Reward interacts with modality shift to reduce cross-modal conflict

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Previous studies have shown that reward can enhance cognitive control and reduce conflict in visual processing. Here we investigate (a) whether and how reward influences cross-modal conflict control and (b) how the shift of attention across modalities modulates the effect of reward on cross-modal conflict control. In four experiments, a cue indicating the reward availability of a given trial (reward vs. no reward) was presented prior to a target. The target was either a visual or an auditory letter, which was accompanied by a distracting letter from the other modality. The identity of the distracting letter was either the same as or different from the identity of the target letter (congruent vs. incongruent). When the cue modality was constant (Experiment 1) or changed across different experimental blocks (Experiment 3), the interference effect (i.e., the response time difference between incongruent and congruent trials) was smaller following a reward cue than a no-reward cue, suggesting that reward can reduce cross-modal conflict. In contrast, when the cue modality was changed trial-by-trial in an unpredictable way (Experiments 2 and 4), reward reduced cross-modal conflict only when the cue and the target were from different modalities and had a long stimulus onset asynchrony (SOA) between them but not when they shared the same modality or had a short SOA between them. These results suggest that reward can facilitate cross-modal conflict resolution, and this effect may critically depend on both the preparatory state between the cue and the target and timing to initiate cognitive control.

Introduction

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P a, 2015; S , S , Pa , Wa , & S b , 2015; V , W b a , & S , 2015; Wa , Y , & Z , 2013). F a , Pa a a a P a (2011) a a b a a a a a a a a a b . T b a ("XXXXX"), ("HOUSE"), - ("BUILDING") (. ., a). A a a , a a a a a a a a a a a a a .

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R a a b a a a a a a (Pa a a & P a, 2011; S a ., 2015; a B a ., 2014; V & Aa , 2010). I , a a a a a - a . T a b a a a a a , a - a a a a a a a b (C & Z , 2013; D , A - ba , Pa , R b , & W , 2013; E , C a , & Va -I a , 1998; W a , Wa , & W , 2004, 2009). W a a a a a a a a a a a . T a a a a a a , a a a b a a a a a a . T b (C & Z , 2013; W a a ., 2009). Pa a a a (. ., a a) a a (. ., a a). W a , a a - a , - a b a a a a a a a a a a .

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Method

Participants

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Apparatus and materials

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Design and procedure

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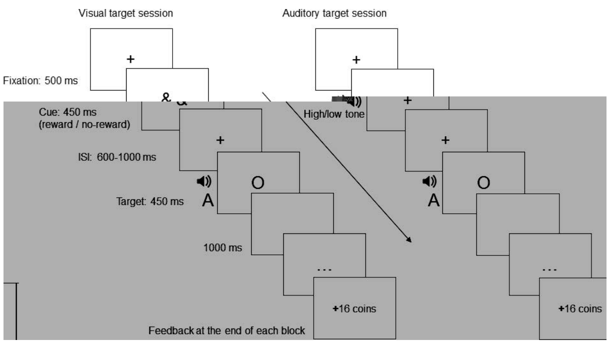

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Data analysis

I a RT a a . F a a a , a RT a a a a ab b a RT a a - a a . I , 1.0% a a a . A a - a ANOVA a a RT a a a a a (a a . a a), a (a . a), a a (.) a - b a ab . S a a a a a a , a a a a a a .

Results

ANOVA RT (F 2) a a a a , (1, 18) = 6.32, = 0.022, $\eta^2 = 0.26$, RT a a a a a (400 . 424). T a a a a , (1, 18) = 12.21, = 0.003, $\eta^2 = 0.40$, a a a a a a a - a a (401 . 424). T a a a a a , (1, 18) = 52.35, < 0.001, $\eta^2 = 0.74$, RT a (402 . 423). M , a b a a a a a a , (1, 18) = 5.80, = 0.027, $\eta^2 = 0.24$, a a a b a a , (1, 18) = 19.58, < 0.001, $\eta^2 = 0.52$. T - a a a a , (1, 18) = 0.45, = 0.511, $\eta^2 = 0.02$.

A a a 2 (a . a) × 2 (.) ANOVA a a a a a a , . F a a , a a a , (1, 18) = 37.84, < 0.001, $\eta^2 = 0.68$, RT a (410 . 390). H , a a a a , (1, 18) = 2.83, = 0.110, $\eta^2 = 0.14$. T a b a a a a , (1, 18) = 7.21, = 0.015, $\eta^2 = 0.29$. A a a (. ., RT RT) a a a a - a (14 . 26), (18) = 2.67, = 0.015. F a , a a a RT a a a - a a , (18) = 2.17, = 0.043, , (18) = 0.93, = 0.363.

F a a , a a a a , (1, 18) = 15.90, = 0.001, $\eta^2 = 0.47$, a a a a , (1, 18) = 17.75, = 0.001, $\eta^2 = 0.50$. Pa a a a a a - a a (407 . 441) a a a a (413 . 435). T a - b a a a a , (1, 18) = 8.51, = 0.009, $\eta^2 = 0.32$. A a a a a a a - a (13 . 31), (18) = 2.91, = 0.009. F a , a a a a (. ., RT - a RT a) a a a (25 . 43), (18) = 2.93, = 0.009.

A 2 × 2 × 2 ANOVA a a a a , (1, 18) = 16.11, = 0.001, $\eta^2 = 0.47$, a a a (4.7% . 2.2%).

Discussion

I E 1, a a a , a a a a a b a a a (K , D - , & E , 2009; Pa a a & P a, 2011, 2014; W & Ka , 2014). M , a a - a b a a a a a , a a a a a (B & B a , 2015; Pa a a & P a, 2011; P a, 2009) a a ab .

Experiment 2

I E 2, a a a a a a a - a . W a a a a

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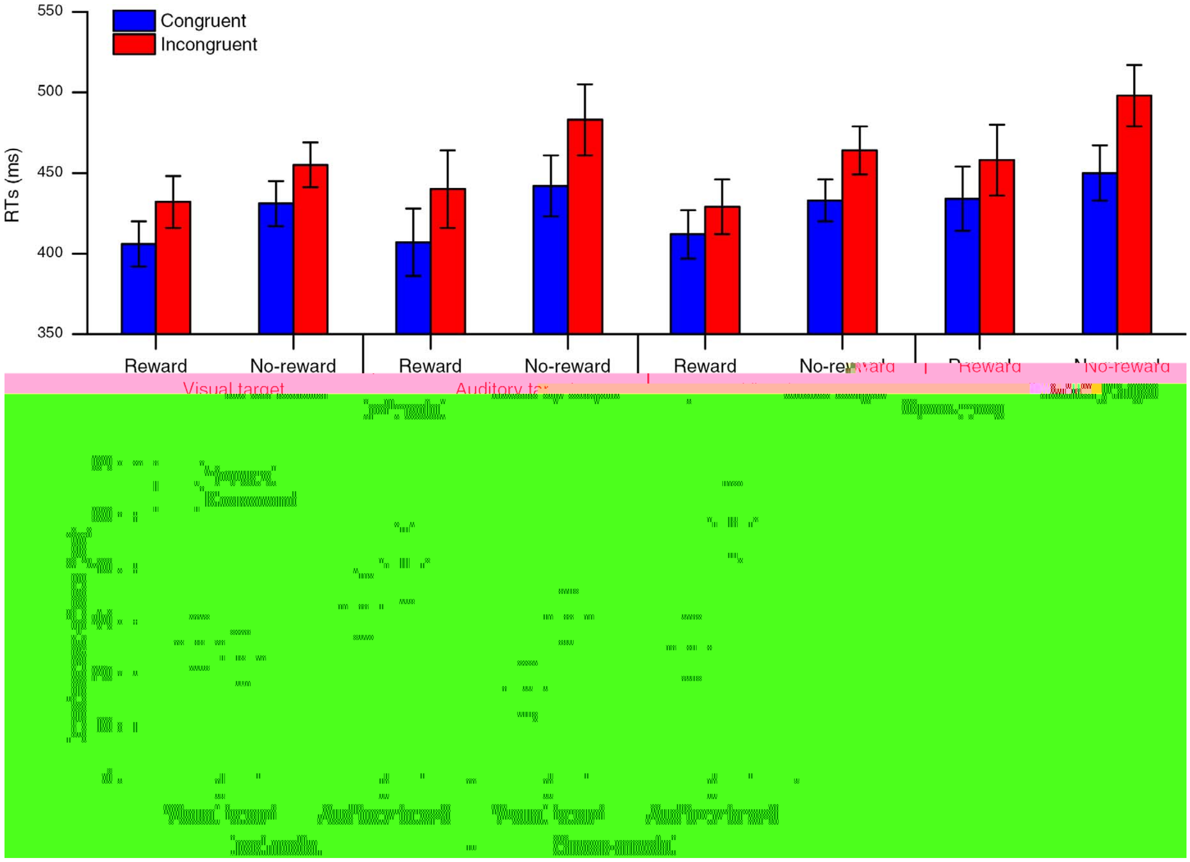

Figure 3. Experiment 2. Top: Mean RTs with standard errors as a function of the experimental condition. Bottom: the interference effects with standard errors as a function of the experimental condition.

0.35, a a a (4.6% . 2.4%). N a a .

Discussion

I E 2, b RT - a a a - , a a a a a (a /) a a (/a). T RT a (T a a ., 2002; T a a ., 2004), a a a a a a a a a a . I a , a a - a , a . T a a a a a a a a a (Ma a ., 2014). A b a a a b a a a a a - a a a a

b a a a ; a b a a a b a a a a (Ma a ., 2014; P a, 2009). T a a a a a a a (a) a a a a - ab a a a b a . I a ab a a a a , b a a a a b a a , a a - a - a a . T b a .

Experiment 3

T a E 3 a a a - a a a a ab . T - a a a a a a a

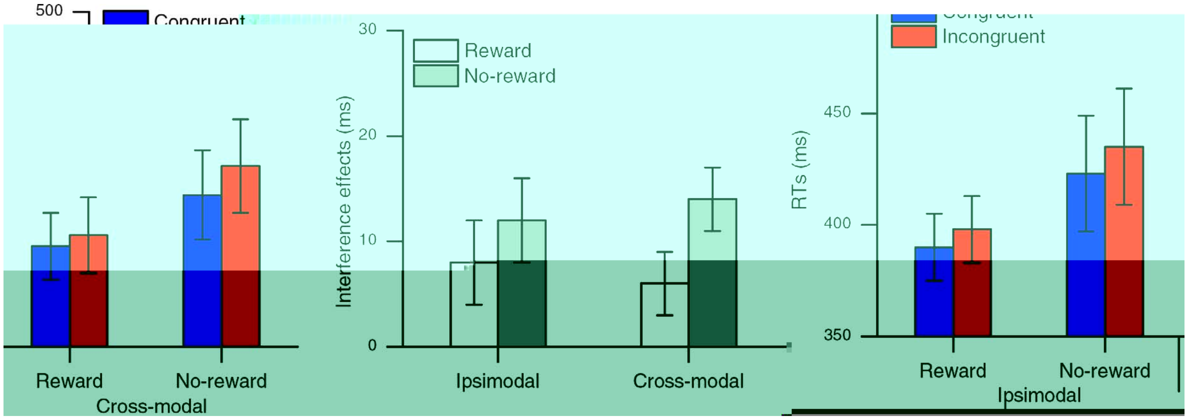

Figure 4. Experiment 3. Left: Mean RTs with standard errors as a function of the experimental condition. Right: the interference effects with standard errors as a function of the experimental condition.

a - a b a .

Method

Participants

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Apparatus and materials

T a a a a a a a a .

Design and procedure

G a a b E 1 a 2 a a a , a a E 3. T a a a a a E 2 a a a a a E 3. T a a a (a) a a a (- a). S a , a , a a a ab a a b a a ( ), a a , a a a ab a a b a a (# &).

Results

O a a a . F a a a , a RT a a a a ab b a RT a a a a a a a a (0.8%). A 2 (a . - a) × 2 (a . a) × 2 (.) a - a ANOVA RT (F 4) a a a , (1, 15) = 4.79, = 0.045, $\eta^2 = 0.24$, RT a a - a (396 . 427), a a a a a , (1, 15) = 16.26, = 0.001, $\eta^2 = 0.52$, RT a a a (406 . 416). T a a a a a (> 0.1), a ab a . T a b a a a a a , (1, 15) = 4.92, = 0.042, $\eta^2 = 0.25$, b - a a a , (1, 15) = 0.78, = 0.391, $\eta^2 = 0.05$. C a a (a) a - a (a) , a a a a a - a (7 . 13), (15) = 2.22, = 0.042; a a a a a (28 . 34), (15) = 2.34, = 0.034. T a a a a a .

Discussion

I a E 2, a a a a a a ab E 3 a b a b a a - . A a , RT a - a a . T , a a a b ab a - E 2 (a T a a ., 2002;

T a a ., 2004), a a a a a a a E 3. R a a - a a b a , a a a a a a a .

(a : .) - - a a . T 768 a a , 12 b 64 a a b . Pa a 32 a a , a a ba a .

Experiment 4

I E 4, a a b a a a E 2 a b a a a b a . A a a a

b a a a (C & B a , 2016). H a a , a a a a a b a a a , a b a b a a ab a a . T , a a a SOA E 4.

Method

Participants

T a a a (a , 18~26 a) a E 4. A a a a a - - a , - a a , a - a . T a a .

Apparatus and materials

T a a a a a a a a .

Design and procedure

T a a a E 3 : T a a a a a a a -b - a ba a E 2. M , 300 , a a SOA a a a a . F SOA , a SOA a 310 350 ; SOA , SOA a 910 950 . T a SOA a ba a a a a .
T a a 2 (SOA: .) × 2 (a a : a . - a) × 2 (a : a . a) × 2

Results

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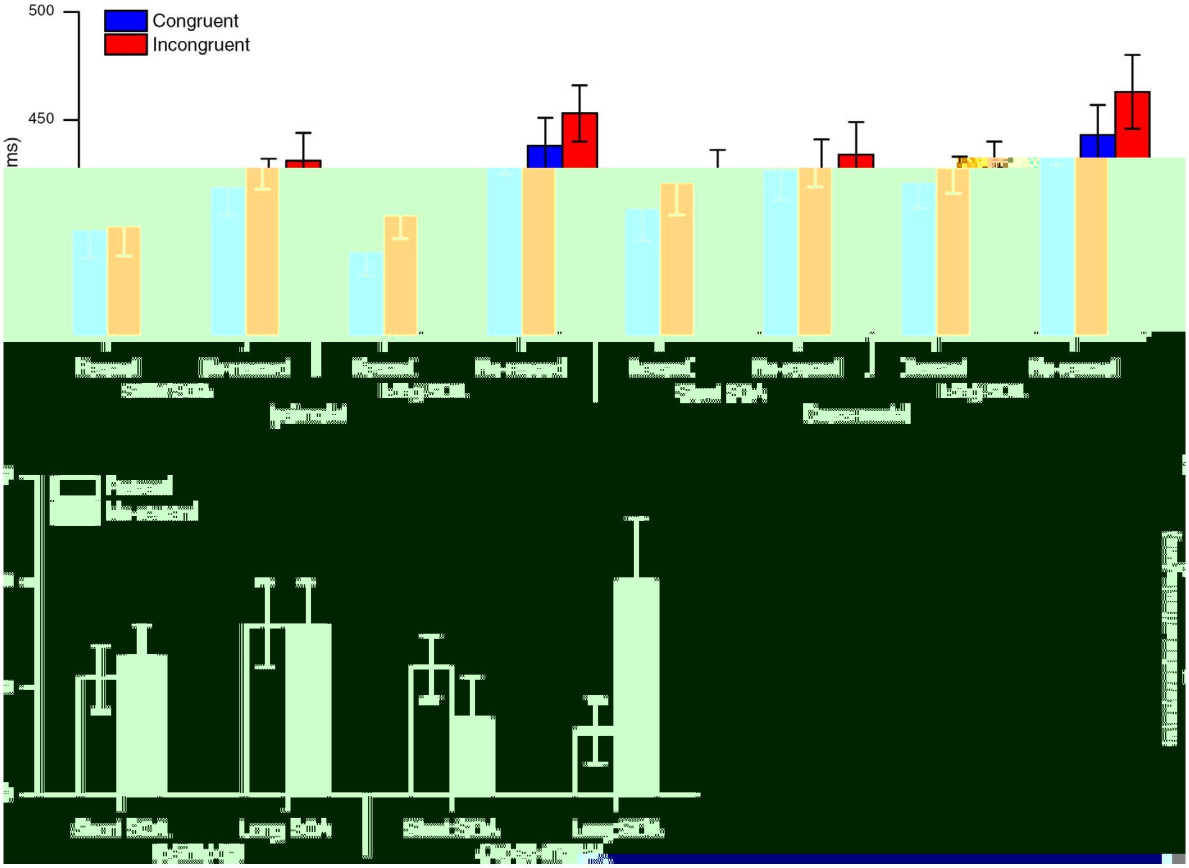

Figure 5. Experiment 4. Top: Mean RTs with standard errors as a function of the experimental condition. Bottom: the interference effects with standard errors as a function of the experimental condition.

ANOVA a a a b a a a , (1, 19) = 4.42, = 0.049, η^2 = 0.19, a a a a a a b SOA a a a , (1, 19) = 4.24, = 0.053, η^2 = 0.18. C a a a SOA a a a , a a a , b - a a (2.8% . 2.2%), (1, 19) = 2.45, = 0.024, a a a (2.6% . 2.7%), (1, 19) = 0.36, = 0.724. S a , a a a a a a , b a a a a - a , b SOA a (3.0% . 2.1%), (19) = 3.01, = 0.007, a SOA a (2.4% . 2.7%), (19) = 0.52, = 0.612.

Discussion

I E 4, b a RT - a a a , a a a ab (E 2).

M , a - a a a a a - a a SOA b a SOA, a a a a b a a a a . T ab a - a a SOA a b b a a a a (C & B a , 2016).

General discussion

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Acknowledgments

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References

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B , E., C , R., & Aa , H. (2009). T

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B , M. M., B a , T. S., Ba , D. M., Ca ,
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B a , T. S. (2015). R a a a
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H , G., Ma a , S., & Y , N. (2013). EEG
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(1), 590 600, :10.1016/ . a .2012.09.
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K , M., D , J., & E , M. (2009). R a
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Ma , H., Aa , H., & C , R. (2014). R a -
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Pa a a, S., & P a, L. (2011). R a
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