#26.552 Can Attention's Temporal Resolution Be Doubled?

Andrew S. Clement[1,2] & Nestor Matthews[1]

[1]Department of Psychology, Denison University, [2]Department of Psychology, University of Notre Dame

Introduction

Extant research shows that visual attention periodically samples the environment at a rate of ~7 Hz, regardless of whether attention is allocated to one or more locations.[1] However, other studies suggest that separate neural resources mediate attention to the left and right visual fields (LVF & RVF, respectively).[2-4] If this is the case, attention's temporal resolution may not be a unitary value. Instead, it may be set independently within each hemifield.[5]

In the present study, we investigated whether separate LVF and RVF resources could operate additively to increase attention's temporal resolution. To test this hypothesis, we used several variants of a bilateral-stream RSVP task.[6-8] Participants viewed rapid visual displays containing two successive targets (T1 and T2) and reported target identities on each trial. Four target-hemifield configurations (LL, RR, RL, LR) were varied randomly across trials.

In Experiment 1, the LVF and RVF streams were either temporally synchronized or asynchronized so that new visual information appeared at 7.5 or 15 Hz, respectively (see Figure 1). Thus, we tested whether attention's temporal resolution could be doubled across the two hemifields. In Experiment 2, the asynchronous condition was compared to a "triple" condition that embedded T1 and T2 within separate LVF-only or RVF-only stimulus triplets at 15 Hz. This allowed us to test whether a doubled temporal resolution could persist within each hemifield. We also manipulated the task demands and presence of T1 to rule out any artifacts of the attentional blink.[3,6-8]

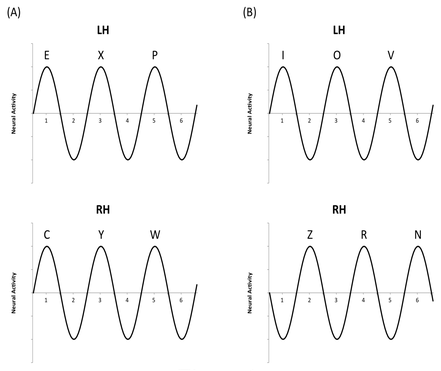
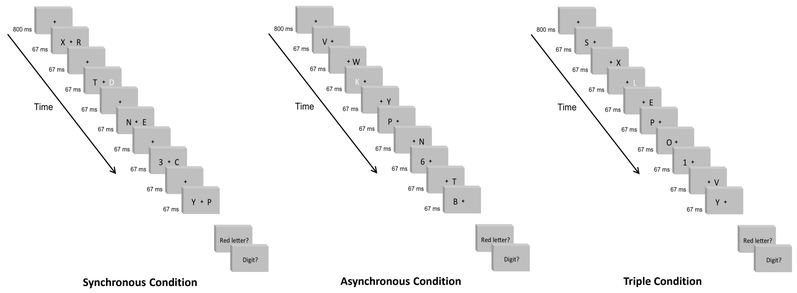


Figure 1.

Acknowledgements

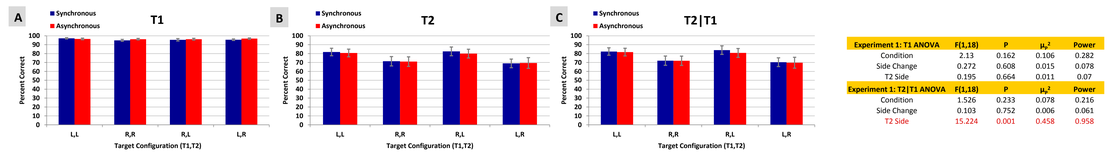
This study was made possible by contributions from the Reid and Polly Anderson Endowment and the Sigma Xi Grants-In-Aid of Research Program.

Methods



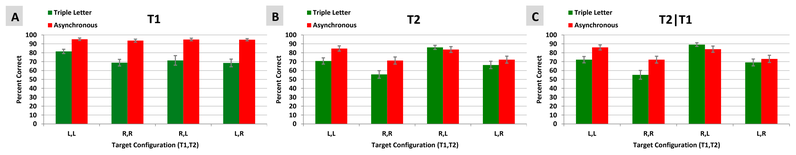
Results

Experiment 1: Synchronous vs. Asynchronous



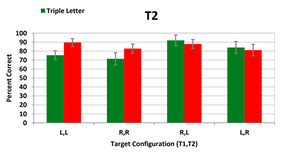
Experiment 1: T1 ANOVA	F(1,18)	P	μ_p^2	Power
Condition	2.13	0.162	0.106	0.282
Side Change	0.272	0.608	0.015	0.078
T2 Side	0.195	0.664	0.011	0.07
Experiment 1: T2|T1 ANOVA	**F(1,18)**	**P**	**μ_p^2**	**Power**
Condition	1.526	0.233	0.078	0.216
Side Change	0.103	0.752	0.006	0.061
T2 Side	15.224	0.001	0.458	0.958

Experiment 2A: Asynchronous vs. Triple (T1 Present, T1 & T2 Identification)



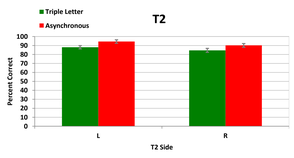
Experiment 2A: T1 ANOVA	F(1,15)	P	μ_p^2	Power
Condition	53.126	p<.001	0.78	1
Side Change	1.355	0.263	0.083	0.193
T2 Side	31.226	p<.001	0.676	0.999
Condition x Side Change	1.463	0.245	0.089	0.205
Condition x T2 Side	17.676	0.001	0.541	0.975
Side Change x T2 Side	3.663	0.075	0.196	0.433
3-Way Interaction	5.979	0.027	0.285	0.628
Experiment 2A: T2|T1 ANOVA	**F(1,15)**	**P**	**μ_p^2**	**Power**
Condition	10.346	0.006	0.408	0.852
Side Change	16.025	0.001	0.517	0.962
T2 Side	17.016	0.001	0.531	0.971
Condition x Side Change	15.225	0.001	0.504	0.954
Condition x T2 Side	8.226	0.012	0.354	0.764
Side Change x T2 Side	0.002	0.966	0	0.05
3-Way Interaction	0.976	0.339	0.061	0.152

Experiment 2B: Asynchronous vs. Triple (T1 Present, T2 Identification Only)



Experiment 2B: T2 ANOVA	F(1,12)	P	μ_p^2	Power
Condition	18.102	0.001	0.601	0.973
Side Change	7.345	0.019	0.38	0.702
T2 Side	8.949	0.011	0.427	0.784
Condition x Side Change	20.054	0.001	0.626	0.984
Condition x T2 Side	0.162	0.695	0.013	0.066
Side Change x T2 Side	2.667	0.128	0.182	0.324
3-Way Interaction	0.469	0.506	0.038	0.097

Experiment 2C: Asynchronous vs. Triple (T1 Absent, T2 Identification Only)



Experiment 2C: T2 ANOVA	F(1,12)	P	μ_p^2	Power
Condition	51.464	p<0.001	0.811	1
T2 Side	14.48	p=0.003	0.547	0.937
Condition x T2 Side	0.316	p=0.584	0.026	0.081

Discussion

In Experiment 1, doubling the visual information rate from 7.5 Hz (synchronous condition) to 15 Hz (asynchronous condition) did not impair T2|T1 accuracy (p=.162, n.s.). This finding demonstrates that attention's temporal resolution can be effectively doubled, providing support for independent LVF and RVF neural resources.[2-5] A LVF advantage was also observed, as T2|T1 accuracy for LVF-T2s exceeded that for RVF-T2s (p<.001).[5-8]

In Experiment 2A, T2|T1 accuracy in the asynchronous condition exceeded that in the laterally faster triple condition when both targets appeared in the same hemifield (p<.001). However, the effect vanished when the two targets appeared in separate hemifields. These results suggest that attention's temporal resolution can only be doubled across hemifields, lending further support to the separate resources account.[2-5] T2 accuracy also exceeded T1 accuracy in the triple condition's RL hemifield configuration, indicating a LVF advantage.[5-8]

However, Experiment 2A's findings are partially consistent with cross-hemifield advantages for the attentional blink.[3] To eliminate any artifacts of this effect, we conducted several more manipulations. In Experiment 2B, removing the identification requirement for T1 did not appreciably alter our results. In Experiment 2C, removing T1 entirely yielded similar effects. Here, T2 accuracy in the asynchronous condition exceeded that in the triple condition (p<.001), reinforcing our previous findings. T2 accuracy for LVF-T2s also exceeded that for RVF-T2s (p=.003), revealing a clear LVF advantage. Along with the previous advantages, this finding is consistent with accounts of a right parietal lobe "when" pathway.[5,9]

References

1. VanRullen *et al.* (2007). [PubMed ID: 18042716]
2. Alvarez & Cavanagh (2005). [PubMed ID: 16102067]
3. Scalf *et al.* (2007). [PubMed ID: 17469970]
4. Alvarez *et al.* (2012). [PubMed ID: 22637710]
5. Matthews *et al.* (2013). [PubMed ID: 23818678]
6. Verleger *et al.* (2008) [PubMed ID: 18564053]
7. Śmigasiewicz *et al.* (2010). [PubMed ID: 20546763]
8. Verleger *et al.* (2011). [PubMed ID: 21265863]
9. Batelli *et al.* (2007). [PubMed ID: 17379569]

External Resources

http://www.denison.edu/~matthewsn/vss2014clementmatthews.html