Studying multiple neural representations at once in autism and controls

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Autism abnormalities

Social

↑

High sensory

↑

Low sensory

faces

voices

gabor

loudness
DSM-5: ASD- Autism Spectrum Disorders

• A. Persistent **deficits in social communication** and social interaction across multiple contexts
• B. **Restricted, repetitive patterns of behavior**, interests, or activities
• C. Present in the **early developmental** period
• D. **Significant impairment** in social, occupational areas.
• E. These disturbances are **not better explained** by intellectual disability or global developmental delay.

**B4. Hyper-or hypo-reactivity to sensory input** or unusual interest in sensory aspects of environment; (such as apparent indifference to pain/heat/cold, adverse response to specific sounds or textures, excessive smelling or touching of objects, fascination with lights or spinning objects).
Typical studies

mentalizing network

Precuneus-PC  TPJ  posterior & anterior mPFC
Studying multiple brain representations at once

A) Audio-Visual stimuli combinations

- Positive
  - Animate
  - Inanimate
- Negative
  - Animate
  - Inanimate

- X

- M
  - Fear
  - Negative
- F
  - Disgust
  - Positive

H. Op de Beeck
KU Leuven

Congruent  Incongruent
Experimental trials

Task: congruent or incongruent social reaction?

[0 - 2.5 secs]

[0.6 - 1.3 secs]

trial duration: [0 - 4.5 secs]
For me, this is appropriate. But what do ‘most people’ think?
Behavioral task validation

« Self-reference » task

versus

« Social norm » task

Similarity of response patterns

Within-subjects: r = 0.65 vs 0.67; t(43) = −0.3

*** Between-subjects: r = 0.33 vs 0.50; t(43) = −7.1; p < 0.0001
Hierarchical Brain Areas

High-Order Cognition

High-Level Sensory

Low-Level Sensory

mentalizing network

Precuneus-PC  TPJ  posterior & anterior mPFC
Separate GLMs: visual, audio and congruency GLMs

Visual GLM
- Duration & onset for visual stimuli (0-2.5 sec)
- Conditions: 12 visual stimuli

Auditory GLM
- Duration & onset for auditory stimuli (0.6-1.3 sec)
- Conditions: 8 auditory stimuli

Congruency GLM
- Duration & onset: 0.6 - 4.5 sec
- 2 Conditions: congruent vs incongruent
Studying multiple brain representations at once

3 GLMs:

- Pegado et al, Frontiers 2018
- Pegado et al, Sci Rep 2018

MVPA

RSA

congruency
# Groups’ matching

22 High-Functioning Autism (HFA) vs
22 matched Typically Developing (TD)

<table>
<thead>
<tr>
<th></th>
<th>ASD N = 22</th>
<th>Matched TD N = 22</th>
<th>T-statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>22.5 (+/- 4.09)</td>
<td>22.8 (+/- 2.94)</td>
<td>T(42) = 0.34</td>
<td>P = 0.74</td>
</tr>
<tr>
<td>IQ</td>
<td>108.6 (+/- 14.5)</td>
<td>112.4 (+/- 15.4)</td>
<td>T(42) = 0.84</td>
<td>P = 0.40</td>
</tr>
<tr>
<td>SRS-A</td>
<td>63.0 (+/- 13.0)</td>
<td>49.0 (+/- 8.0)</td>
<td>T(42) = 4.28</td>
<td>P = 0.0001</td>
</tr>
</tbody>
</table>
Variability across subjects

Behavioral ratings

Similarity of visual valence ratings across participants

Similarity of auditory valence ratings across participants

** T(42) = -2.83; p = 0.007

*** T(42) = -4.78; p < 0.0001
Behavioral ratings

Similarity of *congruency* judgements
*within* and *between* participants
(inside the scanner)

**within-subject** correlations (TD: $r = 0.51$ vs ASD: $r = 0.54$; T(42) = -0.59; $p = 0.56$).

**between-subject** correlations (TD: $r = 0.26$; ASD: $r = 0.19$; T(42) = 2.62; $p = 0.01$).
HFA show more *low-level* visual information in PC.
Partial correlations

Temporal Voice Area - TVA

1- Fundamental Frequency (F0)
2- Auditory Valence
3- Emotion
4- Voice Gender
Variability across subjects

Similarity of Neural Representations across subjects

Visual

Auditory
Functional Connectivity

Between brain regions

Between subjects [all 8 ROI]

n.s.
**Functional Connectivity**

Between subjects [Only TVA]

**group difference**

\[ T(36) = 2.76; \]

\[ p = 0.009 \]
HFA show *more uniqueness* of neural patterns and functional connectivity in the Voice Area.

Behavioral judgments of *auditory valence*... and those of *auditory congruency* were also *more idiosyncratic* in HFA.
High Functioning Autism

Social

High sensory

Low sensory

faces

voices

gabor

loudness
Financial Support

Open science

OSF  bioRxiv
THE PREPRINT SERVER FOR BIOLOGY
Summary

- **Striking similar neural representations among HFA and TD adults at all hierarchical levels**, including low and high level sensory processing and higher-order social processing.

- The only exception is a **high-level area** (Precuneus) **carrying more low-level information** (pixel information) in HFA.

- At the individual-subject level, one brain region showed **more interindividual variability in the HFA group**, both for neural representations and functional **connectivity**: the **Temporal Voice Area** (TVA).

- This larger neural idiosyncrasy in HFA matches with the increased **behavioral idiosyncrasy**, both for **valence ratings of auditory stimuli** (outside the scan) and for the **congruency of these vocalizations with visual contexts** (inside and outside the scanner).

**Idiosyncrasy in the functioning of high-sensory areas relevant for social understanding could underlie the idiosyncrasy in social behavior in HFA.**