Body perception in Tourette syndrome – Interoception, tics & premonitory urges

Dr Charlotte Rae
c.rae@sussex.ac.uk
@NeuroRae
What is interoception?

“the sensing of internal bodily signals, producing emotions and feelings”
What is interoception?

“the sensing of internal bodily signals, producing emotions and feelings”

insula
PREMONITORY SENSATIONS / URGES

“A feeling of pressure – like something itches deep inside you, and the only way you can relieve it is by tics. It’s like your brain itches, or your insides are being tickled…”

Physical sensations that generate urges to move

Reported by 95% of adults with TS

92% say tics are fully or partially a voluntary response to premonitory urges

(Leckman et al, 1993, American Journal of Psychiatry)
Why interoception?

Rae, Critchley & Seth (2019) *Frontiers in Psychiatry*

![Diagram showing brain areas involved in tics and premonitory sensations](image-url)
How do we investigate it?

HEARTBEAT COUNTING

silent counting

START | TIME | STOP

[Heartbeat diagram]
First evidence...

Ganos et al (2015) *Movement Disorders*

Heartbeat tracking accuracy (%)

CON, TS

\[ p = 0.032^* \]
Multiple dimensions of interoception

Interoceptive accuracy
objective performance

Interoceptive sensibility
subjective sensitivity

During most situations, I am aware of...
- ...how hard my heart is beating
- my nose itching
- muscle tension...

HEARTBEAT COUNTING

NEVER | SOMETIMES | ALWAYS

Multiple dimensions of interoception

**Interoceptive accuracy**
objective performance

**Interoceptive sensibility**
subjective sensitivity

### ACCURACY

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>0.123</td>
<td></td>
</tr>
</tbody>
</table>

### DISCREPANCY

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>0.005*</td>
<td></td>
</tr>
</tbody>
</table>

### SENSIBILITY

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>p</td>
<td>0.072</td>
<td></td>
</tr>
</tbody>
</table>

Rae et al (2019) *Psychiatry Research*
Premonitory Urge for Tics Scale (PUTS)

Right before I do a tic, I feel like my insides are itchy

NOT AT ALL  A LITTLE  PRETTY MUCH  VERY MUCH

☐  ☑  ☐  ☐

Yale Global Tic Severity Scale (YGTSS)

Number of tics, frequency, force, complexity, interruption
### TABLE 2. Prediction of premonitory urges (PUTS scores) in the GTS group

A. Correlation matrix for clinical variables used in the multiple regression model

<table>
<thead>
<tr>
<th>Variable</th>
<th>PUTS</th>
<th>IA</th>
<th>Y-BOCS</th>
<th>YGTSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUTS</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA</td>
<td>0.5427</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y-BOCS</td>
<td>0.4881</td>
<td>0.3463</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>YGTSS</td>
<td>0.4076</td>
<td>-0.1242</td>
<td>0.7147</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

B. Partial regression coefficients and significance tests from the multiple regression model

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Beta</th>
<th>$R^2$</th>
<th>Standard Error</th>
<th>t(15)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>0.6999</td>
<td>0.4024</td>
<td>8.1472</td>
<td>3.0831</td>
<td>0.0076</td>
</tr>
<tr>
<td>Y-BOCS</td>
<td>-0.2202</td>
<td>0.7031</td>
<td>0.1811</td>
<td>0.6838</td>
<td>0.5046</td>
</tr>
<tr>
<td>YGTSS</td>
<td>0.6519</td>
<td>0.6678</td>
<td>0.1094</td>
<td>2.1410</td>
<td>0.049</td>
</tr>
</tbody>
</table>

IA, interoceptive awareness; Y-BOCS, Yale-Brown Obsessive-Compulsive Scale; YGTSS, Yale Global Tic Severity Scale; PUTS, Premonitory Urge for Tics Scale.

Ganos et al (2015) *Movement Disorders*
Interoception and symptom severity

<table>
<thead>
<tr>
<th></th>
<th>Accuracy tracking</th>
<th>Sensibility</th>
<th>tIPE_T</th>
</tr>
</thead>
<tbody>
<tr>
<td>YGTSS tic severity</td>
<td>$r = 0.258$</td>
<td>$r = 0.518$</td>
<td>$r = 0.058$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.129$</td>
<td>$p = 0.008$</td>
<td>$p = 0.401$</td>
</tr>
<tr>
<td></td>
<td>$p_{FDR} = 0.217$</td>
<td>$p_{FDR} = 0.056$</td>
<td>$p_{FDR} = 0.433$</td>
</tr>
<tr>
<td>YGTSS impairment</td>
<td>$r = 0.125$</td>
<td>$r = 0.431$</td>
<td>$r = 0.142$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.295$</td>
<td>$p = 0.026$</td>
<td>$p = 0.270$</td>
</tr>
<tr>
<td></td>
<td>$p_{FDR} = 0.413$</td>
<td>$p_{FDR} = 0.182$</td>
<td>$p_{FDR} = 0.473$</td>
</tr>
<tr>
<td>Premonitory sensations (PUTS)</td>
<td>$r = 0.274$</td>
<td>$r = 0.571$</td>
<td>$r = 0.075$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.114$</td>
<td>$p = 0.003$</td>
<td>$p = 0.373$</td>
</tr>
<tr>
<td></td>
<td>$p_{FDR} = 0.399$</td>
<td>$p_{FDR} = 0.021$</td>
<td>$p_{FDR} = 0.435$</td>
</tr>
</tbody>
</table>

Rae et al (2019) Psychiatry Research
Interoception and symptom severity

YGTTS
(tic severity)

YGTSS
(impairment)

PUTS

\( p = 0.008^* \)

\( p = 0.026^* \)

\( p = 0.003^* \)

Rae et al (2019) Psychiatry Research
Interoceptive accuracy is moderately reduced in TS

But adults with TS self-report as more sensitive to bodily sensations

This means more sensitivity to less accurate body signals

Higher body sensitivity is associated with worse tics, worse impairment, and worse premonitory sensations
...but which came first?

Does altered interoception cause PS?

Or do PS result in altered interoception?

implications for tic management strategies:
do we treat the PS, or do we treat interoception?

HRT / CBIT

INTEROCEPTION TRAINING
Aligning Dimensions of Interoceptive Experience (ADIE)
(Autistic Spectrum Conditions)

Garfinkel et al (2016) Biological Psychology
Training interoception in TS?

**ACCURACY**

- **CON**
  - p = 0.123

- **TS**
  - p = 0.072

**SENSIBILITY**

- **CON**
  - p = 0.123

- **TS**
  - p = 0.072

**Trait anxiety**

- **CON TS**
  - r = 0.273
  - p = 0.115

- **r = -0.477**
  - p = 0.012*

Rae et al (2019) *Psychiatry Research*
May be useful for those experiencing comorbid anxiety (cf ASC)?

May be useful adjunct for HRT / CBIT: increasing interoceptive accuracy of PS could assist in ‘habituating to urge’?

Possible risk of increasing PS and tic expression?

Interaction with tic attacks – currently completely unknown. Could be useful to know when tic attack is coming?
TS spectrum heterogeneity

Need more studies with larger samples to tease apart possible effects of comorbidities on all dimensions of interoception (ADHD, OCD, ASC, anxiety)

As above for medications: Would SSRIs have a beneficial effect in TS, or increase PS?

Different age groups: **95% of adults** with TS report PS, but **few children** – likely that awareness develops with age
Neural basis of TS interoception

Rae et al (2018) Brain

MQ: Transforming mental health

ADIE
Conclusions

Interoception appears to be altered in TS, across dimensions, and relates to symptom severity.

We do not fully understand the (causal) interaction between interoception and symptoms, or differences along the TS spectrum.

We think insula function might play an important role.

…we would love to hear your thoughts on priorities going forward!
Thanks

Sussex team

Prof Hugo Critchley  Prof Sarah Garfinkel

21 participants with TS!
Body perception in Tourette syndrome – Interoception, tics & premonitory urges

Dr Charlotte Rae
c.rae@sussex.ac.uk
@NeuroRae