Interaction contrast assuming a parallel exhaustive model

Yiqi

October 13, 2020

1 Basic assumption of a parallel exhaustive model on RT

$$T_{AB|r} = \max(D_{A|r}, D_{B|r})$$

2 Possible assumptions of a parallel exhaustive model on response

There are several ways to determine the response assuming a parallel exhaustive model.

2.1 The slower takes all

$$R_{AB} = \begin{cases} C_A, & \text{if } D_A > D_B \\ C_B, & \text{if } D_A \leq D_B \end{cases}$$

I have been thinking about the psychological meaning of such a pattern. Under what circumstances should the final response determined only by the output of the slower process? Cannot think of a second example except "report the identity of the second stimulus you perceive."

It appear that the nature of the task should require a complete suppression of the faster stimulus (i.e., the faster is defined as distractor).

2.2 All right

$$R_{AB} = C_A \cdot C_B$$

The final response is positive if and only if the outputs of both processes are positive. For example, the presence of a target should be reported if and only if it has been detected in both modalities.

2.3 Screening

$$R_{AB} = (1 - C_A) \cdot (1 - C_B)$$

The final response is positive if and only if the outputs of both processes are negative. For example, the participant can report "safe" if and only if the target is absent in both modalities.

2.4 XOR

$$R_{AB} = C_A \cdot (1 - C_B) + (1 - C_A) \cdot C_B$$

A positive response should be make if and only if the target appears exactly in one of the modalities.

2.5 Match

$$R_{AB} = 1 - \Big(C_A \cdot (1 - C_B) + (1 - C_A) \cdot C_B\Big)$$

A positive response should be make if and only if the stimuli perceived in both modalities match each other.

Remark. Only the first pattern depends on which process is faster.

3 IC under a parallel exhaustive model with perfect accuracy

Since $\max(D_{a|r}, D_{b|r}) \leq t \iff \Big(D_{a|r} \leq t \cap D_{b|r} \leq t\Big)$, the inequality of IC for CDF can be derived directly.

$$
\begin{aligned}
&\Big(\mathbb{P}(T_{ab} \leq t \mid r) + \mathbb{P}(T_{AB} \leq t \mid r)\Big) - \Big(\mathbb{P}(T_{aB} \leq t \mid r) + \mathbb{P}(T_{Ab} \leq t \mid r)\Big) \\
=&\Big(\mathbb{P}(D_a \leq t \mid r) \cdot \mathbb{P}(D_b \leq t \mid r) - \mathbb{P}(D_a \leq t \mid r) \cdot \mathbb{P}(D_B \leq t \mid r)\Big) \\
&- \Big(\mathbb{P}(D_A \leq t \mid r) \cdot \mathbb{P}(D_b \leq t \mid r) - \mathbb{P}(D_A \leq t \mid r) \cdot \mathbb{P}(D_B \leq t \mid r)\Big) \\
=&\Big(\mathbb{P}(D_a \leq t \mid r) - \mathbb{P}(D_A \leq t \mid r)\Big) \cdot \Big(\mathbb{P}(D_b \leq t \mid r) - \mathbb{P}(D_B \leq t \mid r)\Big) \\
\geq& 0
\end{aligned}
$$

4 IC under a parallel exhaustive model with imperfect accuracy