.43$, $df=2$, $p=<.01^{**}$

Table 25. Adjusted means of percentage of gesture by conversation role and participant type

Conversation role	Participant	Mean	S.E	95% Wald Confidence Interval	
				Lower	Upper
Speaker	Patient	4.48	1.64	1.27	7.70
	HPp	15.10	1.85	11.48	18.73
	Control	16.76	1.19	14.41	19.11
Primary	Patient	4.79	1.07	2.70	6.89
	HPp	5.42	0.47	4.50	6.34
	Control	3.39	0.12	3.14	3.65

Table 26. Pair-wise comparison of gesture by conversation role and participant type

Conversation role	P 1	P 2	(P1-P2)	SE	df	P	95% Wald CI	
							Lower	Upper
Speaker	Control	Patient	12.27	2.67	1	<.01**	5.87	18.67
	Control	HPp	1.66	1.91	1	.96	-2.94	6.25
	Patient	HPp	-10.62	3.33	1	<.01**	-18.59	-2.64
Primary	Control	Patient	-1.40	1.16	1	.68	-4.17	1.36
	Control	HPp	-2.03	0.46	1	<.01**	-3.13	-0.92
	Patient	HPp	-0.63	1.49	1	1.00	-4.19	2.94

Overall test results: Speaker Gesture: $\chi^2=23.35$, $df=2$, $p=<.001^{**}$ Primary Gesture: $\chi^2=42.71$, $df=2$, $p=<.001^{**}$

7.3.4 Patterns of nodding and gesture over time

Description: Each section of time had an average length of 31.79 seconds. The patterns of nodding (—) and gesture (- -) in the role of speaker by participant type are displayed in figure 20 (A). Participants' nodding and gesture in the role of primary recipient are displayed in figure 20 (B)

Speakers: Compared to control participants, patients appear to nod and gesture less at the start of the interaction, and gradually show more as the interaction progresses. Where control participants appear to show an increase in the nodding and gesture over time, patients' partners show less nodding and gesture over time. Patients' partners show a prominent peak in their gesture use in the second section of the interaction (approx 32sec -64sec), which reduces after this point to become more in line with the frequency of speaking gesture displayed by control participants.

Primary recipients: In the role of primary recipient, both control participants and healthy participants in the patient group nod more than they gesture. Although patients nod more than gesture overall, there is less of a difference between their frequency of nodding and gesture. Patients display more nodding at the start of their interaction, compared to control participants. Patients' partners appear to display more nodding and gesture than the control participants, but the pattern over time looks similar.

Trend analysis: The results of the trend analysis are displayed in table 27. Patients and control participants both displayed a linear relationship between head nodding while speaking and time. Relating this to figure 20 (A) it can be seen that in both cases this trend refers to participants displaying more head nodding as the interaction progresses. Healthy participants interacting with a patient showed a quadratic relationship between their use of hand gesture when speaking and time. Relating this to figure 20 (A) it can be seen that this refers to the change in direction gesture over time from increasing to decreasing.

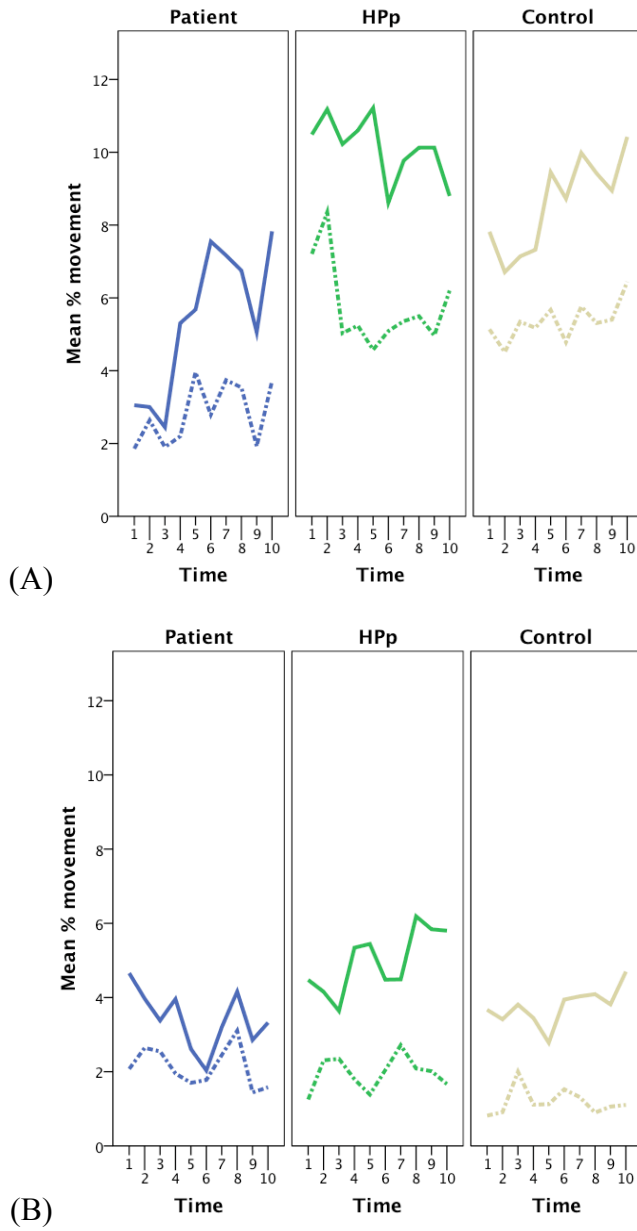


Figure 20. Pattern of nodding (—) and gesture (- - -) in the role of speaker (A) and primary recipient (B) over time by participant time.

Table 27. Trend analysis of the relationship between participants' nonverbal cue production and time

Conversation Role	Nonverbal cue	Participant type	F	df	P	Significant Term
Speaker	Nod	Patient	5.83	1, 187	.02*	Linear
		HPp	0.60	1, 375	.44	
		Control	5.85	1, 566	.02*	Linear
	Gesture	Patient	1.04	1, 187	.31	
		HPp	3.35	1, 375	.07 α	Quadratic
		Control	1.17	1, 566	.28	
Primary recipient	Nod	Patient	0.57	1, 187	.45	
		HPp	1.92	1, 375	.17	
		Control	0.91	1, 566	.33	
	Gesture	Patient	0.22	1, 187	.64	
		HPp	0.10	1, 375	.75	
		Control	0.02	1, 566	.89	

Significance level: **= $p < .01$, *= $p < .05$, α = $p < .10$

7.3.5 Relationship between nonverbal cues and patients' clinical features and social features

Table 28 displays the association between patients' nonverbal cues as speaker and primary addressee and their symptoms, performance on social cognitive assessments and social functioning. The results revealed that patients nodding less as primary recipients were associated with higher negative symptom scores and lower anxiety scores. Patients nodding more as a speaker and gesturing more as a primary recipient were associated with poorer social functioning (SIX) and smaller social networks (SNS-size).

Multiple regression analyses assessed these relationships further (tables 29-31). Patients' increased negative symptoms and symptoms of anxiety predict less nodding in the role of primary recipient (table 29). No relationship was found between patients' social networks and their nonverbal cues after controlling for symptoms (table 30). Independent of patients' symptoms, patients' increased gesture in the role of primary recipient predicted poorer social functioning (table 31).

Table 28. Association between patients' nonverbal cues and their symptoms and social features.

	n	Patient Speaking		Patient Primary	
		Nod Rho (<i>p</i>)	Gesture Rho (<i>p</i>)	Nod Rho (<i>p</i>)	Gesture Rho (<i>p</i>)
Positive symptoms (PANSS_Pos)	19	.226(.35)	.152 (.54)	.241 (.32)	.304 (.21)
Negative symptoms (PANSS_Neg)	19	-.265(.27)	-.265 (.27)	-.469 (.04)*	-.184 (.45)
General symptoms (PANSS_Gen)	19	.296 (.22)	.019 (.94)	.118 (.63)	.215 (.38)
Anxiety symptoms (BAI)	19	.441 (.13)	-.126 (.68)	.574 (.04)*	.210 (.49)
Abstract social cue recognition (SCRT-A)	19	.132 (.62)	.154(.54)	-.014 (.96)	.137 (.59)
Concrete social cue recognition (SCRT-C)	19	-.309 (.25)	-.065 (.80)	-.096 (.70)	.092 (.93)
Sensitivity to nonverbal cues (PONS)	19	.005 (.99)	.112 (.66)	.046 (.85)	.087 (.74)
Theory of Mind: Hinting Task	19	.039 (.88)	-.089 (.72)	.260 (.29)	.022 (.93)
Theory of Mind: 1 st Order (Sally Anne Task)	19	.311 (.29)	.237 (.26)	.049 (.85)	.197 (.46)
Theory of Mind: 2 nd Order (ICV task)	19	-.058 (.85)	.122 (.65)	.055 (.83)	.018 (.95)
Quality of Life (MANSA)	19	-.316 (.19)	-.055 (.82)	-.247 (.31)	-.300 (.21)
Social Functioning (SIX)	19	-.398 (.09)□	-.038 (.88)	-.224 (.36)	-.602 (.00)**
Social Network: Size (SNS-Size)	19	-.475 (.04)*	.231 (.35)	-.354 (.14)	-.680 (.00)**
Social Network: Quality (SNS- Quality)	19	-.105 (.67)	.192 (.44)	-.067 (.79)	-.231 (.35)

Significance level: **= $p < .01$, *= $p < .05$, □= $p < .10$

Table 29. Predictors of patients' nodding in the role of primary recipient

Variable	β	t	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Patients' nodding as primary recipient					
Patient negative symptoms	-.345	-1.65	.10 α	.881	1.14
Patient anxiety symptoms	.404	1.93	.06*	.881	1.14

Model: Adjusted R^2 =.379, $F(2,18)$ =4.87, p =.02 α

Table 30. Predictors of patients' social network size (SNS-size)

Variable	β	t	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable Patients' social network size (SNS-size)					
Patient % speaker nodding	-.263	-0.98	.34	.603	1.66
Patient % primary gesture	-.318	-1.33	.21	.762	1.31
Patient positive symptoms	-.243	-0.98	.35	.700	1.43
Patient negative symptoms	-.127	-0.51	.62	.712	1.41

Model: Adjusted R^2 =.219, $F(4,18)$ =2.27, p =.11

Table 31. Predictors of patients' social functioning (SIX)

Variable	β	t	p	Collinearity Statistics	
				Tol.	VIF
Dependent variable Patients' social functioning scores (SIX)					
Patient % speaker nodding	-.104	-0.40	.69	.603	1.66
Patient % primary gesture	-.509	-2.23	.04*	.762	1.31
Patient positive symptoms	-.223	-0.93	.37	.700	1.43
Patient negative symptoms	-.025	-0.11	.92	.712	1.41

Model: Adjusted R^2 =.287, $F(4,18)$ =2.81, p =.06 α

The association between the patients' partners' nonverbal cues and patients' symptoms are displayed in table 32. Higher patients' positive, negative and general symptom scores were associated with patients' partners using more gesture when speaking and nodding less in the role of primary recipient.

In the regression analysis, patients' nonverbal cues were entered into the model to account for the potential impact of patients' behaviour on their partners. To avoid problems of collinearity, patients' nodding and gesture as speakers and primary recipients were correlated to determine what should be included in the model. Patients' nodding and gesture as primary recipients were significantly correlated ($r(19)=.64$, $p<.01$). Patients' primary nodding was also significantly correlated with nodding when speaking ($r(19)=.46$, $p<.05$). Patients' speaking gesture was not associated with patients' nodding in the role of primary ($r(19)=-.345$, $p=.20$). Therefore, patients' nodding in the role of primary recipient and gesture in the role of speaker were included in the model.

The multiple regression analysis revealed that, after controlling for patients' nonverbal behaviour, increased patients' negative symptoms predicted increased speaking gesture in their healthy participant partners (table 33). Patients' symptoms were not associated with their partners' nodding in the role of primary recipient (table 34)

Table 32. Association of healthy participants' nonverbal cues and patients' symptoms.

	N	HPp Speaking		HPp Primary	
		Nod Rho (<i>p</i>)	Gesture Rho (<i>p</i>)	Nod Rho (<i>p</i>)	Gesture Rho (<i>p</i>)
Positive symptoms (PANSS_Pos)	38	.097 (.56)	.318 (.05)*	-.261 (.10)α	.012 (.94)
Negative symptoms (PANSS_Neg)	38	.010 (.95)	.543 (.00)**	-.346 (.03)*	-.211 (.20)
General symptoms (PANSS_Gen)	38	.123 (.46)	.353 (.03)*	-.202 (.23)	.063 (.71)

Significance level: **= $p<.01$, *= $p<.05$, α= $p<.10$

Table 33. Predictors of patients' healthy participant partners' hand gesture when speaking

Variable	β	<i>t</i>	<i>p</i>	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Healthy participants' speaking gesture					
Patient positive symptoms	.016	0.09	.93	.767	1.30
Patient negative symptoms	.440	2.19	.04*	.608	1.65
Patient % gesture as speaker	-.032	-0.19	.85	.843	1.18
Patient % nod as primary	.014	0.07	.95	.562	1.78

Model: Adjusted R^2 =.094, $F(4,37)$ =1.96, p =.13

Table 34. Predictors of patients' healthy participant partners' nodding in the role of primary recipient

Variable	β	<i>t</i>	<i>p</i>	Collinearity Statistics	
				Tol.	VIF
Dependent variable: Healthy participants' nodding as primary recipient					
Patient positive symptoms	-.276	-1.53	.14	.767	1.30
Patient negative symptoms	-.172	-0.85	.40	.608	1.65
Patient % gesture as speaker	.073	0.43	.67	.843	1.19
Patient % nod as primary	.186	0.88	.38	.562	1.78

Model: Adjusted R^2 =.073, $F(4,37)$ =1.72, p =.17

7.4 Discussion

The findings supported hypothesis one, as patients displayed less nonverbal behaviour within the active pair compared to control participants. Hypothesis two was partially supported. Patients with more negative symptoms showed less nodding in the role of primary recipient. However, increased hand gesture in the role of primary recipient was associated with patients' poorer social functioning. No association was found between patients' nonverbal cues and their performance on social cognitive assessments. Hypothesis three was supported, as patients' partners displayed more head nodding and hand gesture in the role of primary recipient compared to control participants. Finally, hypothesis four was also supported, as healthy participants interacting with a patient with more negative symptoms gestured more when speaking.

Patterns over time reveal that as the interaction progressed, patients nodded more when they spoke. As speakers, patients' partners gestured more at the start of the interaction and less as the interaction progressed over time.

7.4.1 Strengths and limitations

These findings must be considered in the context of the strengths and limitations of this analysis. Firstly, head nodding and hand gesture were approximated based solely on participant movement derived from the 3-D motion capture data. Head nodding was based on both the speed and direction of the head movement. However, detection of hand gesture was based only on movement speed, as gestures can occur in any direction. Therefore, gestures were not classified in any way and movements such as scratching or grooming behaviour may have been detected alongside those hand movements that would be classed as a gesture using observational analysis (McNeill, 1992). Indeed, it must be noted that the method of gesture detection employed in this study differs significantly from those used in traditional observational analysis in that it classifies the movement as the indicator of a gesture, rather than the gesture itself. Thus, what is measured in the current study may be classed as 'preparatory action' occurring prior to the gesture if observation methods were used. Therefore although this method provides an index of how frequently hand movements occur, this may not necessarily equate to the measure of gesture obtained using observation analysis methods. The presence of grooming behaviours in the detected gestures is unlikely to dominate the findings. However, it is possible that patients displayed more of these than healthy participants (Fairbanks, McGuire, & Harris, 1982). It could be argued that even such behaviours are communicatively meaningful, perhaps signaling anxiety or distress. Therefore, any patterns of hand movement detected on this crude level of analysis highlight areas of interest that can be investigated in more detail using observation methods.

A second limiting feature is that head angle of primary recipients was not detected in the version of the Python programme used in this study. Thus, although we know whom the speaker is orientated towards, we do not know if they are returning the speakers' gaze. This would be of interest in future analyses to investigate patients' pattern of mutual gaze during interaction.

7.4.2 Interpretation of the findings

In agreement with findings from previous research of patients' two-way interactions with their clinicians (Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010; Troisi, Spalletta, & Pasini, 1998) patients displayed less head and hand movement during their three-way interaction. Specifically, patients nodded and gestured less in the role of speaker and nodded less in the role of primary recipient. Thus, patients displayed an overall reduction in the amount of nonverbal cues they are sending to their partners. This does not appear to be simply a reduction in their movement per se, as patients did not show any reduction in their speed of head or hand movement.

Patients' partners showed an increase in their nodding and gesture in the role of primary recipient. This suggests that patients' partners are overcompensating for the reduced nonverbal pattern being displayed by the patient. This is in line with the Interaction Adaptation Theory (IAT) (Burgoon, Stern, & Dillman, 1995), discussed previously in chapters 3 and 4, which suggests that behaviours that deviate from expectations will be responded to by compensatory behaviour. This appears to be the case in patients' interactions. Although few studies have investigated the behaviour of patients' partners during interaction, those which have found a reduction in partners' behaviour in line with the reduction in the patient (Krause, Steimer, Sanger-Alt, & Wagner, 1989; Kupper, Ramseyer, Hoffmann, Kalbermatten, & Tschacher, 2010). These previous studies differ from the current study in that they involve only two people. In the current three-way analysis, the increased number of interacting partners means that the nonverbal communication becomes more salient. The exchange of nonverbal cues employed in processes of conversation management such as feedback and turn exchange becomes more important to interacting partners to allow them to negotiate changes in the interaction and drive it forwards. Thus, the overcompensation in nonverbal cues by the healthy participants may be a bid to decipher the dynamics of the interaction in the company of a patient who is providing little nonverbal information.

Patients and their partners display atypical patterns of nodding and gesture in the active pair over time. Patients initially display atypical patterns of nodding and gesture,

particularly when speaking, and this becomes more in line with the patterns seen in the control groups as the interaction progresses. Patients show a return to their original pattern in the final minutes of the interaction. This pattern is consistent with that of patients' coordination (chapter 4) and active involvement in the three-way interaction (chapter 6). Two explanations have been put forward for this dip towards the end of interaction in chapter 6. Firstly, that the patient is unable to sustain the adaptation in behaviour towards the more typical pattern (i.e. increased nodding and gesture) over longer periods of time. However, the results of this chapter demonstrate that patients do show a return to the increased nodding and gesture when speaking in the final section of the interaction, which may indicate that they are able to sustain the pattern when required. The second theory is that it is a result of the task structure. Patients with schizophrenia, particularly those with delusional beliefs, have been shown to display a 'jumping to conclusions bias' (Moritz & Woodward, 2005). This means that they are more likely to come to a decision after a shorter period of time and less flexible in changing that decision once it has been reached. This bias was not assessed in the current study. However, the pattern of disengagement by patients in the final minutes of the interaction (i.e. reduced coordination, reduced speech and reduced nodding and gesture) while they are still actively engaged in the three-way interaction (i.e. in the role of primary recipient) could suggest that it is at this point that the patient is experiencing difficulty with the decision making stage of the task. The current study did not analyse any aspect of speech within this task. Future studies would benefit by investigating the verbal features of the decision making process in patients' interactions to assess for the impact of the jumping to conclusions bias in patients' interactions.

Patients' partners begin the interaction by displaying more nonverbal behaviour than would be expected and over time return to more typical patterns. As with the patients, this pattern is particularly pronounced when they are speaking. In the second section of the interaction, patients' partners show a very high frequency of hand gestures (figure 20). This coincides with the point in time where all members of the patients' three-way interaction display the greatest reduction in their coordination (chapter 4) and patients focus more of their attention towards the patient (chapter 6). Thus, adding more evidence to the hypothesis that it is at this point in the interaction where patients' partners are responding to the atypical patterns being displayed by the patient.

From looking at the graphs in figure 20, displaying the patterns of nonverbal movement over time, it can be seen that healthy participants in both the control and patient groups appear to nod more than gesture. They also show an approximately similar relationship between the amount of nodding and the amount of gesture⁹. Patients' behaviour, on the other hand, shows a different pattern. They appear to have a less predictable relationship between their head nodding and hand gesture. This is seen in both the speaker and primary recipient roles. The nature of this pattern was not investigated in the current study. However, previous studies have found patients to display a lack of coordination between nonverbal behaviour and speech (Condon & Ogston, 1966; Ellgring, 1986). Perhaps this pattern is indicative of a lack of coordination between patients' hand and head movement. Further research would be required to investigate this association.

7.4.2.1 Association with patients' symptoms

Patients' increased negative symptoms were associated with patients displaying less head nodding as primary recipient and their healthy participant partners gesturing more when speaking. Co-speech gestures are employed to add clarity or emphasis to the speakers' speech and gain the attention of the primary addressee if the attention or understanding of the addressee is in question or problematic (Bavelas, Kenwood, Johnson, & Phillips, 2002; Holler & Beattie, 2003). This appears to be consistent with the current finding. Considering that the patients in this sample had very limited variance on negative symptoms, these findings suggest that healthy participants who are not clinically trained and unaware of patients' diagnosis are responding to their negative symptoms even when symptoms are moderate.

⁹ This is approximated from the graph in figure 20 and was not calculated as part of the analysis.

7.4.2.2 Association between nonverbal cues and social cognition

Patients' performance on assessments of social cognition was not found to be associated with their nonverbal cues in their three-way interactions. As discussed in chapter 5 (section 5.4.4 *Patients' coordination and social cognition*), variance of patients' scores on the assessments of social cognition was quite low. Therefore, this study may have lacked the power to detect a relationship if one did exist. However, perhaps patients' use of nonverbal cues in their social encounters is not representative of their social cognitive abilities as assessed by social cognitive tests. One method that could be used to explore this link further would be to employ an experimental investigation of patients' use of nonverbal cues. A simple experiment of this kind similar to that used by Bavelas (Bavelas, Coates, & Johnson, 2000) would be to ask patients to explain a story to another individual (i.e. confederate) in enough detail so as the other individual can relay the story to another. In this scenario the confederate would vary the amount of feedback they give to the patient and the patients' production of nonverbal cues such as hand gesture and head nodding would be measured. If patients were seen to employ more techniques to derive interest, attention or feedback from their partners this would provide empirical evidence for patients' ability to interpret and respond to nonverbal social cues during their actual interactions. This could then be compared with their performance on social cognitive assessments to provide a more robust assessment of their association.

7.4.2.3 Association between nonverbal cues and social functioning

Patients with poorer social functioning were found to display more gesture in the role of primary recipient. This was seen while controlling for patients' symptoms. There are two possible explanations for this association; firstly, gesture in the role of primary recipient may be used to request the wish to take the floor (Jokinen, Nishida, & Yamamoto, 2010). Perhaps patients were attempting to take the floor using gesture but not succeeding. Thus, resulting in a greater number of hand gestures in the role of primary recipient than would be expected. As discussed in chapter 3, the timing of such behaviours is tightly coordinated with the speakers' speech, occurring at specific junctures. As we saw in chapter 4, coordination is impaired in patients' three-way interactions. Perhaps the increased gesture is due to the timing of such 'taking the floor

gestures' being incorrect due to the reduced coordination. However, in figure 20, it can be seen that the time when patients display most gesture as primary recipients is in section 8, which in chapter 4 was found to be the point in time when pairs involving a patient displayed the most coordination (chapter 4 section 4.3.6 *patterns of coordination over time*). This would challenge this theory.

A second explanation is that patients' increased gesture in the role of primary recipient may be reflective of their discomfort in the situation, resulting in more adaptor behaviours such as self touching and grooming. Patients with thought disorder have been shown in previous studies to display more of these behaviours (Fairbanks, McGuire, & Harris, 1982). However, this association was found in the absence of a link with symptoms or anxiety. Observational analysis of the precise nature and timing of these hand gestures would be required to say with certainty the nature of this association. However, it can be surmised that the increased hand gesture of primary recipient patients is anomalous in interaction and predictive of poorer social functioning.

7.4.2.4 Interactional relevance

So what are the interactional relevance of the patterns of nonverbal cues displayed by patients and their partners? Detection of nodding and gesture was conducted on motion capture data only and not observational. Therefore, although we did not measure participants' feedback specifically, we have derived an approximation of those nonverbal cues employed in this process. Patients display less nonverbal cues when speaking. Movements of the speaker are tightly coordinated with the rhythm and tempo of the speech (Woodall & Burgoon, 1981). Considering that speakers' nonverbal cues are vital in conversation management processes, the reduced frequency of patients' nonverbal cues when speaking could result in the primary recipient finding it difficult to know when to provide feedback, thus, overcompensating by producing more nonverbal feedback than would be expected. This appears to be what is happening in the current interaction. As discussed in chapter 3, the feedback process is one of the most critical features of a social interaction as it is the reciprocal exchange between interacting partners that drives the interaction forwards (Allwood, Cerrato, Jokinen, Navarretta, & Paggio, 2008; Clark & Schaefer, 1989). Patients and their partners display an imbalance

in the amount of feedback behaviours being exchanged, demonstrating a compensatory pattern rather than reciprocity. This pattern is exacerbated by patients' increased negative symptoms and results in patients being rated as having poorer rapport (chapter 5). This imbalance appears to become less prominent over the course of the interaction. Further investigation using longer interactions and would be required to determine if this pattern prevails.

7.5 Conclusion

In conclusion, the results from this chapter demonstrate that within a three-way interaction, patients display less nonverbal cues, while their healthy participant partners compensate by displaying more. Patients' increased negative symptoms intensify this pattern. However, independent of symptoms, patients who gesture more in the role of primary recipient have poorer social functioning. In line with previous chapters, the atypical patterns of nonverbal cues in patients' interactions is more pronounced at the start of the interaction and becomes less pronounced over time. Once again, this chapter demonstrates the systemic impact of the patient on the behaviour of their interacting partners and the influence of patients' symptoms on the behaviour of others.

Part V : Methodological Interlude

Chapter 8: Methodological Interlude

8.1 Introduction

This section of the thesis will be used to describe the process by which the methods for investigating nonverbal behaviour in each chapter were chosen and implemented. The primary aim of this thesis was to determine if nonverbal anomalies are present in patients' social interactions. 3-D motion capture techniques are ideal for the study of nonverbal behaviour as they allow the precise spatial and temporal movements of interacting partners to be captured as they happen (4.2.4 *3-Dimension motion capture equipment*) This provides an opportunity to measure nonverbal behaviour without the need for hand coding, reducing the possibility of human error¹⁰. Participants' two and three-way interactions were motion captured in 3-D, and simultaneously recorded using traditional 2-D audio-visual cameras. The 3-D data derived from this data was rich, as the movement of the entire upper body of each participant in each frame was recorded (see chapter 4 section 4.2.6.2 Exporting the 3-D data)

8.2 Global level analysis: Interpersonal coordination

The first objective of this thesis was to investigate interpersonal coordination between interacting partners on a group level (Chapter 4). The nature of the 3-D data enabled the precise movements of interacting partners to be compared, providing a measure of the overall coordination of nonverbal movement between interacting partners. This measure

¹⁰ Human error is not completely eliminated, as human judgement was used in calculations involved in exploiting the 3-D data such as cross-correlation analyses, deciphering head angle and defining the nature of nonverbal cues. However, it is greatly reduced.

provided a global level of analysis of patients' interactions, and enabled comparison of patient interactions with control interaction on this global level. Patients' three-way interactions were found to be distinguishable from control three-way interactions at this global level.

8.3 Interaction context: Conversation role

The second stage of the analysis moved from analysis on a global level to provide context to the interaction by determining the conversation roles (Chapter 6). This analysis met the requirements of the second objective of this thesis. This contextual level of analysis was important for a number of reasons; firstly, it provided information on the overall dynamics of participation in patients' interaction, and secondly, it provided context for further analysis of specific nonverbal behaviours. At this stage of the analysis, the identity of the speaker was needed, and as such, 3-D motion data alone was insufficient. Speaker identity was hand coded from the 2-D audio-visual recordings using the ELAN annotation tool. The coded transcript was combined with the 3-D data and the speaker(s) was identified at each frame in the 3-D data. The angle of the speakers' head was then calculated from their head movement and this identified whom they were orientated towards (i.e. the primary recipient). Patients and their interacting partners were distinguishable both from control participants and from each other in their patterns of interaction participation. This analysis set the scene for the more fine-grained analysis of specific nonverbal cues.

8.4 Individual level analysis: Nonverbal cues

The final stage of analysis investigated the specific nonverbal movements, on an individual level, within the context of their conversation roles. This analysis met the requirements of the third objective of this thesis. The head and hand movements of each individual were determined as they actively participated in the interaction (i.e. in the role of speaker or primary recipient). A further level of granularity was added to this analysis by approximating the interactionally meaningful nonverbal cues of nodding and hand gesture for each individual. As with previous analysis, the patients, their healthy participant partners and control participants could be distinguished as three separate

groups based on their production of these specific nonverbal cues within their conversation roles.

8.5 Summary

The three levels of analysis described above enabled the level of granularity with which the interaction was viewed to be built up in each stage. Beginning at the global level, which provided information on the overall coordination within the group, then focusing on the dynamics of the interaction, to provide context of conversation role within which the nonverbal behaviours occur, and finally on an individual level, to assess the use of specific nonverbal cues. At each stage, the pattern of behaviour was viewed over the course of the interaction, adding another dimension to the analysis. This enabled the patterns of adaptation and compensation between interacting partners over the course of the interaction to be revealed.

Part VI: Discussion

Chapter 9: Concluding Discussion

9.1 Introduction

The purpose of this thesis was to investigate whether anomalies arise in the nonverbal behaviour of patients with a diagnosis of schizophrenia and their healthy participant partners as they engage in social interaction, and to investigate the link between such anomalies and patients' clinical features, social cognitive abilities, social functioning and rapport.

Previous studies have assessed patients' social deficits indirectly through social cognitive assessments. Patients' social deficits lie in their social interactions with others. However, few studies directly measure the behaviour of patients and their partners during their social encounters. Those that have, focus predominantly on patients' clinical two-way interactions, which may be limited in what they can reveal.

This thesis used contemporary methodology to investigate the nonverbal behaviour of patients and their healthy participant partners, who were unaware of the patients' diagnosis, as they engage in two and three-way social interactions. Three specific nonverbal features of interaction were investigated; Firstly, on a group level assessing the **interpersonal coordination** between interacting partners; secondly, to provide context of the dynamics of the interaction, the **participation** of interacting partners within the conversation roles of speaker, primary recipient, and secondary recipient in a three-way interaction were explored, and thirdly, on an individual level, the use of **nonverbal cues** (i.e. nodding and gesture) when actively participating in the interaction (i.e. as speaker or primary recipient) were investigated. The pattern of these behaviours over time, and the association between these behaviours and patients' clinical features, social cognition, social functioning and rapport were also assessed.

Three sets of research questions were posed:

1. Interpersonal coordination

- (a) Is interpersonal coordination reduced in patients' two and three-way interactions?
- (b) What is the pattern of coordination over time?
- (c) Is interpersonal coordination associated with patients' clinical features, social cognition, social functioning and rapport?

2. Participation in three-way interaction

- (a) Is the pattern of participation (i.e. as speaker, addressed or unaddressed recipient) in patients' three-way interactions atypical?
- (b) Is this pattern associated with patients' clinical features and social functioning?

3. Nonverbal cues in the three-way interaction

- (a) Is patients' use of nonverbal cues (i.e. nodding and gesture) atypical when actively involved in the three-way interaction (i.e. as speaker or addressed recipient)?
- (b) Is this associated with their clinical features, social cognition and social functioning?
- (b) Do patients' partners adapt their nonverbal cues to compensate for the patient?
- (d) Is this associated with the patients' clinical features?

The main findings of this thesis revealed that nonverbal anomalies arise in patients' three-way interactions. Anomalous behaviours were present on every level of analysis. On a group level, patients' three-way interactions were less coordinated than controls; On a participation level, patients spoke less and spent a greater proportion of their time in the role of primary recipient; On an individual level, patients displayed less nonverbal cues and their partners displayed more. The nonverbal behaviour of the patient and their healthy participant partners was distinguishable both from control comparisons and each other. The atypical behaviours of patients and their partners became less pronounced over the course of the interaction and were associated with patients' clinical features, social functioning and others' experience of patient rapport. They were not associated with patients' performance on assessments of social cognition. The specific findings within each chapter are presented below:

9.2 Chapter summaries

The **first research question** was addressed in **chapters 4 and 5**. Within these chapters, the interpersonal coordination between interacting partners was assessed in their two and three-way interactions. The findings revealed that, patients' two-way interactions did not differ from controls in their interpersonal coordination. However, interpersonal coordination was reduced between all interacting partners in patients' three-way interactions. Patterns over time revealed that, in both two and three-way interactions, patient groups displayed the most atypical patterns at the start of the interaction, and became more similar to control group patterns over time. The adaptation needed in patients' three-way interaction was greater and the tendency towards increased coordination reverses at the end of the interaction. Associations between coordination and clinical features revealed that patients who were taking antipsychotic medication were less coordinated than those who were medication free. Patients' coordination with their interacting partners was not related to their symptoms. However, patients' increased positive symptoms were associated with reduced coordination between their healthy participant partners. Reduced interpersonal coordination between any interacting pairs in patients' interactions (i.e. healthy participant pairs or patient-healthy participant pairs) was associated with others experiencing less rapport with the patient. Patients with more negative symptoms were also rated as having poorer rapport.

The **second research question** was addressed in **chapter 6**. The amount of time participants spent within each conversation role as speaker, primary and secondary recipient in patients' three-way interaction was investigated. Patients spent less time speaking and more time in the role of primary recipient, meaning that patients were the focus of others' attention more frequently. This is seen even though healthy participants were unaware that they are interacting with a patient. Over the course of the interaction, patients spent more time speaking. Again, this pattern reversed at the end of the interaction. The time patients spend speaking was mediated by their symptoms, with patients with more negative symptoms speaking less and patients with more positive symptoms speaking more. Patients that spent more time in the role of secondary

recipient (i.e. not actively participating in the interaction) reported a better quality of life.

The **third research question** was addressed in **chapter 7**. Participants' head nodding and hand gesture when involved in the active pair of speaker and primary recipient were measured. Overall, patients displayed less nonverbal cues, while their healthy participant partners display more. Patients' increased negative symptoms exacerbated this pattern, with patients displaying less nodding in the role of primary recipient and their partners gesturing more as they spoke. As with previous chapters, the most atypical patterns were found at the start of the patients' interaction, and over time patients produced more nonverbal cues and their healthy participant partners produced less. Patients that gestured more in the role of primary recipient reported poorer real world social functioning (i.e. poorer occupational functioning, relationship status and living situation)

A striking finding in patients' three-way interaction is that, at every level of analysis, the second section of the interaction (approx 30 sec - 60sec) is the point at which the healthy participant partners display the greatest response to the presence of the patient. This is visible as a greater reduction in their coordination between all interacting partners, their increased frequency of speaking gestures, and their increased attention towards the patient. It would appear that it is within this stage of the interaction that the healthy participants are detecting and responding to something unusual in the behaviour of the patient.

9.3 Contributions to knowledge

Taken together, these findings contribute some important information to study of patients' social interactions.

1. It has demonstrated, using a contemporary methodology, that patients' three-way social interactions are discernable from interactions involving only healthy participants by their anomalous nonverbal behaviour. Specifically, the interactionally significant behaviours including; reduced interpersonal coordination between interacting partners, asymmetrical patterns of conversation role across participants (i.e. patients take the role of primary recipient more often

and speaker less often) and the atypical production of nonverbal cues that are involved in the conversation management process of feedback (i.e. nodding and gesture).

- 2 It has provided evidence that the presence of patient in a three-way social interaction changes the behaviour of the others even when they are unaware that a patient is present. Specifically, patients' partners were found to display behaviour, which compensates for the reduced nonverbal behaviour of the patient.
- 3 On a finer level of granularity, patterns of nonverbal behaviour over the course of patients' three-way interactions have been revealed. The evidence suggests that patients and their interacting partners display nonverbal adaptation over the course of the interaction from atypical towards more typical behaviour. This finding is of particular importance, as it demonstrates that patients are capable of interpreting and responding to the nonverbal cues of their interacting partners.
- 4 Evidence has been provided which suggests patients' positive and negative symptoms mediate the nonverbal behaviour of all participants involved in a patients' conversation, and are associated with others' experience of rapport with the patient.
- 5 A link has been made between patients' poorer social functioning and their increased time spent as the focus of others' attention (i.e. as primary recipient) and their increased hand movement when being attended to.

This thesis has also contributed to the methodology used to study patients' social interactions.

- 6 It has demonstrated the benefits of investigating nonverbal behaviour of patients' social interactions under the more demanding and complex conditions of three-way interaction. Firstly, this provides an opportunity to view the patterns of nonverbal behaviour of the patient when nonverbal communication is of the utmost importance and nonverbal cues are salient. Thus, if patients do have any

nonverbal anomalies, they will be more easily detected under these conditions. Secondly, it enables analysis of the impact of the patient on the interaction system by investigating the relationship between the two other partners.

- 7 It has demonstrated the feasibility and advantages of using 3-D motion capture techniques to measure the nonverbal behaviour of patients' social interactions.

9.4 How do these findings fit with previous research in the field?

This study was the first 3-D analysis of patients' social interactions. It was also the first empirical assessment of nonverbal communication in patients' three-way social interactions, with others who are unfamiliar to them and unaware of their diagnosis. As such, the methodology used in this study is not directly comparable to previous studies. However, the nonverbal behaviour indexed by this method can be compared to that derived in previous studies using alternative methods.

9.4.1 Nonverbal behaviour of patients and their partners

The majority of studies investigating nonverbal behaviour in schizophrenia have employed ethnological methods to assess the behaviour of patients during their two-way clinical interactions. The findings of such studies reveal a reduction in patients' nonverbal behaviour, with a particular reduction in pro-social expression such as, eye gaze, head and hand gestures (Brüne et al., 2008; Brüne, Abdel-Hamid, Sonntag, Lehmkämer, & Langdon, 2009; Dimic et al., 2010; Pitman, Kolb, Orr, & Singh, 1987; Troisi, Pasini, Bersani, Di Mauro, & Clani, 1991; Troisi, Pompili, Binello, & Sterpone, 2007; Troisi, Spalletta, & Pasini, 1998). The findings of the current study corroborate with these findings, demonstrating that patients display a similar reduction in their nonverbal behaviour during their three-way interactions with those who are unfamiliar to them. Specifically, approximations of patients' nodding and gesture, both in the role of speaker and primary recipient, were significantly reduced.

Few studies have investigated the impact of the patient on the behaviour of their interacting partners. Once again, these studies have predominately focused on patients' two-way clinical interactions and found patients' partners to show reduced nonverbal

behaviour similar to that of the patient (Fairbanks, McGuire, & Harris, 1982). In contrast to this, the current findings suggest that patients' partners compensate for patients' reduced pattern by increasing their nonverbal communication. The discrepancy between findings may be explained by the difference in interaction conditions. As discussed previously, interactions involving more than two people are more complex and demanding. The exchange of nonverbal cues between participants becomes more salient in these situations, as participants must monitor all partners for potentially relevant cues regarding the dynamics of the conversation and the conversational processes, i.e. interpreting when turns are starting and ending, knowing when to take the next turn of speech, when to provide feedback and the level of mutual attention and affiliation between partners (Kendon, 1970; Clarke & Schaefer, 1989; Allwood, Cerrato, Jokinen, Navarretta & Paggio, 2008). As such, the patterns displayed in patients' three-way interactions may reflect those that occur under more demanding interacting conditions, and may be masked under the less demanding conditions of two-way interaction.

A previous investigation of patients' clinic interactions found that psychiatrists direct their gaze more towards their interacting partner when interacting with a schizophrenia patient (Fairbanks, McGuire, & Harris, 1982). In line with this, the current study found patients' partners looked more towards the patient than the other healthy participant during their three-way interaction. This was seen even though patients' partners were not medically trained and unaware they were interacting with a patient. This suggests that there is something atypical in the patients' behaviour that is being detected and responded to by others.

9.4.2 Interpersonal coordination

This study conducted the first empirical assessment of interpersonal coordination in patients' interactions. The findings revealed a reduction in interpersonal coordination in patients' three-way interactions but not in their two-way interactions. A previous study using micro-analysis of whole body movements in only three patients' clinical interactions found interpersonal coordination to be reduced in this sample (Condon & Ogston, 1966). The findings of the current study may differ due to the different criteria used to define interpersonal coordination in both studies. In the current analysis,

coordination was limited to head movements, due to the pivotal role of the head in conversation management processes (McClave, 2000; Boholm & Allwood, 2010). Furthermore, coordinated movements were defined by strict criteria, with only significantly similar head movements occurring in the *same* axis of movement being defined as coordination. During interaction people coordinate with each other on a variety of levels. Perhaps the strict criteria imposed in the current study limited the detection of other forms of coordination that may be reduced in patients' two-way interactions.

9.4.3 Links with patients' clinical features & rapport

The reduced interpersonal coordination in patients' three-way interactions was found to be associated with patients' healthy participant partners experiencing less rapport with the patient. This finding agrees with previous studies providing evidence of a link between interpersonal coordination and rapport in non-clinical populations (Bernieri & Rosenthal, 1991; Chartrand & Bargh, 1999; Miles, Nind, & Macrae, 2009). Although patients' negative symptoms were mild in the current sample, patients' increased negative symptoms were also associated with others experiencing less rapport with the patient. This corroborates with previous studies finding psychiatrists to experience a greater intuitive Praecox feeling (i.e. difficulty connecting) with patients who had more affective symptoms (Grube, 2006).

In line with Brüne et al., (2008), the current study found patients' increased negative symptoms was associated with patients' reduced nonverbal behaviour. The current study also found an association between patients' symptoms and the behaviour of their interacting partners, which has not been reported in previous studies. Specifically, patients' increased positive and negative symptoms were associated with their partners' reduced interpersonal coordination and increased co-speech gestures respectively.

9.4.4 Links with social cognition & social functioning

A wealth of previous research in the field of social cognition has found that patients with a diagnosis of schizophrenia have difficulty interpreting nonverbal social cues when assessed using social cognitive tests (Penn, Sanna, & Roberts, 2007). This study has

demonstrated that patients are capable of displaying adaptation to the nonverbal behaviour of their partners over time. This provides evidence for their ability to detect and respond to nonverbal cues in actual interaction. In the current study, patients' nonverbal patterns were not associated with any measure of social cognition. This may have been due to the limited variance on these measures. However, due to the nature of social cognitive assessments, it is also likely that social cognitive abilities used to complete such tests differ from the ability to perform these skills during live interaction. Future studies would be required to provide a more robust investigation of this association.

Few studies have investigated associations between patients' nonverbal behaviour and their social functioning. Troisi et al. (2008) found patients' reduced pro-social facial expression to be associated with poorer social functioning. In the current study, patients' increased hand movements, in the role of primary recipient, was associated with their poorer social functioning. However, these findings are not necessarily contradictory as they investigate two different features of patients' nonverbal behaviour, which could occur simultaneously.

9.5 Thesis strengths and limitations

There are a number of important strengths and limitations to this study that must be considered. A number of these have already been addressed in some detail in the empirical chapters, however the key issues will be recapped here.

This study was the first to use 3-D motion capture techniques and three-way interaction paradigm to investigate nonverbal features in patients' social interactions. This methodology had the advantage of eliminating the need for observational analysis and greatly reducing the role of human judgement. Investigating patients' three-way interactions offers a number of advantages over traditional two-way studies. They enable assessment of nonverbal features when the nonverbal communication is salient, complex and demanding. Thus, nonverbal anomalies were more easily detected. Furthermore, it provides an opportunity to investigate the impact of the presence of the patient on the interaction between their interacting partners, enabling the systemic impact of the patient

on the interaction to be assessed. However, investigating only patients' three-way interactions could also be seen as a limiting feature of this study. Patients with schizophrenia have repeatedly been shown to have smaller social networks and, as a result, are likely to have less frequent social encounters with others (Macdonald, Hayes, & Baglioni, 2000). As such it is likely that they are less practiced at three-way interactions than their healthy participant partners. However, patients with schizophrenia, at least in their clinical encounters, are frequently involved in multiparty interactions such as outpatient appointments involving a psychiatrist and family member or key worker (McCabe, Skelton, Heath, Burns, & Priebe, 2002), multi-disciplinary care plan meetings, or group-based activities at day centers. Therefore, although patients may encounter these situations less than healthy participants, multi-party interactions are still relevant to patients' lives. Future studies should compare patterns of nonverbal behaviour in patients' two-way interactions using similar methodology to unpick the precise impact of increased interacting partners on the behaviour of patients and their partners.

This study had the advantage of analyzing patients' social interactions outside the clinical context with unfamiliar others. This eliminated the potentially confounding features of familiarity, prior knowledge of the diagnosis, personal history and the clinical relationship. Furthermore, it explored patients' interactions over time. This provided another dimension of analysis, and enabled patterns of adaptation to be derived in both the patients and their interacting partners.

A limitation of this study was the inability to systematically match participants in the patient and healthy participant samples on important socio-demographic features including age and gender. Although effort was made to do this, the high non-attendance rates of healthy participants reduced the pool available for recruitment, resulting in samples that differed in on these features. Gender has been shown to influence both the perception and production of nonverbal behaviour. Specifically, females demonstrate better performance on detecting and producing nonverbal cues during conversation and in social cognitive assessments (Zukerman, Lipets, Koivumaki, & Rosenthal, 1975; Hall, Roter, Blanch, & Frankel, 2009). Indeed, the Profile Of Nonverbal Sensitivity test, used in this study, requires participants to make inferences about the social cues being

produced by a female. Females have been shown to outperform males on this task, perhaps due to a bias in gender of the task (Hall, Roter, Blanch, & Frankel, 2009). Furthermore, evidence suggests that males and females display micro-level differences in head movement during conversation (Ashenfelter, Boker, Waddell, & Vitanov, 2009). On an interaction level, the gender pairing between interacting partners has also shown differences in nonverbal cue production (La France & Ickes, 1981). Although the gender differences were significant between the patient and healthy participant sample, they did not differ between patient and control interaction conditions, and gender was adjusted for in the analyses. Therefore, the impact of gender would not be expected to dominate the differences detected between patient and control conditions.

Although all participants were fluent English speakers, a small number (i.e. 15) were non-native English speakers. Gesture use has been shown to increase in speakers when they are concerned about the listeners' comprehension or communication is difficult (Bavelas, Kenwood, Johnson, & Phillips, 2002; Holler & Beattie, 2003). It is possible that non-native English speakers gestured more than their healthy participant partners. However, a greater number of non-native speakers were found in the control group and the increased gesture frequency was found in the healthy participants interacting with the patient. Therefore any influence of non-native speakers should not undermine the findings of this study.

The 3-D motion-capture equipment, although essential in the analysis of nonverbal behaviour, could also be deemed a limiting feature of this study. Despite efforts being made to allow participants time to adapt to their surroundings and the motion capture suits prior to the start of the task, it is possible that the motion capture equipment had a greater impact on the nonverbal behaviour of the patients, particularly those with more paranoid symptoms, than the healthy participants. However, patients' nonverbal behaviour in the current study was comparable to that found in patients' two-way interactions in traditional observational studies. It was the behaviour of their partners that differed. Therefore, it is more likely that this is due to the nature of the interaction. In order to unpick the precise impact of the motion capture equipment on nonverbal behaviour, future studies should compare interactions using non invasive motion capture detection methods (e.g. Motion Energy Analysis or Kinect systems) with those using

optical motion capture equipment to experimentally determine the precise impact of the equipment on participants' behaviour.

The nature of the two-way and three-way tasks differed in their content and structure. The three-way task required the group to come to a joint decision on the outcome of a moral dilemma. Perhaps the need for group convergence influenced the interpersonal coordination between interacting partners (Kendon, 1970; Schefflen, 1964; Lakin & Chartrand, 2003). Furthermore, patients with a 'jumping to conclusions bias' (Freeman, Pugh, & Garety, 2008) may have been less flexible in their decision making and come to a decision more quickly, changing the decision making dynamic within their group, thus influencing the nonverbal communication. Future studies should compare a three-way interaction using a discussion rather than a decision making task to identify if the same patterns of behaviour emerge under such circumstances.

The analysis of speech was beyond the scope of this study. Nonverbal behaviour is intrinsically interwoven with the verbal features of conversation. Patients with schizophrenia have deficits in verbal communication such as alogia, reduced prosody and intonation and incoherence. Verbal features of patients' communication have received much more attention in research (DeLisi, 2001). However, much less is known about patients' nonverbal communication. Specifically, this study measured specific nonverbal behaviours of patients and their partners in terms of their interactional relevance, thus providing the first step in linking the atypical patterns of nonverbal behaviour with potential functional outcomes of patients' interaction patterns. Many nonverbal behaviors are employed in the management of conversation such as facial expressions, posture use and speech intonation. However, head and hand movements (i.e. including approximations of nodding, eye gaze, and hand gesture) were chosen as the focus of this study due to their pervasive use in the processes of turn-taking and feedback in interaction, the lack of research on such features in schizophrenia, the reliability at which they could be measured and their increased salience in multiparty interaction specifically (Jokinen, Nishida, & Yamamoto, 2010; Loomis, Kelly, Pusch, Bailenson, & Beall, 2008).

As discussed in chapter 7, the approximations of gesture used in the current study were based on movement speed and not form. Therefore, in contrast to observational methods of gesture detection, gesture was detected as hand motion rather than the shape of the hand in space. As such, the frequency of gestures detected in the current analysis may not necessarily equate to that observed. However, the advantage of this method is that it automatically detects hand movements within the range of a gesture so atypical patterns can then be highlighted and investigated more closely using observational methods.

Ultimately, multimodal analysis of patients' verbal and nonverbal communication would provide a more comprehensive assessment of patients' three-way interactions and perhaps provide answers to some of the questions left unanswered in this thesis, such as why patients display a return to atypical behaviour at the end of their interactions after a period of adaptation.

Finally, the limited variance on patients' symptoms, social functioning and social cognitive performance may have impeded the power to detect associations between patients' nonverbal behaviour and their clinical and social features. This narrow variance may have been a selection bias due to the nature of the study. Patients who are less symptomatic may be more willing to volunteer to interact with people they have not met yet and be recorded doing so. Despite this, clear and disparate patterns of behaviour have emerged for patients' positive or negative symptoms, suggesting that patients' symptoms influence behaviour within their social interactions, even when symptoms are mild.

9.6 Implications of these findings

Difficulty directly measuring patients' social deficits is one of the biggest challenges to the development of clinical treatments specifically targeting patients' social deficits. The results of this study provide evidence of specific and measurable patterns of atypical nonverbal behaviour in patients' social interactions. Due to the exploratory nature of this study, further research would be required to investigate the specificity of these patterns to schizophrenia and refine the atypical patterns in patients' behaviour. However, in time, this line of research could provide nonverbal markers of patients' social deficits,

which could be employed in conjunction with clinical trials to directly assess patients' social features for markers of improvement. Such markers could also be employed to aid early detection of schizophrenia, which has been shown to delay the onset of schizophrenia (McGorry et al., 2002) and improve patients' symptoms and functioning (McGorry, Edwards, Mihalopoulos, Harrigan, & et al., 1996).

Recent research suggests that interpersonal coordination may be a marker of therapeutic relationship in psychotherapy sessions (Ramseyer & Tschacher, 2011). In schizophrenia, the therapeutic relationship between patients and their clinicians is thought to play a direct role in the patients' outcome (McCabe & Priebe, 2004). Recent advances in motion capture techniques mean that motion can now be captured without the need for markers, a lab, or expensive equipment, using such tools as the Kinect Motion Sensor system (Berger et al., 2011). These systems would make it possible to detect motion and derive a measure of interpersonal coordination between patients and their clinician during a clinical consultation. Thus, providing a behavioural measure of therapeutic relationship directly from the interaction and reducing the need for subjective based measures.

In the current study, patients' coordination was not impaired in their two-way interactions but was impaired in their three-way interactions. This would suggest that for patients with schizophrenia, their optimal interaction conditions would be a one-to-one scenario. Particularly, if the duration of the interaction is quite short and the time to adapt to the behaviour of their partners is not available. This finding has implications for clinical interactions where therapeutic relationships are important and time is limited. These studies would suggest that the presence of a third individual in patients' clinical consultations could be detrimental to the interaction, resulting in poorer coordination, which could be detrimental to the therapeutic relationship.

9.7 Future directions

9.7.1 Employing the current data

The 3-D motion capture data collected for this study was vast. This thesis has only analysed the head and hand movement data, however all upper-body movement was

recorded. As discussed in chapters 4 and 5 the measure of interpersonal coordination used within this study was very conservative. However, patient groups were distinguishable using this conservative measure, suggesting that interpersonal coordination is an avenue warranting further research within this patient group. Future research within this area could begin by investigating coordination between partners' head movements in any direction and move on to coordination between head and hand movements. This would provide a more encompassing measure of interpersonal coordination within patients' interactions. Time series analysis of this data could also be employed to take a closer look at the changes in nonverbal patterns over time. Specifically, it would be of interest to focus on the second section of the three-way interactions in a bid to identify what is atypical in the patients' behaviour within this section that the healthy participants are detecting and responding to.

Although the current study did not analyse speech, it has been recorded. Multimodal analysis of patients' interactions, investigating both nonverbal and verbal features together, could further enlighten the picture of patients' social deficits. This could inform the change in pattern in patients' behaviour towards the end of the interaction. Future studies could also delve deeper into the patterns of nonverbal nodding and gesture in patients' social interactions, using a combination of 3-D motion and observation analyses. The atypical relationship between patients' nodding and speech revealed in chapter 7, but not analysed within the study, could potentially be due to a lack of coordination between patients' speech and their nonverbal movement. Multimodal analysis of the timing and form of nonverbal cues in patients' interactions would provide a much deeper understanding of these patterns.

In the current study, only the head angle of the speaker was detected. As such, it was impossible to tell if the primary listener shared the speakers' gaze. Future analysis could assess the head angle of all three individuals. This could be used to investigate patients' level of mutual gaze. Furthermore, it could be used to investigate the formation of parties within the three-way interaction (i.e. if healthy participants are both directing their attention towards the patient).

9.7.2 Collection of new data

Future studies would benefit from recruiting a larger sample of patients who are medication free, such as patients attending first episode clinics to unpick the precise influence of medication effects on the interpersonal coordination and hand and head movement of patients. The current study found that the nonverbal behaviour of patients and their partners was mediated by patients' positive and negative symptoms. These symptoms influence the behaviour of patients and their partners in disparate ways. Separate samples of patients with positive and negative symptom profiles could also be compared to build a clearer picture of the specific nonverbal patterns within these patient profiles. As mentioned previously, future studies would also benefit from recruiting patients that are more diverse in terms of symptoms, social functioning, and social cognitive abilities in order to increase the power to assess relationships between variables. Using new, marker less motion detection could be beneficial in the recruitment of patients that are more unwell and may not be willing to participate in the lab, but may take part in a more familiar environment. In such cases, patients' interactions with their family members or clinicians could be recorded. This would provide the benefit of determining the influence of familiarity and the clinical relationship on the nonverbal features of the interaction. Future investigations should also investigate patients' interactions over longer periods of time to investigate how patients' pattern of adaptation unfolds over time. This could be achieved through analysis of one off interactions or numerous interactions over a period of time such as a clinical consultation.

The findings of this thesis demonstrate that patients are capable of displaying adaptation over time, thus they must be interpreting and responding to the cues of their interacting partners. An experimental investigation of patients' ability to respond to social cues could be conducted similar to that used by Bavelas et al. (2000). In such an experiment, patients would relay a story to a confederate and the amount of feedback they receive from the confederate would be manipulated (i.e. no feedback/ normal feedback patterns) and the patients' production of nonverbal cues such as hand gesture would be measured. If patients were seen to employ more techniques to derive interest, attention from their partners this would provide empirical evidence for patients' social cognitive during interaction. This could then be compared with patients' performance on social cognitive

assessments to provide a more robust investigation of the link between these two measures of social cognition.

9.8 Concluding remarks

The content of this thesis has added to the current knowledge of social deficits in schizophrenia. It has demonstrated the benefits of investigating patients' social deficits under the more demanding conditions of three-way interaction. Doing so, it has revealed that patients' interactions do display atypical patterns of nonverbal behaviour, which is mediated by patients' symptoms and predicts patients' social functioning and others' experience of rapport with the patient. It has also revealed that patients are capable of displaying nonverbal adaptation over time, suggesting that, although there may be some difficulty initially, over time, patients' interactions become less problematic. This exploratory study has laid the foundations for investigating patients' social deficits from a new interaction focused perspective.

REFERENCES

- Addington, J., & Addington, D. (2008). Social and cognitive functioning in psychosis. *Schizophrenia Research*, 99(1-3), 176-181.
- Addington, J., Penn, D., Woods, S. W., Addington, D., & Perkins, D. O. (2008). Social functioning in individuals at clinical high risk for psychosis. *Schizophrenia Research*, 99(1-3), 119-124.
- Addington, J., Saeedi, H., & Addington, D. (2006). Facial affect recognition: A mediator between cognitive and social functioning in psychosis? *Schizophrenia Research*, 85(1-3), 142-150.
- Allardyce, J., & van Os, J. (2008). Long-term course and outcome of schizophrenia. *Psychiatry*, 7(10), 440-442.
- Allwood, J., Cerrato, L., Jokinen, K., Navarretta, C., & Paggio, P. (2008). The MUMIN coding scheme for the annotation of feedback, turn management and sequencing phenomena. *Language Resources and Evaluation*, 41(3-4), 273-287.
- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental health disorders* (Vol. 4th ed).
- Appelo, M. T., Woonings, F. M. J., van Nieuwenhuizen, C. J., Emmelkamp, P. M. G., Slooff, C. J., & Louwerens, J. W. (1992). Specific skills and social competence in schizophrenia. *Acta Psychiatrica Scandinavica*, 85(6), 419-422.
- Argyle, M., & Cook, M. (1976). *Gaze and mutual gaze*: Oxford, England: Cambridge U Press.
- Ashenfelter, K. T., Boker, S. M., Waddell, J. R., & Vitanov, N. (2009). Spatiotemporal Symmetry and Multifractal Structure of Head Movements During Dyadic Conversation. *Journal of Experimental Psychology: Human Perception and Performance*, 35(4), 1072-1091.
- Atkins, M., Burgess, A., Bottomley, C., & Riccio, M. (1997). Chlorpromazine equivalents: a consensus of opinion for both clinical and research applications. *Psychiatric Bulletin*, 21, 224-226.
- Bailenson, J., & Yee, N. (2005). Digital Chameleons: Automatic Assimilation of Nonverbal Gestures in Immersive Virtual Environments. *Psychological Science*, 16(10), 814-819.
- Ballon, J. S., Kaur, T., Marks, I. I., & Cadenhead, K. S. (2007). Social functioning in young people at risk for schizophrenia. *Psychiatry Research*, 151(1-2), 29-35.
- Barbui, C., Saraceno, B., Liberati, A., & Garattini, S. (1996). Low-dose neuroleptic therapy and relapse in schizophrenia: meta-analysis of randomized controlled trials. *European Psychiatry*, 11(6), 306-313.
- Baron-Cohen, S. (1989). The Autistic Child's Theory of Mind: a Case of Specific Developmental Delay. *Journal of Child Psychology and Psychiatry*, 30(2), 285-297.
- Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a theory of mind? *Cognition*, 21(1), 37-46.
- Battersby, S. A. (2011). *Moving Together: The organisation of non-verbal cues during multiparty conversation*. . PhD, Queen Mary University of London, London.
- Battersby, S. A., & Healey, P. G. T. (2010, 11th - 14th August). *Head and Hand Movements in the Orchestration of Dialogue*. Paper presented at the Thirty-Second Annual Conference of the Cognitive Science Society, Portland, Oregon.
- Bavelas, J. B., & Chovil, N. (2000). Visible Acts of Meaning: An Integrated Message

- Model of Language in Face-to-Face Dialogue. *Journal of Language and Social Psychology*, 19(2), 163-194.
- Bavelas, J. B., Coates, L., & Johnson, T. (2000). Listeners as co-narrators. *Journal of Personality and Social Psychology*, 79(6), 941-952.
- Bavelas, J. B., Coates, L., & Johnson, T. (2002). Listener Responses as a Collaborative Process: The Role of Gaze. *Journal of Communication*, 52(3), 566-580.
- Bavelas, J. B., & Gerwing, J. (2007). Conversational hand gestures and facial displays in face-to-face dialogue. In K. Fiedler (Ed.), *Social Communication*. New York: Psychology Press.
- Bavelas, J. B., Kenwood, C., Johnson, T., & Phillips, B. (2002). An experimental study of when and how speakers use gestures to communicate. *Gesture*, 2, 1-17.
- Beattie, G., & Aboudan, R. (1994). Gestures, pauses and speech: An experimental investigation of the effects of changing social context on their precise temporal relationships. *Semiotica*, 99(3-4), 239-272.
- Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An Inventory for Measuring Clinical Anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology*, 56, 893-897.
- Bellack, A. S., Gold, J. M., & Buchanan, R. W. (1999). Cognitive Rehabilitation for Schizophrenia. *Schizophrenia Bulletin*, 25(2), 257-274.
- Berger, K., Ruhl, K., Schroeder, Y., Bruemmer, C., Scholz, A., & Magnor, M. (2011). *Markerless Motion Capture using multiple Color-Depth Sensors* Paper presented at the In Proceedings of Vision, Modeling and Visualization (VMV).
- Bernieri, F., & Rosenthal, R. (1991). Interpersonal coordination: Behavior matching and interactional synchrony. In R. S. Feldman & B. Rimé (Eds.), *Fundamentals of nonverbal behavior* (pp. 401-432): Cambridge University Press.
- Bernieri, F. J. (1988). Coordinated movement and rapport in teacher-student interactions. *Journal of Nonverbal Behavior*, 12(2), 120-138.
- Bernieri, F. J., Reznick, J. S., & Rosenthal, R. (1988). Synchrony, pseudosynchrony, and dissynchrony: Measuring the entrainment process in mother-infant interactions. *Journal of Personality and Social Psychology*, 54(2), 243-253.
- Bigelow, N. O., Paradiso, S., Adolphs, R., Moser, D. J., Arndt, S., Heberlein, A., Andreasen, N. C. (2006). Perception of socially relevant stimuli in schizophrenia. *Schizophrenia Research*, 83(2-3), 257-267.
- Binz, B., & Brune, M. (2010). Pragmatic Language Abilities, Mentalising Skills an Executive Functioning in Schizophrenia Spectrum Disorders. *Clinical Neuropsychiatry*, 7(3), 91-99.
- Blairy, S., Herrera, P., & Hess, U. (1999). Mimicry and the Judgment of Emotional Facial Expressions. *Journal of Nonverbal Behavior*, 23(1), 5-41.
- Boholm, M., & Allwood, J. (2010, May 18th 2010). *Repeated head movements, their function and relation to speech*. Paper presented at the In the Proceedings of the seventh international conference on Language Resources and Evaluation (LREC) Malta.
- Boker, S. M., Minquan, X., Rotondo, J. L., & King, K. (2002). Windowed Cross-Correlation and Peak Picking for the Analysis of Variability in the Association Between Behavioral Time Series. *Psychological methods*, 7 (1), 338-355.
- Bora, E., Eryavuz, A., Kayahan, B., Sungu, G., & Veznedaroglu, B. (2006). Social functioning, theory of mind and neurocognition in outpatients with schizophrenia; mental state decoding may be a better predictor of social functioning than mental state reasoning. *Psychiatry Research*, 145(2-3), 95-103.

- Braff, D. L. (1993). Information Processing and Attention Dysfunctions in Schizophrenia. *Schizophrenia Bulletin*, 19(2), 233-259.
- Brekke, J., Nakagami, E., Kee, K., & Green, M. (2005). Cross-ethnic differences in perception of emotion in schizophrenia. *Schizophrenia Research*, 77(2-3), 289-298.
- Brekke, J. S., Hoe, M., Long, J., & Green, M. F. (2007). How Neurocognition and Social Cognition Influence Functional Change During Community-Based Psychosocial Rehabilitation for Individuals with Schizophrenia. *Schizophrenia Bulletin*, 33(5), 1247-1256.
- Brothers, L. (1990). The neural basis of primate social communication. *Motivation and Emotion*, 14(2), 81-91.
- Brüne, Sonntag, C., Abdel-Hamid, M., Lehmkämpfer, C., Juckel, G., & Troisi, A. (2008). Nonverbal behaviour during standardized interviews in patients with schizophrenia spectrum disorders. *Journal of Nervous and Mental Disease*, 196(4), 282-288.
- Brune, M. (2003). Theory of mind and the role of IQ in chronic disorganized schizophrenia. *Schizophrenia Research*, 60(1), 57-64.
- Brune, M. (2005). "Theory of Mind" in Schizophrenia: A Review of the Literature. *Schizophrenia Bulletin*, 31(1), 21-42.
- Brüne, M., Abdel-Hamid, M., Sonntag, C., Lehmkämpfer, C., & Langdon, R. (2009). Linking social cognition with social interaction: Non-verbal expressivity, social competence and "mentalising" in patients with schizophrenia spectrum disorders. *Behavioral and Brain Functions*, 5(1), 6.
- Burgess, P., & Shallice, T. (1997). *The Hayling and Brixton Tests*. Bury St. Edmunds, UK: Thames Valley Test Company.
- Burgoon, J. K., Buller, D. B., & Woodall, W. G. (1989). *Nonverbal Communication: The Unspoken Dialogue*. New York: Harper & Row Publishers Inc.
- Burgoon, J. K., Stern, L. A., & Dillman, L. (1995). *Interpersonal Adaptation: Dyadic Interaction Patterns*. Cambridge University Press.
- Cappella, J., & Panalp, A. (1981). Talk and silence sequences in informal conversations: Interspeaker influence. *Human Communication Research*, 7, 117-132.
- Cappella, J. N. (1996). Dynamic coordination of vocal and kinesic behavior in dyadic interaction: Methods, problems, and interpersonal outcomes. In J. H. Watt & C. A. VanLear (Eds.), *Dynamic patterns in communication processes*. (pp. 353-386): Thousand Oaks, CA, US: Sage Publications, Inc.
- Caspi, A., Reichenberg, A., Weiser, M., Rabinowitz, J., Shmushkevich, M., Lubin, G., Davidson, M. (2007). Premorbid behavioral and intellectual functioning in schizophrenia patients with poor response to treatment with antipsychotic drugs. *Schizophrenia Research*, 94(1-3), 45-49.
- Cassell, J., Nakano, Y. I., Bickmore, T. W., Sidner, C. L., & Rich, C. (2001). *Non-verbal cues for discourse structure*. Paper presented at the Proceedings of the 39th Annual Meeting on Association for Computational Linguistics, Toulouse, France.
- Castle, D. J., & Murray, R. M. (1993). The Epidemiology of Late-Onset Schizophrenia *Schizophrenia Bulletin*, 19(4), 691-700.
- Cerrato, L., & Svanfeldt, G. (2005). *A method for the detection of communicative head nods in expressive speech*. Paper presented at the Proceedings from The Second Nordic Conference on Multi-modal Communication, Gothenburg University, Sweden.

- Chartrand, T. L., & Bargh, J. A. (1999). The Chameleon Effect: The Perception-Behaviour Link and Social Interaction. *Journal of Personality and Social Psychology*, 76(6), 893-910.
- Chartrand, T. L., Maddux, W. W., & Lakin, J. L. (2005). Beyond the Perception-Behaviour Link: The Ubiquitous Utility and Motivational Moderators of Nonconscious Mimicry. In R. R. Hassin, S. J. Uleman & J. A. Bargh (Eds.), *The new unconscious*: Oxford University Press.
- Christensen, A. J., Dornink, R., Ehlers, S. L., & Schultz, S. K. (1999). Social Environment and Logevity in Schizophrenia. *Psychosomatic Medicine*, 61, 141-145.
- Clark, H. H., & Schaefer, E. F. (1989). Contributing to discourse. *Cognitive Science*, 13(2), 259-294.
- Condon, W. S., & Ogston, W. D. (1966). Sound film analysis of normal and pathological behaviour patterns. *Journal of Nervous and Mental Disease*, 113(4), 338-347.
- Corcoran, R., & Frith, C. D. (2003). Autobiographical memory and theory of mind: evidence of a relationship in schizophrenia. *Psychological Medicine*, 33(5), 897-905.
- Corcoran, R., Mercer, G., & Frith, C. D. (1995). Schizophrenia, symptomatology and social inference: Investigating 'theory of mind' in people with schizophrenia. *Schizophrenia Research*, 17(1), 5-13.
- Corrigan, P. W. (1997). The social perceptual deficits of schizophrenia. *Psychiatry: Interpersonal and Biological Processes*, 60(4), 309-326.
- Corrigan, P. W., & Addis, I. B. (1995). The effects of cognitive complexity on a social sequencing task in schizophrenia. *Schizophrenia Research*, 16(2), 137-144.
- Corrigan, P. W., & Green, M. F. (1993). Schizophrenic Patients' Sensitivity to Social Cues: The Role of Abstraction. *American Journal of Psychiatry*, 150(4), 589-594.
- Corrigan, P. W., & Nelson, D. R. (1998). Factors that affect social cue recognition in schizophrenia. *Psychiatry Research*, 78(3), 189-196.
- Corrigan, P. W., & Phelan, S. M. (2004). Social Support and Recovery in People with Serious Mental Illnesses. *Community Mental Health Journal*, 40(6), 513-523.
- Corrigan, P. W., & Toomey, R. (1995). Interpersonal problem solving and information processing in schizophrenia. *Schizophrenia Bulletin*, 21(3), 395-403.
- Couture, S. M., Penn, D. L., & Roberts, D. L. (2006). The Functional Significance of Social Cognition in Schizophrenia: A Review. *Schizophrenia Bulletin*, 32(Supplement 1), S44-S63.
- Crasborn, O., & Sloetjes, H. (2008). *Enhanced ELAN functionality for sign language corpora*. Paper presented at the 3rd Workshop on the Representation and Processing of Sign Languages: Construction and Exploitation of Sign Language Corpora.
- Dabbs, J. M., Jr. (1969). Similarity of gestures and interpersonal influence. *Proceedings of the Annual Convention of the American Psychological Association*, 4(Pt. 1), 337-338.
- Daivdson, M., Reichenberg, A., Rabinowitz, J., Weiser, M., Kaplan, Z., & Mark, M. (1999). Behavioral and Intellectual Markers for Schizophrenia in Apparently Healthy Male Adolescents. *The American Journal of Psychiatry*, 156, 1328-1335.
- Davison, P. S., Frith, C. D., Harrison-Read, P. E., & Johnstone, E. C. (1996). Facial and

- other non-verbal communicative behaviour in chronic schizophrenia. *Psychological Medicine*, 26, 707-713.
- DeLisi, L. E. (2001). Speech disorder in schizophrenia: Review of the literature and exploration of its relation to the uniquely human capacity for language. *Schizophrenia Bulletin*, 27(3), 481-496.
- Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious Facial Reactions to Emotional Facial Expressions. *Psychological Science*, 11(1), 86-89.
- Dimic, S., Wildgrube, C., McCabe, R., Hassan, I., Barnes, T. R. E., & Priebe, S. (2010). Non-Verbal Behaviour of Patients with Schizophrenia in Medical Consultations: A Comparison with Depressed Patients and Association with Symptom Levels. *Psychopathology*, 43(4), 216-222.
- Dittmann, A. T., & Llewellyn, L. G. (1969). Body movement and speech rhythm in social conversation. *Journal of Personality and Social Psychology*, 11(2), 98-106.
- Donahoe, C. P., Carter, M. J., Bloem, W. D., Hirsch, G. L., & et. al. (1990). Assessment of interpersonal problem-solving skills. *Psychiatry: Interpersonal and Biological Processes*, 53(4), 329-339.
- Drolet, A. L., & Morris, M. W. (2000). Rapport in conflict resolution: Accounting for how nonverbal exchange fosters coordination on mutually beneficial settlements to mixed motive conflicts. *Journal of Experimental Social Psychology*, 36, 26-50.
- Duncan, S., & Niederehe, G. (1974). On signalling that it's your turn to speak. *Journal of Experimental Social Psychology*, 10(3), 234-247.
- Dunn, M., O'Driscoll, C., Dayson, D., Wills, W., & Leff, J. (1990). The TAPS Project. 4: An observational study of the social life of long- stay patients *British Journal of Psychiatry*, 157, 842-848.
- Ekman, P., & Friesen, W. V. (1976). Measuring facial movement. *Journal of Nonverbal Behavior*, 1(1), 56-75.
- Ekman, P., & Friesen, W. V. (1978). *Facial Action Coding System (FACS): A Technique for Measurement of Facial Action*. Palo Alto: CA: Consulting Psychologists Press.
- Ellgring, H. (1986). Nonverbal Expression of Psychological States in Psychiatric Patients *European Archives of Psychiatry and Clinical Neuroscience*, 236, 31-34.
- Erickson, D. H., Beiser, M., & Iacono, W. G. (1998). Social Support Predicts 5-Year Outcome in First-Episode Schizophrenia. *Journal of Abnormal Psychology*, 107(4), 681-685.
- Erickson, D. H., Beiser, M., Iacono, W. G., Fleming, J. A., & Lin, T. Y. (1989). The role of social relationships in the course of first episode schizophrenia and affective psychosis. *American Journal of Psychiatry*, 146, 1456-1461.
- Eshghi, A. (2009). *Uncommon ground: The distribution of dialogue contexts*. PhD, Queen Mary University of London, London.
- Fairbanks, L. A., McGuire, M. T., & Harris, C. J. (1982). Nonverbal Interaction of Patients and Therapists During Psychiatric Interviews. *Journal of Abnormal Psychology*, 91(2), 109-119.
- Freeman, D., Pugh, K., & Garety, P. (2008). Jumping to conclusions and paranoid ideation in the general population. *Schizophrenia Research*, 102(1-3), 254-260.
- Frith, C. D., & Corcoran, R. (1996). Exploring 'theory of mind' in people with schizophrenia. *Psychological Medicine*, 26(03), 521-530.

- Gaebel, W., & Wolwer, W. (2004). Facial expressivity in the course of schizophrenia and depression. *European Archives of Psychiatry and Clinical Neurosciences*, 254(5), 335-342. doi: 10.1007/s00406-004-0510-5
- Gerwing, J., & Bavelas, J. (2004). Linguistic influences on gestures form. *Gesture*, 4(2), 157-195. doi: 10.1075/gest.4.2.04ger
- Goffman, E. (1981). *Forms of Talk*. Philadelphia, Pennsylvania: University of Pennsylvania Press.
- Goodwin, C. (1979a). The Interactive Construction of a Sentence in Natural Conversation. In G. Psathas (Ed.), *Everyday Language: Studies in Ethnomethodology*: Irvington Publishers.
- Goodwin, C. (1979b). The Interactive Construction of a Sentence in Natural Conversation. In G. Psathas (Ed.), *Everyday Language: Studies in Ethnomethodology* (pp. 97-121). New York: Irvington Publishers.
- Goodwin, C. (1980). Restarts, Pauses, and the Achievement of a State of Mutual Gaze at Turn-Beginning. *Sociological Inquiry*, 50(3-4), 272-302.
- Grammer, K., Kruck, K. B., & Magnusson, M. S. (1998). The Courtship Dance: Patterns of Nonverbal Synchronization in Opposite-Sex Encounters. *Journal of Nonverbal Behavior*, 22(1), 3-29.
- Grant, E. C. (1968). An ethological description of non-verbal behaviour during interviews. *British Journal of Medical Psychology*, 41, 177-183
- Green, M. F. (1996). What are the functional consequences of neurocognitive deficits in schizophrenia. *American Journal of Psychiatry*, 153(3), 321-330.
- Green, M. F., Kern, R. S., Braff, D. L., & Mintz, J. (2000). Neurocognitive Deficits and Functional Outcome in Schizophrenia: Are We Measuring the 'Right Stuff'? *Schizophrenia Bulletin*, 26(1), 119-136.
- Gresty, M., Leech, J., Sanders, M., & Eggars, H. (1976). A study of head and eye movement in spasmus nutans. *British Journal of Ophthalmology*, 60(9), 652-654.
- Grube, M. (2006). Towards an Empirically Based Validation of Intuitive Diagnostic: Rümke's 'Praecox Feeling' across the Schizophrenia Spectrum. *Psychopathology*, 39(5), 209-217.
- Guy, W. (1976). *ECDEU Assessment Manual for Psychopharmacology: Publication ADM 76-338*. Washington, DC. : US Department of health, Education and Welfare.
- Hadar, U., Steiner, T. J., Grant, E. C., & Clifford Rose, F. (1983). Head Movement Correlates of Juncture and Stress at Sentence Level. *Language and Speech*, 26(2), 117-129.
- Hafner, H., Maurer, K., Löffler, W., an der Heiden, W., Munk-Jürgensen, P., Hambrecht, M., & Riecher-Rössler, A. (1998). The ABC schizophrenia study: a preliminary overview of the results. *Social Psychiatry and Psychiatric Epidemiology*, 33, 380-386.
- Hall, J., Roter, D., Blanch, D., & Frankel, R. (2009). Nonverbal Sensitivity in Medical Students: Implications for Clinical Interactions. *Journal of General Internal Medicine*, 24(11), 1217-1222.
- Herold, R., Tényi, T., Lénárd, K., & Trixler, M. (2002). Theory of mind deficit in people with schizophrenia during remission. *Psychological Medicine: A Journal of Research in Psychiatry and the Allied Sciences*, 32(6), 1125-1129.
- Holler, J., & Beattie, G. (2003). Pragmatic aspects of representational gestures: Do speakers use them to clarify verbal ambiguity for the listener? *Gesture*, 3(2), 127-154.

- Holler, J., & Wilkin, K. (2011). Co-Speech Gesture Mimicry in the Process of Collaborative Referring During Face-to-Face Dialogue. *Journal of Nonverbal Behavior*, 35(2), 133-153.
- Ihnen, G. H., Penn, D. L., Corrigan, P. W., & Martin, J. (1998). Social perception and social skill in schizophrenia. *Psychiatry Research*, 80(3), 275-286.
- Issartel, J., Marin, L., & Cadopi, M. (2007). Unintended interpersonal co-ordination: Can we march to the beat of our own drum? *Neuroscience Letters*, 411(3), 174-179.
- Jablensky, A. (2000). Epidemiology of schizophrenia: the global burden of disease and disability. *European Archives of Psychiatry and Clinical Neuroscience*, 250(6), 274-285.
- Jaeger, J., & Douglas, E. (1992). Neuropsychiatric rehabilitation for persistent mental illness. *Psychiatric Quarterly*, 63(1), 71-94.
- Jobe, T. H., & Harrow, M. (2010). Schizophrenia Course, Long-Term Outcome, Recovery and Prognosis. *Current Directions in Psychological Science*, 19(4), 220-225.
- Johnstone, E. C., MacMillan, J. F., Frith, C. D., Benn, D. K., & Crow, T. J. (1990). Further investigation of the predictors of outcome following first schizophrenic episodes. *British Journal of Psychiatry*, 157, 182-189.
- Jokinen, K., Nishida, M., & Yamamoto, S. (2009). *Eye-gaze experiments for conversation monitoring*. Paper presented at the Proceedings of the 3rd International Universal Communication Symposium, Tokyo, Japan.
- Jokinen, K., Nishida, M., & Yamamoto, S. (2010). *On eye gaze and turn-taking*. Paper presented at the International Conference on Intelligent User Interfaces, Hong Kong.
- Kay, S., Friszbein, A., & Opler, L. A. (1987). The Positive and Negative Syndrome Scale for Schizophrenia. *Schizophrenia Bulletin*, 13, 261-276.
- Kee, K. S., Horan, W. P., Mintz, J., & Green, M. F. (2004). Do the siblings of schizophrenia patients demonstrate affect perception deficits? *Schizophrenia Research*, 67(1), 87-94.
- Kelso, J. S., Holt, K. G., Rubin, P., & Kugler, P. N. (1981). Patterns of human interlimb coordination emerge from the properties of non-linear, limit cycle oscillatory processes: Theory and data. *Journal of Motor Behavior*, 13(4), 226-261.
- Kendon, A. (1967). Some functions of gaze direction in social interaction. *Acta Psychol.*, 26, 22-63.
- Kendon, A. (1970). Movement coordination in social interaction: Some examples described. *Acta Psychologica*, 32, 101-125.
- Kendon, A. (1976). The F-Formation System: Spatial-Orientational Relations in Face to Face Interaction. *Man-Environment Systems*, 6, 291-296.
- Kendon, A. (1996). *Conducting Interaction: Patterns of Behaviour in Focused Encounters*: Cambridge University Press.
- Kim, J., Doop, M. L., Blake, R., & Park, S. (2005). Impaired visual recognition of biological motion in schizophrenia. *Schizophrenia Research*, 77(2-3), 299-307.
- Kohler, C. G., Turner, T. H., Bilker, W. B., Brensinger, C. M., Siegel, S. J., Kanes, S. J., Gur, R. C. (2003). Facial Emotion Recognition in Schizophrenia: Intensity Effects and Error Pattern. *American Journal of Psychiatry*, 160(10), 1768-1774.
- Kohler, S., van der Werf, M., Hart, B., Morrison, G., McCreddie, R., Kirkpatrick, B., . . . Allardyce, J. (2009). Evidence that better outcome of psychosis in women is reversed with increasing age of onset: A population-based 5-year follow-up

- study. *Schizophrenia Research*, 113(2-3), 226-232.
- Koiso, H., Horiuchi, Y., Tutiya, S., Ichikawa, A., & Den, Y. (1998). An Analysis of Turn-Taking and Backchannels Based on Prosodic and Syntactic Features in Japanese Map Task Dialogs. *Language and Speech*, 41(3-4), 295-321.
- Krause, R., Steimer, E., Sanger-Alt, C., & Wagner, G. (1989). Facial Expression of Schizophrenic Patients and their Interaction Partners. *Psychiatry*, 52, 1-12.
- Kupper, Z., Ramseyer, F., Hoffmann, H., Kalbermatten, S., & Tschacher, W. (2010). Video-based quantification of body movement during social interaction indicates the severity of negative symptoms in patients with schizophrenia. *Schizophrenia Research*, 121(1-3), 90-100.
- Kurtz, M., Wexler, B., Fujimoto, M., Shagan, D., & Seltzer, J. (2008). Symptoms versus neurocognition as predictors of change in life skills in schizophrenia after outpatient rehabilitation. *Schizophrenia Research*, 102(1-3), 303-311.
- LaFrance, M. (1985). Postural Mirroring and Intergroup Relations. *Personality and Social Psychology Bulletin*, 11(2), 207-217.
- LaFrance, M., & Broadbent, M. (1976). Group Rapport: Posture Sharing as a Nonverbal Indicator. *Group & Organization Management*, 1(3), 328-333.
- LaFrance, M., & Ickes, W. (1981). Posture mirroring and interactional involvement: Sex and sex typing effects. *Journal of Nonverbal Behavior*, 5(3), 139-154.
- Lakin, J. L., & Chartrand, T. L. (2003). Using Nonconscious Behavioral Mimicry to Create Affiliation and Rapport. *Psychological Science*, 14(4), 334-339.
- Lakin, J. L., Chartrand, T. L., & Arkin, R. M. (2008). I Am Too Just Like You. *Psychological Science*, 19(8), 816-822.
- Lehman, A. F., & Steinwachs, D. M. (1998). At Issue: Translating Research Into Practice: The Schizophrenia Patient Outcomes Research Team (PORT) Treatment Recommendations. *Schizophrenia Bulletin*, 24(1), 1-10.
- Leucht, S., Pitschel-Walz, G., Abraham, D., & Kissling, W. (1999). Efficacy and extrapyramidal side-effects of the new antipsychotics olanzapine, quetiapine, risperidone, and sertindole compared to conventional antipsychotics and placebo. A meta-analysis of randomized controlled trials. *Schizophrenia Research*, 35(1), 51-68.
- Leung, A., & Chue, P. (2000). Sex differences in schizophrenia, a review of the literature. *Acta Psychiatrica Scandinavica*, 101(401), 3-38.
- Lewis, S. F., & Garver, D. L. (1995). Treatment and Diagnostic Subtype in Facial Affect Recognition in Schizophrenia. *Journal of Psychiatric Research*, 29(1), 5-11.
- Loomis, J. M., Kelly, J. W., Pusch, M., Bailenson, J. N., & Beall, A. C. (2008). Psychophysics of perceiving eye-gaze and head direction with peripheral vision: Implications for the dynamics of eye-gaze behavior. *Perception*, 37(9), 1443-1457.
- Macdonald, E. M., Hayes, R. L., & Baglioni, A. J. (2000). The quantity and quality of the social networks of young people with early psychosis compared with closely matched controls. *Schizophrenia Research*, 46, 25-30.
- Mangalore, R., & Knapp, M. (2007). Cost of Schizophrenia in England. *The Journal of Mental Health Policy and Economics*, 10(1), 23-41.
- Marder, S. R. (2008). Neurocognition as a Treatment Target in Schizophrenia. *Focus*, 6(2), 180-183.
- Marder, S. R., & Fenton, W. (2004). Measurement and Treatment Research to Improve Cognition in Schizophrenia: NIMH MATRICS initiative to support the development of agents for improving cognition in schizophrenia. *Schizophrenia*

- Research*, 72(1), 5-9.
- Marwaha, S., & Johnson, S. (2004). Schizophrenia and Employment. *Social Psychiatry and Psychiatric Epidemiology*, 39, 337-349.
- Maxmen, A. (2010). Antipsychotic deflates the brain. *Nature news*, 6th June.
- Mazza, M., De Risio, A., Surian, L., Roncone, R., & Casacchia, M. (2001). Selective impairments of theory of mind in people with schizophrenia. *Schizophrenia Research*, 47(2-3), 299-308.
- McCabe, R., Leudar, I., & Antaki, C. (2004). Do people with schizophrenia display theory of mind deficits in clinical interactions? *Psychological Medicine*, 34, 401-412.
- McCabe, R., & Priebe, S. (2004). The Therapeutic Relationship in the Treatment of Severe Mental Illness: A Review of Methods and Findings. *International Journal of Social Psychiatry*, 50(2), 115-128.
- McCabe, R., Skelton, J., Heath, C., Burns, T., & Priebe, S. (2002). Engagement of patients with psychosis in the consultation: conversation analytic study. Commentary: Understanding conversation. *British Medical Journal*, 325(7373), 1148-1151.
- McClave, E. Z. (2000). Linguistic functions of head movements in the context of speech. *Journal of Pragmatics*, 32, 855-878.
- McCleary, L. (2002). Using Multiple Imputation for Analysis of Incomplete Data in Clinical Research. *Nursing Research*, 51(5), 339-343.
- McDowall, J. J. (1978). Interactional synchrony: A reappraisal. *Journal of Personality and Social Psychology*, 36(9), 963-975.
- McGorry, P. D., Edwards, J., Mihalopoulos, C., Harrigan, S. M., & et al. (1996). EPPIC: An evolving system of early detection and optimal management. *Schizophrenia Bulletin*, 22(2), 305-326.
- McGorry, P. D., Yung, A. R., Phillips, L. J., Yuen, H. P., Francey, S., Cosgrave, E. M., Jackson, H. (2002). Randomized Controlled Trial of Interventions Designed to Reduce the Risk of Progression to First-Episode Psychosis in a Clinical Sample With Subthreshold Symptoms. *Arch Gen Psychiatry*, 59(10), 921-928.
- McGrath, J., Saha, S., Chant, D., & Welham, J. (2008). Schizophrenia: A Concise Overview of Incidence, Prevalence, and Mortality. *Epidemiologic Reviews*, 30(1), 67-76.
- McNeill, D. (1992). *Hand and Mind: What gestures reveal about thought*. Chicago: University of Chicago Press.
- Meltzer, H. Y., Thompson, P. A., Lee, M. A., & Ranjan, R. (1996). Neuropsychologic deficits in schizophrenia: Relation to social function and effect of antipsychotic drug treatment. *Neuropsychopharmacology*, 14(3, Supplement 1), 27S-33S.
- Michael, B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (2002). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Patient Edition. (SCID-I/P)*. New York: New York State Psychiatric Institute Biometrics Research.
- Miles, L. K., Nind, L. K., & Macrae, C. N. (2009). The rhythm of rapport: Interpersonal synchrony and social perception. *Journal of Experimental Social Psychology*, 45(3), 585-589.
- Monte, R. C., Goulding, S. M., & Compton, M. T. (2008). Premorbid functioning of patients with first-episode nonaffective psychosis: A comparison of deterioration in academic and social performance, and clinical correlates of Premorbid Adjustment Scale scores. *Schizophrenia Research*, 104(1-3), 206-213.

- Moritz, S., & Woodward, T. S. (2005). Jumping to conclusions in delusional and non-delusional schizophrenic patients. *British Journal of Clinical Psychology, 44*(2), 193-207.
- Mueser, K. T., Bellack, A. S., Douglas, M. S., & Wade, J. H. (1991). Prediction of social skill acquisition in schizophrenic and major affective disorder patients from memory and symptomatology. *Psychiatry Research, 37*(3), 281-296.
- Mueser, K. T., Doonan, R., Penn, D. L., Blanchard, J. J., Bellack, A. S., Nishith, P., & DeLeon, J. (1996). Emotion recognition and social competence in chronic schizophrenia. *Journal of Abnormal Psychology, 105*(2), 271-275.
- Nelson, A. L., Combs, D. R., Penn, D. L., & Basso, M. R. (2007). Subtypes of social perception deficits in schizophrenia. *Schizophrenia Research, 94*(1-3), 139-147.
- Neumann, R., & Strack, F. (2000). "Mood contagion": The automatic transfer of mood between persons. *Journal of Personality and Social Psychology, 79*(2), 211-223.
- O'Brien, M., Gordon, J., Bearden, C., Lopez, S., Kopelowicz, A., & Cannon, T. (2006). Positive family environment predicts improvement in symptoms and social functioning among adolescents at imminent risk for onset of psychosis. *Schizophrenia Research, 81*(2-3), 269-275.
- Penn, D. L., Sanna, L. J., & Roberts, D. L. (2007). Social Cognition in Schizophrenia: An Overview. *Schizophrenia Bulletin, 34*(3), 408-411.
- Phillips, M. L., Drevets, W. C., Rauch, S. L., & Lane, R. (2003). Neurobiology of emotion perception II: implications for major psychiatric disorders. *Biological Psychiatry, 54*(5), 515-528.
- Phillips, M. L., Williams, L., Senior, C., Bullmore, E. T., Brammer, M. J., Andrew, C., David, A. S. (1999). A differential neural response to threatening and non-threatening negative facial expressions in paranoid and non-paranoid schizophrenics. *Psychiatry Research: Neuroimaging, 92*, 11-31.
- Pickup, G. J., & Frith, C. D. (2001). Theory of mind impairments in schizophrenia: symptomatology, severity and specificity. *Psychological Medicine, 31*, 207-220.
- Pinkham, A. E., & Penn, D. L. (2006). Neurocognitive and social cognitive predictors of interpersonal skill in schizophrenia. *Psychiatry Research, 143*(2-3), 167-178.
- Pitman, R. K., Kolb, B., Orr, S. P., & Singh, M. M. (1987). Ethological study of facial behavior in nonparanoid and paranoid schizophrenic patients. *American Journal of Psychiatry, 144*, 99-102.
- Poole, J. H., Tobias, F. C., & Vinogradov, S. (2000). The functional relevance of affect recognition errors in schizophrenia. *Journal of the International Neuropsychological Society, 6*(6), 649-658.
- Priebe, S., Huxley, P., Knight, S., & Evans, S. (1999). Application and results of the Manchester Short Assessment of Quality of Life (MANSA). *International Journal of Social Psychiatry, 45*(1), 7-12.
- Priebe, S., Watzke, S., Hansson, L., & Burns, T. (2008). Objective social outcomes index (SIX): a method to summarise objective indicators of social outcomes in mental health care. *Acta Psychiatrica Scandinavica, 118*(1), 57-63.
- Ramseyer, F., & Tschacher, W. (2008). Synchrony in Dyadic Psychotherapy Sessions. In S. Vrobel, O. E. Rössler & T. Marks-Tarlow (Eds.), *Simultaneity: temporal structures and observer perspectives*: World Scientific.
- Ramseyer, F., & Tschacher, W. (2010). Nonverbal Synchrony or Random Coincidence? How to Tell the Difference Development of Multimodal Interfaces: Active Listening and Synchrony. In A. Esposito, N. Campbell, C. Vogel, A. Hussain &

- A. Nijholt (Eds.), (Vol. 5967, pp. 182-196): Springer Berlin / Heidelberg.
- Ramseyer, F., & Tschacher, W. (2011). Nonverbal Synchrony in Psychotherapy: Coordinated body movement reflects relationship quality and outcome. *Journal of Consulting and Clinical Psychology, 79*(3), 284-295.
- Raven, J. C., & Court, J. H. (1992). *Manual for Raven's progressive matrices and vocabulary scales*. Oxford, UK:: Oxford University Press.
- Revheim, N., & Medalia, A. (2004). The Independent Living Scales as a Measure of Functional Outcome for Schizophrenia. *Psychiatr Serv, 55*(9), 1052-1054.
- Richardson, M. J., Marsh, K. L., Isenhower, R. W., Goodman, J. R. L., & Schmidt, R. C. (2007). Rocking together: Dynamics of intentional and unintentional interpersonal coordination. *Human Movement Science, 26*(6), 867-891.
- Richardson, M. J., Marsh, K. L., & Schmidt, R. C. (2005). Effects of Visual and Verbal Interaction on Unintentional Interpersonal Coordination. *Journal of Experimental Psychology: Human Perception and Performance, 31*(1), 62-79.
- Roncione, R., Falloon, I. R. H., Mazza, M., De Risio, A., Pollice, R., Necozone, S., Casacchia, M. (2002). Is Theory of Mind in Schizophrenia More Strongly Associated with Clinical and Social Functioning than with Neurocognitive Deficits? *Psychopathology, 35*(5), 280-288.
- Rosenfeld, H. M. (1977). Conversational control functions of nonverbal behavior. In W. A. Siegman & S. Feldstein (Eds.), *Nonverbal Behavior and Communication*, (pp. 291-328). Hillsdale, US, : Lawrence Erlbaum, .
- Rosenthal, R., Hall, J. A., DiMatteo, M. R., Rogers, P. L., & Archer, D. (1979). *Sensitivity to nonverbal communication. The PONS test*. Baltimore: John Hopkins University Press.
- Rumke, H. C. (1990). The nuclear symptom of schizophrenia and the praecoxfeeling. *History of Psychiatry, 1*, 331-341.
- Rutter, D. R., & Stephenson, G. M. (1977). The role of visual communication in synchronising conversation. *European Journal of Social Psychology, 7*(1), 29-37.
- San, L., Ciudad, A., Alvarez, E., Bobes, J., & Gilaberte, I. (2007). Symptomatic remission and social/vocational functioning in outpatients with schizophrenia: Prevalence and associations in a cross-sectional study. *European Psychiatry, 22*(8), 490-498.
- Sato, W., & Yoshikawa, S. (2007). Spontaneous facial mimicry in response to dynamic facial expressions. *Cognition, 104*(1), 1-18.
- Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological methods, 7*(2), 147-177.
- Schefflen, A. E. (1964). The significance of posture in communication systems. *Psychiatry: Journal for the Study of Interpersonal Processes, 27*(4), 316-331.
- Schefflen, A. E. (1973). *Communicational structure: Analysis of a psychotherapy transaction*: Oxford, England: Indiana U. Press.
- Schefflen, A. E. (1981). *Levels of Schizophrenia*. New York: Brunner / Mazel
- Schenkel, L. S., Spaulding, W. D., & Silverstein, S. M. (2005). Poor premorbid social functioning and theory of mind deficit in schizophrenia: evidence of reduced context processing? *Journal of Psychiatric Research, 39*(5), 499-508.
- Schmidt, R. C., Bienvenu, M., Fitzpatrick, P. A., & Amazeen, P. G. (1998). A comparison of intra- and interpersonal interlimb coordination: Coordination breakdowns and coupling strength. *Journal of Experimental Psychology: Human Perception and Performance, 24*(3), 884-900.

- Schmidt, R. C., Carello, C., & Turvey, M. T. (1990). Phase transitions and critical fluctuations in the visual coordination of rhythmic movements between people. *Journal of Experimental Psychology: Human Perception and Performance*, *16*(2), 227-247.
- Schmidt, R. C., & O'Brien, B. (1997). Evaluating the dynamics of unintended interpersonal coordination. *Ecological Psychology*, *9*(3), 189-206.
- Schneider, F., Gurb, R. C., Gurb, R. E., & Shtasel, D. L. (1995). Emotional processing in schizophrenia: Neurobehavioral probes in relation to psychopathology. *Schizophrenia Research*, *17*(1), 67-75.
- Schwartz, M. A., & Wiggins, O. P. (1987). Typifications: The first step for clinical diagnosis in psychiatry. *Journal of Nervous and Mental Disease*, *175*(2), 65-77.
- Sergi, M., Rassovsky, Y., Widmark, C., Reist, C., Erhart, S., Braff, D., Green, M. (2007). Social cognition in schizophrenia: Relationships with neurocognition and negative symptoms. *Schizophrenia Research*, *90*(1-3), 316-324.
- Sergi, M. J., & Green, M. F. (2003). Social perception and early visual processing in schizophrenia. *Schizophrenia Research*, *59*(2-3), 233-241.
- Social Exclusion Unit. (2004). *Mental Health and Social Exclusion*. London.
- Sprong, M., Schothorst, P., Vos, E., Hox, J., & van Engeland, H. (2007). Theory of mind in schizophrenia: meta-analysis. *The British journal of psychiatry : the journal of mental science*, *191*, 5-13.
- Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *British Medical Journal*, *338*, b2393.
- Strauss, G. P., Jetha, S. S., Ross, S. A., Duke, L. A., & Allen, D. N. (2010). Impaired facial affect labeling and discrimination in patients with deficit syndrome schizophrenia. *Schizophrenia Research*, *118*(1-3), 146-153.
- Tandon, R., Keshavan, M. S., & Nasrallah, H. A. (2008). Schizophrenia, "Just the Facts" What we know in 2008. 2. Epidemiology and etiology. *Schizophrenia Research*, *102*(1-3), 1-18.
- Tarbox, S. I., & Pogue-Geile, M., F. (2008). Development of Social Functioning in Preschizophrenia Children and Adolescents: A Systematic Review. *Schizophrenia Bulletin*, *34*(4), 561-583.
- Tickle-Degnen, L., & Rosenthal, R. (1990). The nature of rapport and its nonverbal correlates. *Psychological Inquiry*, *1*(4), 285-293.
- Toomey, R., Schuldberg, D., Corrigan, P., & Green, M. F. (2002). Nonverbal social perception and symptomatology in schizophrenia. *Schizophrenia Research*, *53*, 83-91.
- Toomey, R., Wallace, C. J., Corrigan, P. W., Schuldberg, D., & Green, M. F. (1997). Social processing correlates of nonverbal social perception in schizophrenia. *Psychiatry: Interpersonal and Biological Processes*, *60*(4), 292-300.
- Troisi, A. (1999). Ethological research in clinical psychiatry: the study of nonverbal behavior during interviews. *Neuroscience & Biobehavioral Reviews*, *23*(7), 905-913.
- Troisi, A., Pasini, A., Bersani, M., Di Mauro, M., & Clani, N. (1991). Negative symptoms and visual behavior in DSM-III-R prognostic subtypes of schizophreniform disorder. *Acta Psychiatrica Scandinavica*, *83*(5), 391-394.
- Troisi, A., Pompili, E., Binello, L., & Sterpone, A. (2007). Facial expressivity during the clinical interview as a predictor functional disability in schizophrenia. A pilot study. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*,

- 31(2), 475-481.
- Troisi, A., Spalletta, A., & Pasini, A. (1998). Non-verbal behaviour deficits in schizophrenia: an ethological study of drug-free patients. *Acta Psychiatrica Scandinavica*, 97(2), 109-115.
- Turetsky, B. I., Kohler, C. G., Indersmitten, T., Bhati, M. T., Charbonnier, D., & Gur, R. C. (2007). Facial emotion recognition in schizophrenia: When and why does it go awry? *Schizophrenia Research*, 94(1-3), 253-263.
- Ustun, T. B., Rehm, J., Chatterji, S., Saxena, S., Trotter, R., Room, R., & Bickenbach, J. (1999). Multiple-informant ranking of the disabling effects of different health conditions in 14 countries. *The Lancet*, 354(9173), 111-115.
- van Baaren, R. B., Holland, R. W., Steenaert, B., & van Knippenberg, A. (2003). Mimicry for money: Behavioral consequences of imitation. *Journal of Experimental Social Psychology*, 39(4), 393-398.
- Vauth, R., Rusch, N., Wirtz, M., & Corrigan, P. W. (2004). Does social cognition influence the relation between neurocognitive deficits and vocational functioning in schizophrenia? *Psychiatry Research*, 128(2), 155-165.
- Velligan, D. I., Bow-Thomas, C. C., Mahurin, R. K., Miller, A. L., & Halgunseth, L. C. (2000). Do Specific Neurocognitive Deficits Predict Specific Domains of Community Function in Schizophrenia? *The Journal of Nervous and Mental Disease*, 188(8), 518-524.
- Vertegaal, R., Weevers, I., Sohn, C., & Cheung, C. (2003). *GAZE-2: conveying eye contact in group video conferencing using eye-controlled camera direction*. Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems, Ft. Lauderdale, Florida, USA.
- von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *British Medical Journal*, 335(806-808).
- Watzlawick, P., Bavelas, J. B., & Jackson, D. D. (1967). *Pragmatics of human communication: A study of interactional patterns, pathologies, and paradoxes*. New York: Norton.
- Wayman, J. C. (2003). *Multiple imputation for missing data: what is it and how can I use it?* Paper presented at the The Annual Meeting of the American Educational Research Association, , Chicago, IL.
- Wiemann, J. M., & Knapp, M. L. (1975). Turn-taking in Conversations. *Journal of Communication*, 25(2), 75-92.
- Woodall, W. G., & Burgoon, J. K. (1981). The effects of nonverbal synchrony on message comprehension and persuasiveness. *Journal of Nonverbal Behavior*, 5(4), 207-223.
- Woods, S. W. (2003). Chlorpromazine equivalent doses for the newer atypical antipsychotics. *Journal of Clinical Psychology*, 64(6), 663-667.
- World Health Organization. (2004). *The global burden of disease: 2004 Update*. WHO Library.
- Yung, A. R., & McGorry, P. D. (1996). The Prodromal Phase of First-Episode Psychosis: Past and Current Conceptualizations. *Schizophrenia Bulletin*, 22(2), 353-370.
- Zivotofsky, A., & Hausdorff, J. (2007). The sensory feedback mechanisms enabling couples to walk synchronously: An initial investigation. *Journal of NeuroEngineering and Rehabilitation*, 4(1), 28.

Zuckerman, M., Lipets, M. S., Koivumaki, J. H., & Rosenthal, R. (1975). Encoding and decoding nonverbal cues of emotion. *Journal of Personality and Social Psychology*, 32(6), 1068-1076.

Appendix A.

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT: PATIENT INFORMATION SHEET & CONSENT FORM

Two and Three Party Interactions

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

The purpose of the study is to investigate communication in two-party and three-party interactions.

Why have I been chosen?

We are asking you to take part as you have experienced mental health problems and are currently being treated by a psychiatrist.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be asked to sign a consent form. You will be given this information sheet and a copy of the consent form to keep. If you decide to take part, you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

What will happen to me if I take part?

If you decide to participate, you will have an interview with the researcher to discuss your symptoms. You will then be asked to come along on a separate day to take part in two discussions with one or two other people. These discussions will be audio-visually

recorded and will be motion captured in 3D. For this you will be asked to wear a baseball cap and a jumper, which have reflective markers on them while taking part in the discussions. After the discussions you will be asked to complete some questionnaires. Altogether we expect the questionnaires and the discussions to take approximately 2 hours. You will be given £20 for your participation.

What are the possible disadvantages of taking part?

If you decide to take part, your treatment will not be affected in any way and you will not be exposed to any hazards. If you find the presence of a video camera uncomfortable or find the interview stressful, you may stop at any time and withdraw from the study.

What are the possible benefits of taking part?

As we are not changing your treatment in any way, there is no direct clinical benefit from taking part. However, you may value the opportunity to make a valued contribution to improving mental health services. We hope that the information from this study may ultimately improve the quality of treatment in mental health services.

Will my taking part in the study be kept confidential?

We will inform your GP that you have agreed to participate in the study. However, all information which is collected about you during the course of the research will be kept strictly confidential. Any information about you which leaves the Trust will have your name and personal details removed so that you cannot be recognised from it. Your consultant or GP will not have access to this information and it will be treated as highly confidential. The only people who will see information about your part in the study are the research team. The video tapes will be destroyed once the study is completed.

What if something goes wrong?

We believe that this study is safe and do not expect you to suffer any harm or injury because of your participation in the study. However, *Queen Mary, University of London*, has agreed that if your health does suffer as a result of your being in the study then you will be compensated. In such a situation, you will not have to prove that the harm or injury, which affects you is anyone's fault. If you are not happy with any proposed compensation, you may have to pursue your claim through legal action.

What will happen to the results of the research study?

The results of the study will be published in scientific journals and presented at scientific conferences. Some of the video-recorded consultations may be used for training purposes. If you agree to the use of your video for training or other presentation

purposes, faces will be blanked out and voices will be distorted so that individuals cannot be recognised.

What happens if you would like more information about the study?

You will always be able to contact an investigator:

Name: Mary Lavelle

Address: Academic Unit, Newham centre for mental health, E13 8SP

Tel Number: 020 75406755

CONSENT FORM

Title of Project: Two and Three Party interactions

Name of Researcher: Mary Lavelle

Please initial box

- 1. I confirm that I have read and understand the information sheet dated
(version) for the above study and have had the opportunity to ask questions.
- 2. I understand that my participation is voluntary and that I am free to withdraw at any
time, without giving any reason, without my medical care or legal rights being effected.
- 3. I understand that sections of my medical notes may be looked at by responsible
individuals from East London and the City Mental Health Trust or from regulatory
authorities where it is relevant to my taking part in research. I give permission for these
individuals to have access to my records.
- 4. I agree to my interview and my participation in the tasks being video-taped.
- 5. I agree to take part in the above study.

Do you agree to the video, and /or transcript of your participation, being used for
training and/ or publication purposes?

Please initial the box/ boxes you wish to consent to.

	Transcription	Audio-Visual Recording
Training purposes		
Publications		

_____	_____	_____
Name of Patient (print)	Date	Signature

_____	_____	_____
Name of Researcher	Date	Signature

Appendix B.

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT: PARTICIPANT INFORMATION SHEET & CONSENT FORM

Two and Three Party Interactions

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

The purpose of the study is to investigate communication in two-party and three-party interactions.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be asked to sign a consent form. You will be given this information sheet and a copy of the consent form to keep. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

If you decide to participate, you will be joined by one or two other participants and given topics to chat about for approx 20 minutes. All tasks will be audio-visually recorded and motion captured in 3-D and will be carried out in a human interaction lab. You will be asked to wear a baseball cap and a jumper, which have reflective markers on them while taking part in the tasks. After the chat you will be asked to complete a series of questionnaires altogether we expect it to take approximately 2 hours in total. You will be given £15 for your time.

What are the possible disadvantages of taking part?

If you decide to take part, you will not be exposed to any hazards. If you find the presence of a video camera uncomfortable or find the interview stressful, you may stop at any time and withdraw from the study.

What are the possible benefits of taking part?

There is no direct benefit from taking part. We hope that the information from this study may ultimately improve the quality of research on communication.

Will my taking part in the study be kept confidential?

All information collected about you during the course of the research will be kept strictly confidential. With your consent recordings may be used for training and publications.

What if something goes wrong?

We believe that this study is basically safe and do not expect you to suffer any harm or injury because of your participation in the study. However, *Queen Mary, University of London*, has agreed that if your health does suffer as a result of your being in the study then you will be compensated. In such a situation, you will not have to prove that the harm or injury, which affects you is anyone's fault. If you are not happy with any proposed compensation, you may have to pursue your claim through legal action.

What will happen to the results of the research study?

The results of the study will be made available on websites accessible to the general public (www.dcs.qmul.ac.uk). They will also be published in scientific journals and presented at scientific conferences. Some of the video-recorded consultations may be used for training purposes.

What happens if you would like more information about the study?

You will always be able to contact an investigator:

Name: Mary Lavelle

Address: Room 413, Department of Computer Science, Queen Mary University of London

Tel Number: 020 75406755

CONSENT FORM

Title of Project: Two and Three Party Interactions

Name of Researcher: Mary Lavelle

Please initial box

1. I confirm that I have read and understand the information sheet dated
(version) for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any
time, without giving any reason, without my medical care or legal rights being affected.

3. I agree to my interview and my participation in the tasks being video-taped.

4. I agree to take part in the above study.

Do you agree to the use of your video, and /or transcript of your participation, being
used for training and/ or publication purposes?

Please initial the box/ boxes you wish to consent to.

Do you agree to the video, and /or transcript of your participation, being used for
training and/ or publication purposes?

Please initial the box/ boxes you wish to consent to.

	Transcription	Audio-Visual Recording
Training purposes		
Publications		

Name of Patient (print)

Date

Signature

Name of Researcher

Date

Signature

Appendix C.

Missing data

Table C1. Number and % of missing values for each variable (chapter 5)

Variable	Number Missing	% Missing
Anxiety (BAI)	36	30.58
Executive functioning: Brixton (BSAT)	22	19.01
Executive functioning: Hayling (HSCT)	25	21.49
IQ: Spatial (SPMR)	35	29.75
IQ: Verbal (MHV)	34	28.93
Abstract social cue recognition (SCRT)	24	20.66
Concrete social cue recognition (SCRT)	24	20.66
Sensitivity to nonverbal cues (PONS)	21	18.18
Theory of Mind: Hinting Task	28	23.97
Theory of Mind: 1 st Order (SA Task)	26	22.31
Theory of Mind: 2 nd Order (ICV task)	26	22.31
Quality of Life (MANSA)	18	15.70
Social Functioning (SIX)	11	9.92
Rapport	34	28.93

Key:

BAI=Beck Anxiety Inventory; BAST=Brixton Spatial Anticipation Task; HSCT=Hayling Sentence Completion Task; SPMR=Standard Progressive Matrices Raven's; MHV=Mill Hill Vocabulary Test; SCRT_Abtract= Social Cue Recognition Test Abstract cue detection score; SCRT_Concrete= Social Cue Recognition Test Concrete cue detection score; PONS=Profile of Nonverbal Sensitivity test; ToM= Theory of Mind; MANSA=Manchester short assessment of subjective social outcomes; SIX=Objective social outcomes index.

Table C2. Assessment scores by participant type prior to imputation of missing data

Variables	Patients M (SD)	Healthy Participants M (SD)	t	df	p
Anxiety (BAI)	35.86 (13.84)	28.81 (8.77)	-2.46	81	<.01**
Executive functioning: Brixton (BSAT)	2.89 (2.11)	5.04 (1.94)	4.23	95	<.01**
Executive functioning: Hayling (HSCT)	3.83 (1.85)	5.00 (1.60)	2.74	92	<.01**
IQ: Spatial (SPMR)	42.25 (12.93)	45.64 (9.31)	1.10	82	.27
IQ: Verbal (MHV)	17.00 (5.47)	17.89 (5.39)	0.55	83	.58
Abstract social cue recognition (SCRT)	1.23 (0.50)	1.16 (0.17)	-1.03	92	.30
Concrete social cue recognition (SCRT)	1.12 (0.31)	1.18 (0.21)	0.62	96	.54
Sensitivity to nonverbal cues (PONS)	26.22 (3.08)	28.15 (2.59)	2.75	95	<.01**
Theory of Mind: Hinting Task	18.22 (2.24)	19.90 (0.44)	6.05	89	<.01**
Theory of Mind: 1 st Order (SA Task)	1.00 (0.34)	1.00 (0.0)	0.00	91	1.00
Theory of Mind: 2 nd Order (ICV task)	0.78 (0.55)	0.95 (0.22)	2.06	91	.04*
Quality of Life (MANSA)	3.75 (0.59)	4.05 (0.66)	1.86	99	.06□
Social Functioning (SIX)	3.40 (1.23)	4.58 (1.15)	4.08	106	<.01**
Rapport	6.21 (2.31)	6.85 (1.27)	1.42	83	.16

Key: BAI=Beck Anxiety Inventory; BAST=Brixton Spatial Anticipation Task; HSCT=Hayling Sentence Completion Task; SPMR=Standard Progressive Matrices Raven's; MHV=Mill Hill Vocabulary Test; SCRT_Abstract= Social Cue Recognition Test Abstract cue detection score; SCRT_Concrete= Social Cue Recognition Test Concrete cue detection score; PONS=Profile of Nonverbal Sensitivity test; ToM= Theory of Mind; MANSA=Manchester short assessment of subjective social outcomes; SIX=Objective social outcomes index.

Significance levels **= p<.01 *= p<.05 □=p<.10