The role of age and executive function in auditory category learning

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Background
- Auditory categorization is a natural and adaptive process that allows for the organization of high-dimensional, continuous acoustic information into discrete representations.
- Rule-based category learning evidence in the visual field has demonstrated that the ability to accurately test and update new rules improves with age, parallel to prefrontally modulated cognitive processes, e.g. executive function.
- Despite the importance of rule-based categorization at all stages in life, and its dependence on executive function – rule-based auditory category learning has not been examined from a developmental perspective.

Aims
- The aims of this study are:
  (1) To examine the developmental trajectory of rule-based auditory category learning from childhood through early adulthood
  (2) To apply computational models to examine auditory categorization success beyond accuracy
  (3) To examine the extent to which individual differences in rule-based category learning relate to individual differences in executive function.

Methodology

Participants

<table>
<thead>
<tr>
<th></th>
<th>Children</th>
<th>Adolescents</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>20</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>age-mean</td>
<td>7.12</td>
<td>11.19</td>
<td>20.25</td>
</tr>
<tr>
<td>age-range</td>
<td>7.00-7.70</td>
<td>10.00-13.20</td>
<td>20.00-26.50</td>
</tr>
<tr>
<td>IQ</td>
<td>110.50(12.50)</td>
<td>105.16(13.42)</td>
<td>113.89(11.24)</td>
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<tr>
<td>TOMAL-2</td>
<td>verbal</td>
<td>103.40(11.31)</td>
<td>108.57(13.90)</td>
</tr>
<tr>
<td>TOMAL-2</td>
<td>nonverbal</td>
<td>101.75(11.88)</td>
<td>108.62(11.81)</td>
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<tr>
<td>TOMAL-2</td>
<td>composite</td>
<td>108.00(10.44)</td>
<td>105.24(11.41)</td>
</tr>
</tbody>
</table>

SES = socio-economic status of the parents as measured by the General Background Questionnaire. IQ = standard score of the Kaufman Brief Intelligence Test, Second Edition (KBIT-2). 1 Verbal, nonverbal, and composite memory are all standard scores of the Test of Memory and Learning, Second Edition (TOMAL-2). 2

Stimuli

- Figure 1. Spectrograms of example stimuli that are representative of the 4 categories:
  (a) low temporal, low spectral, (b) low temporal, high spectral, (c) high temporal, low spectral, (d) high temporal, high spectral.

Experimental Design

Session 1
- Participants learned to categorize novel ripple sounds across six 100-trial blocks during the ripple categorization task.
- Kaufman Brief Intelligence Test-Second Edition (KBIT-2)

Session 2
- 1 week later, participants returned to complete the:
  (1) Test of Memory and Learning-Second Edition (TOMAL-2) 2
  (2) Wisconsin Card Sort Test (WCST) ²

Results

1. Rule-based auditory categorization performance improved with age.
2. Children were least likely to use MD strategies, instead focusing more on UD strategies, whereas young adults were most likely to use MD strategies.
3. Adolescents demonstrated intermediate levels of MD use.

Conclusions
- Our findings suggest that:
  (1) Rule-based auditory category learning improves with age.
  (2) Computational modeling results suggest that children may not have developed the hypothesis-testing skills necessary for successful rule-based category learning.
  (3) The results further suggest that executive flexibility plays an integral role in successful rule-based auditory category learning.

References


Acknowledgements

Special thanks to Dr. Rachel Fleurant. NCRR T32 NS066547, Arielle Glick, Lorie Smith, Hao-Yi Li, Ziming Xu and other members of the SoundBrain Lab. This work was supported by NIH RO1 DC013315 to BC.