Humour experience and schizophrenia: phenomenology and neurobiology

Dr Daniel Tsoi
Consultant Psychiatrist & Clinical Teaching Fellow Nottinghamshire Healthcare NHS Trust
Honorary Senior Clinical Lecturer
University of Sheffield
Outline

• Humour – importance and theory
• Social Cognition
• Humour experience in schizophrenia
• Neural basis of humour recognition deficit in schizophrenia
Importance of humour

• Important source of pleasure to human life
  (Brownell et al. 1983)

• Also important in social functioning and facilitates social contact
  (Fraley & Aron 2004)
Dissecting humour

• Cognitive element
  – “getting the joke” (recognition)

• Affective element
  – “enjoying the joke” (appreciation)

Suls (1972), Gardner et al. (1975)
Dissecting Humour - incongruity
What is social cognition?

• Array of abilities that involve cognitive capability applied to social situations
• Origin from social psychology in the late 1960s and early 1970s
• Focus on how people process information within social context
• Understand and interpret the self, others, and the self-in-relation-to-others within social environment.
Social Stimulus

Emotion Perception (EP)
Social Perception (SP)

Conclusion: “My co-worker is angry.”

Attribution: “My co-worker is angry with me.”

Behavior: Acting unfriendly toward co-worker

Attributional Style (AS)

Deficits in Theory of Mind (ToM) may prevent the client from countering AS biases

Why is social cognition important?

• Human beings are social creatures
• Some psychiatric disorders have social cognition impairment as a clinical feature
Autism

• “mind-blindness”

<table>
<thead>
<tr>
<th></th>
<th>Correct Answer to belief question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinically unimpaired children (n=27)</td>
<td>85%</td>
</tr>
<tr>
<td>Down syndrome (n=14)</td>
<td>86%</td>
</tr>
<tr>
<td>Autism (n=20)</td>
<td>20%</td>
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</table>

Schizophrenia

- blunted **Affect** (diminished emotional response to stimuli)
- loosening of **Associations** (disordered pattern of thought)
- **Ambivalence** (an apparent inability to make decisions)
- **Autism** (a loss of awareness of external events, and a preoccupation with the self and one's own thoughts).
Social cognition in schizophrenia

• Impairment in at least 4 different domains:
  – Emotion Perception
  – Social Perception
  – Theory of Mind
  – Attributional style

• A clear and consistent relationships between aspects of functional outcome and social cognition in schizophrenia (Shannon et al. 2006)
Humour Experience in schizophrenia
Humour Recognition in schizophrenia

• Corcoran et al. (1997), Marjoram et al. (2005)
• Visual jokes – cartoon (behavioural/slapstick vs “mentalising”)
• Individuals with schizophrenia performed worse in appreciation of jokes (both types), especially “mentalising” jokes
Humour recognition in schizophrenia

- Static cartoon pictures as stimuli
- Relationships between humour appreciation and symptoms are inconclusive
- Cognitive and neuropsychological basis related to humour appreciation deficit was unknown
Sheffield Humour Study - Participants

• English first language and no major neurological disorders
• 30 patients with DSM-IV diagnosis of schizophrenia
• 30 matched (age, ethnicity, NART IQ, gender) Controls: No history of psychiatric illness

Tsoi et al. (2008) Psychological Medicine
### Sheffield Humour Study - Participants

<table>
<thead>
<tr>
<th></th>
<th>Patients (n=30)</th>
<th>Controls (n=30)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean BDI score</td>
<td>14.2</td>
<td>4.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean WCST perseverative error score</td>
<td>21.0</td>
<td>10.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Task

• Identify humorous moments in 4 different comedy film clips (slapstick)
• All clips are slapstick in nature without sound
• A non-humorous video recognition task as control task
Results – Humour Recognition

Humour recognition between patient and control group

Mean Sensitivity of Humour Recognition ($d''$)

- Patient
  - $0.4$ (SE: $0.01$)

- Control
  - $0.8$ (SE: $0.01$)

($p=0.01$)
Results – Humour Recognition

Baseline non-humorous recognition between patient and control group

Mean Sensitivity of non-humorous baseline recognition task

(p<0.001)
Results – Humour Recognition

• Analysis of Co-variance (ANCOVA) to adjust the difference in performance of the baseline non-humorous recognition task and BDI score
  – $F(1, 56) = 4.70, p = 0.03$

• Analysis of Co-variance (ANCOVA) to control for the WCST perseverative error score
  – $F(1, 57) = 1.64, p = 0.21$
## Correlation of Humour Recognition and other measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pearson correlation (n=30)</th>
<th>p-value after controlling for the non-humorous task</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAPS delusion score</td>
<td>r = -0.39</td>
<td>p=0.03</td>
</tr>
<tr>
<td>SANS avolition &amp; apathy score</td>
<td>r = -0.38</td>
<td>p=0.04</td>
</tr>
<tr>
<td>CDSS (depressive symptoms)</td>
<td>r = -0.41</td>
<td>p=0.03</td>
</tr>
<tr>
<td>Life Skills Profile (psychosocial functioning)</td>
<td>r = -0.40</td>
<td>p=0.03</td>
</tr>
<tr>
<td>WCST perservative error score</td>
<td>r = -0.40</td>
<td>p=0.03</td>
</tr>
</tbody>
</table>
Summary

• Patients with schizophrenia had reduced ability in detecting humour
• Cannot be explained by baseline recognition impairment
• Humour recognition deficit associates with:
  – poor psychosocial functioning
  – Delusion
  – Avolition & apathy
  – depressive symptoms
  – frontal executive dysfunction
Neural basis of humour recognition deficit in schizophrenia
Humour recognition – neural correlates

• A number of neuroimaging studies have revealed certain brain areas are involved in humour recognition (Goel et al 2001, Mobbs et al 2003, Moran et al 2004, Wild et al 2006, Bartolo et al 2006)
  – Inferior frontal gyrus (IFG)
  – Temporo-occipital junction (TOJ)
  – Limbic system

• No neuroimaging study so far to investigate among patients with schizophrenia
"Mentalising" – Theory of Mind

• Understanding other people’s intentions
• Individuals with schizophrenia have difficulty to understand other people’s intentions (Sarfati 1997, Brunet 2003)
• Medial prefrontal cortex may be involved in this deficit in schizophrenia (Brunet 2003)
Interaction between humour recognition and understanding others’ intention

• Patients with schizophrenia find it particularly difficult to understand humour which involves understanding other people’s intentions (Corcoran 1997, Marjoram 2006)

• Prefrontal cortex has been shown to play a role in integration emotion and cognition, in particular lateral prefrontal cortex (Gray 2002)
Research Questions

• Comparing individuals with schizophrenia to healthy controls, is there any difference in
  – brain activations for humour detection?
  – brain activations for understanding others’ intentions?
  – brain activations for the interaction of these two processes?
Hypotheses

• Inferior frontal gyrus (IFG), temporo-occipital junction (TOJ) and limbic systems would be under-activated in schizophrenia, compared to that of healthy controls, in humour recognition
• Medial prefrontal cortex (MPFC) would be under-activated in schizophrenia, compared to that of health controls, in understanding of others’ intentions
• Lateral prefrontal cortex (LPFC) would be under-activated in schizophrenia, compared to that of healthy controls for the interaction of the two processes
### Subjects

<table>
<thead>
<tr>
<th></th>
<th>Schizophrenia patients (n=20)</th>
<th>Healthy controls (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All right-handed</td>
<td>Schizophrenia patients (n=20)</td>
<td>Healthy controls (n=23)</td>
</tr>
<tr>
<td>Mean Age (years)</td>
<td>36.3 (10.1)</td>
<td>38.8 (10.0)</td>
</tr>
<tr>
<td>Sex (Male/female)</td>
<td>19/1</td>
<td>22/1</td>
</tr>
<tr>
<td>Mean years of education</td>
<td>13.3 (2.1)</td>
<td>14.0 (2.4)</td>
</tr>
<tr>
<td>Mean Intelligence (NART IQ)</td>
<td>102 (14)</td>
<td>107 (13)</td>
</tr>
</tbody>
</table>
Procedure

• Subjects viewed video clips within the MRI scanner
• They were asked to indicate whether each clip was funny or not by pressing one of the two buttons in an intra-scanner button box
• After scanning, subjects watched all the video clip again to indicate whether they noticed any character in the clip show an intention to perform an action or to do anything on others.
Functional MRI (fMRI) paradigm

- All colour 15-sec silent video clips
- All clips validated in pilot study with healthy volunteers
- 2 functional runs – total 18 clips for each condition (sequence of video clips are pseudo-randomised and counterbalanced)
- 3T MRI with echo-planar technique (TR=3 sec; 288 time points for each run)
Functional MRI (fMRI) paradigm

• 2x2 factorial design with 4 conditions
  – Humorous and requires understanding of intention
  – Non-humorous but requires understanding of intention
  – Humorous and does not require understanding of intention
  – Non-humorous and does not require understanding of intention
Results - Behavioural

$P = 0.04$ (adjusted for depression score)

Tsoi et al. (in preparation)
Results – Humour Recognition

• [Controls – Patients]: dorsal tegmentum near peri-aqueductal grey matter (PAG) in midbrain

\[ p < 0.001 \text{ uncorrected, extent threshold 20 voxels} \]
Results – Humour Recognition

[Patients – Controls]:

- Left Inferior frontal gyrus (BA 47)
- Left anterior cingulate cortex (BA24/32)

\[ p < 0.001 \text{ uncorrected, extent threshold 20 voxels} \]
Results – Understanding others’ intention

[Controls – Patients]

- Left MPFC (BA10)
- Bilateral parahippocampal gyrus (BA27/35)
- Bilateral posterior cingulate cortex
- Bilateral thalamus
- Bilateral cerebellum
- Left Temporo-occipital junction (BA 37/39)
- Left Midbrain
- Right Superior Temporal gyrus (BA 41)

\[ p < 0.001 \text{ uncorrected, extent threshold 20 voxels} \]
Results – interaction effect

[Controls-Patients]: Left Dorsolateral Prefrontal Cortex (DLPFC – BA 9)
Left Inferior Parietal Lobule (IPL – BA2/40)

$p<0.001$ uncorrected, extent threshold 20 voxels
Results – interaction effect (DLPFC)

**Control**

- Humour: No, Intention: No (NN)
- Humour: No, Intention: Yes (AN)
- Humour: Yes, Intention: No (NH)
- Humour: Yes, Intention: Yes (AH)

**Patients**

- Humour: No, Intention: No (NN)
- Humour: No, Intention: Yes (AN)
- Humour: Yes, Intention: No (NH)
- Humour: Yes, Intention: Yes (AH)

* p<0.05
** p<0.01
*** p<0.001

NS = Not significant
Results – interaction effect (DLPFC)

• Brain activations in control group (not the patient group) at DLPFC were significantly correlated with:
  – Sensitivity of humour recognition \((r=0.51, p=0.01)\)
  – Sensitivity of understanding others’ intention \((r=0.43, p=0.04)\)
Summary

• When compared with healthy controls during humour detection, individuals with schizophrenia showed:
  – Reduced brain activation at dorsal tegmentum around PAG in midbrain
  – Increased brain activation at left inferior frontal gyrus (BA 47) and left anterior cingulate cortex (BA24/32)
Summary

• When compared with healthy controls during understanding others’ intentions, individuals with schizophrenia showed:
  – Reduced brain activation at Left MPFC, parahippocampal gyrus, posterior cingulate cortex (PCC), thalamus, cerebellum, left temporo-occipital junction (TOJ), left Midbrain and right Superior Temporal Gyrus (STG)
Summary

- Patients with schizophrenia exhibited different pattern of brain activations across conditions requiring humour recognition and understanding others’ intentions, when compared to controls in:
  - Left DLPFC
  - Left IPL
Discussions

• Role of DLPFC in schizophrenia – integration?
• Treatment options?
  – Transcranial magnetic stimulation?
  – Medications
    • Oxytocin
  – Psychological Treatment
Oxytocin

- Neuropeptide
- Best known for its role in lactation and parturition ("quick birth")
- Only 1 receptor known so far (OXTR)
- Primarily synthesised in magnocellular neurons of paraventricular (PVN) and supraoptic (SON) nuclei of hypothalamus
Oxytocin – “facilitator of life”

• Important role in mother-infant bonding and the onset of maternal nurturing behaviour

• Role in social cognition (*Ishak et al 2011*)
  – Animal studies
  – Human studies

• Role in schizophrenia (*Rosenfeld et al 2011*)
Oxytocin - treatment

Scientists Probe Oxytocin Therapy for Social Deficits in Autism, Schizophrenia

Emotion recognition and oxytocin in patients with schizophrenia

B. B. Averbeck¹*, T. Bobin², S. Evans³ and S. S. Shergill²
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Email: daniel.tsoi@nottshc.nhs.uk