FUNCTIONAL NETWORK ACTIVITY MEDIATING THE SHIFT OF ATTENTIONAL RESOURCES DURING INATTENTIONAL DEAFNESS IN AN AVIATION PURSUIT TASK

Robert J. Gougelet, Cengiz Terzibas, Bradley Voytek, Daniel E. Callan

UC San Diego

NICT

Swartz Center for Computational Neuroscience

UC San Diego VOYTEKlab

CiNet

Inattentional Deafness

Inattention to clearly audible information, dual-task

Inferior frontal gyrus
suppresses auditory regions
during high workload/low performance
to focus on non-auditory primary task

Implies an attentional bottleneck

Durantin, G., Dehais, F., Gonthier, N., Terzibas, C., & Callan, D. E. (2017). Neural signature of inattentional deafness. Human brain mapping, 38(11), 5440-5455.

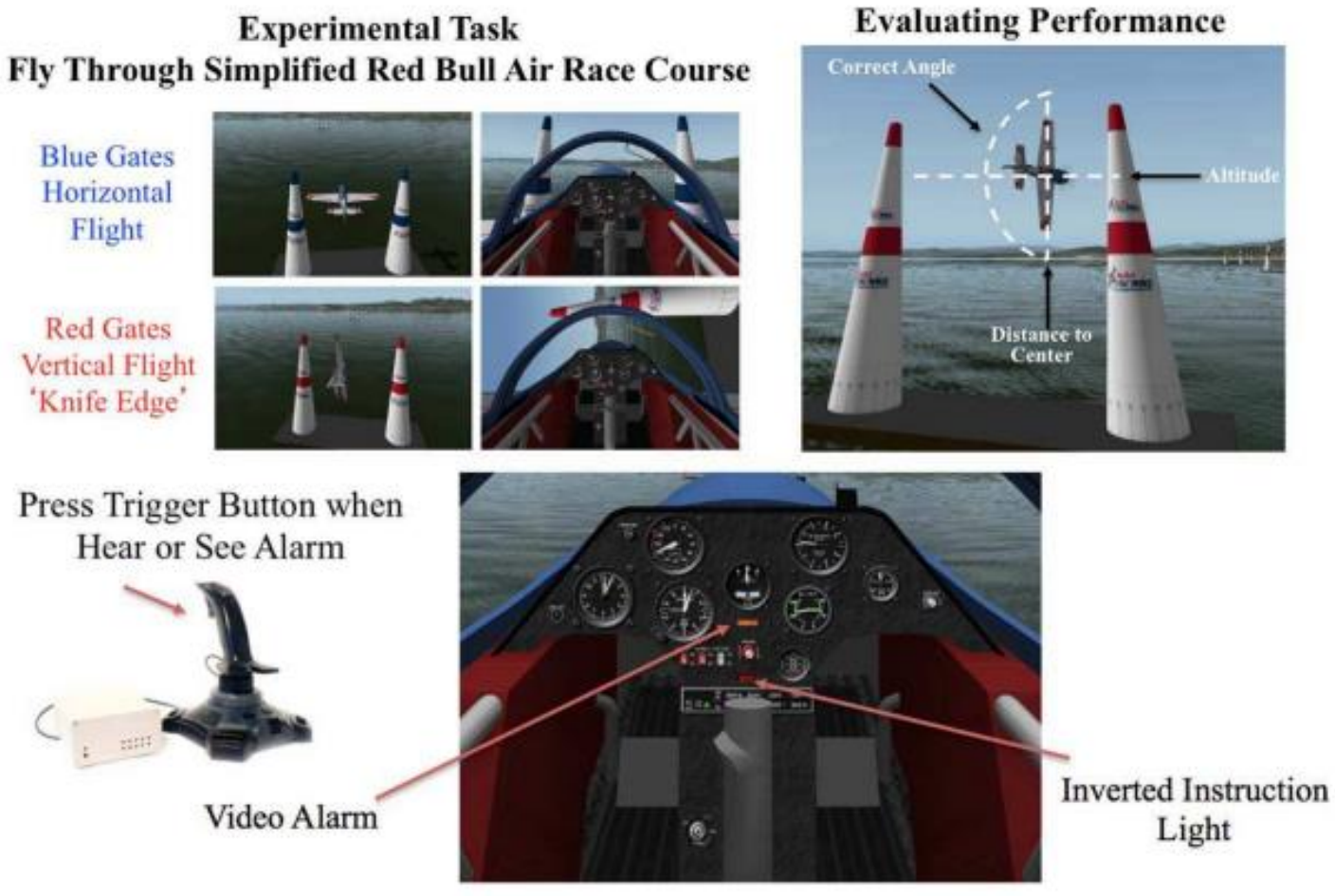
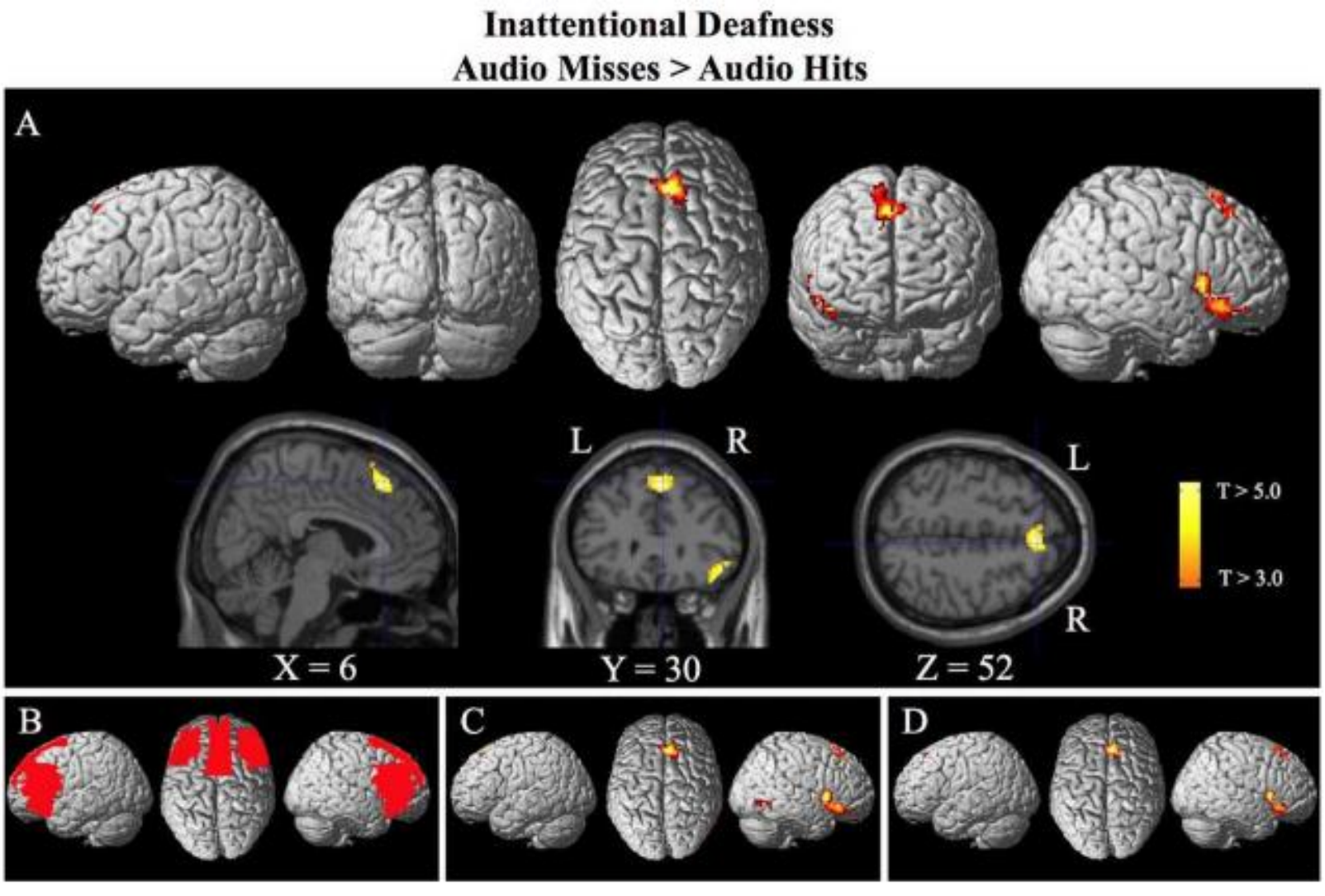
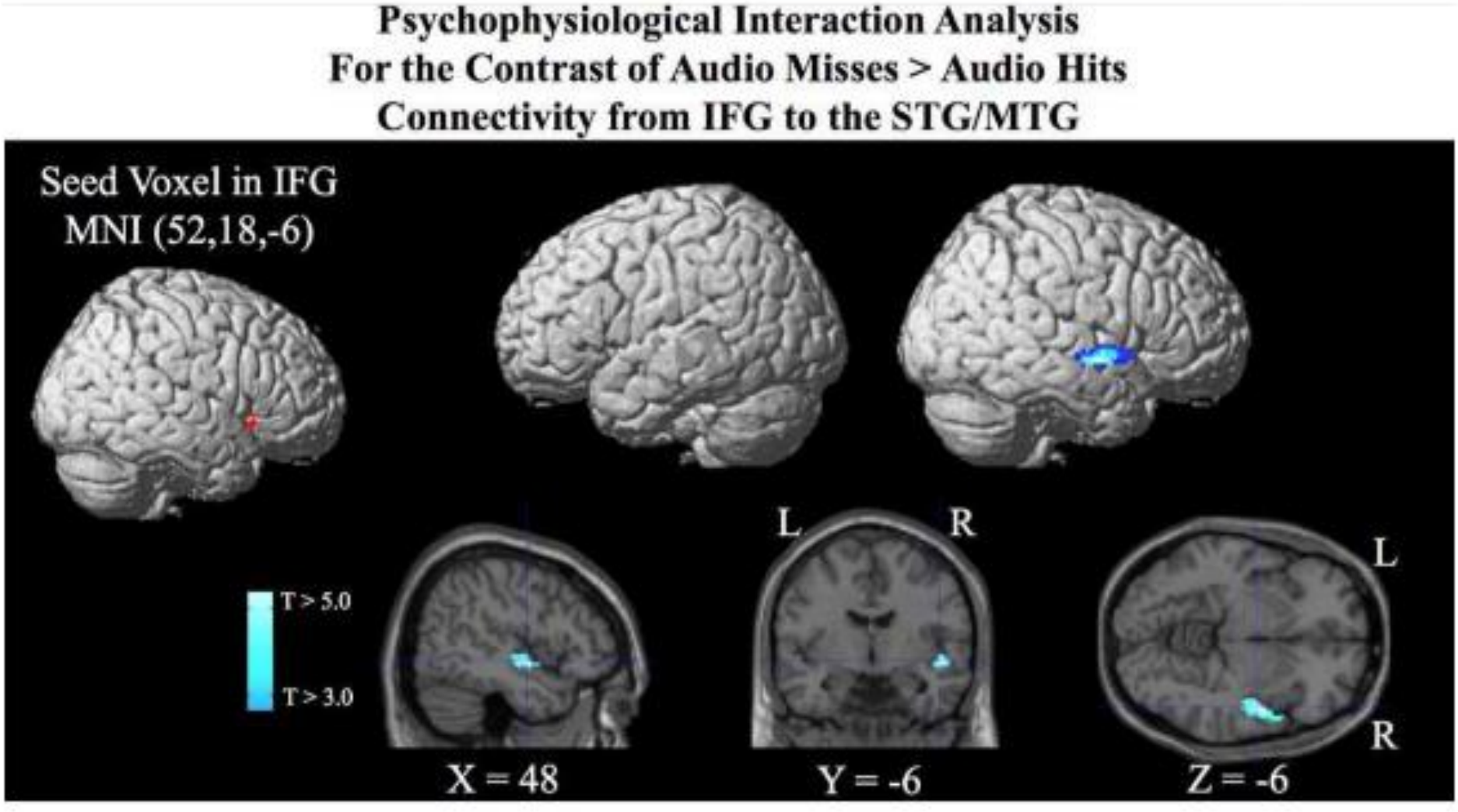


Figure 1.
The Red Bull flying task.

Durantin, G., Dehais, F., Gonthier, N., Terzibas, C., & Callan, D. E. (2017). Neural signature of inattentional deafness. Human brain mapping, 38(11), 5440-5455.

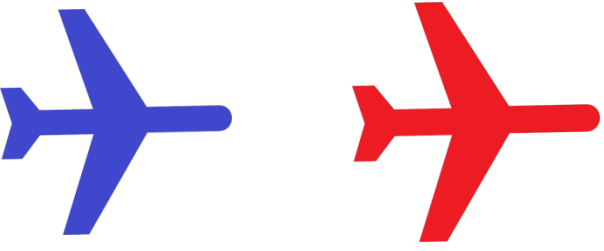


Durantin, G., Dehais, F., Gonthier, N., Terzibas, C., & Callan, D. E. (2017). Neural signature of inattentional deafness. Human brain mapping, 38(11), 5440-5455.

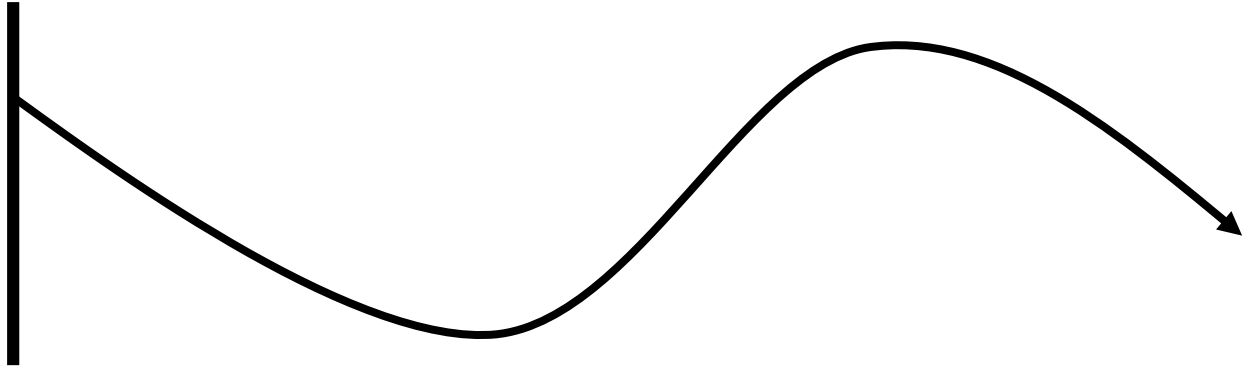


Durantin, G., Dehais, F., Gonthier, N., Terzibas, C., & Callan, D. E. (2017). Neural signature of inattentional deafness. Human brain mapping, 38(11), 5440-5455.

Plane that the participant controls
Plane that the participant pursues

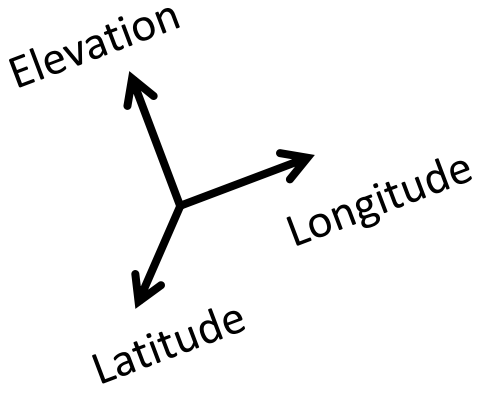


We manipulated distance →



Participant plane

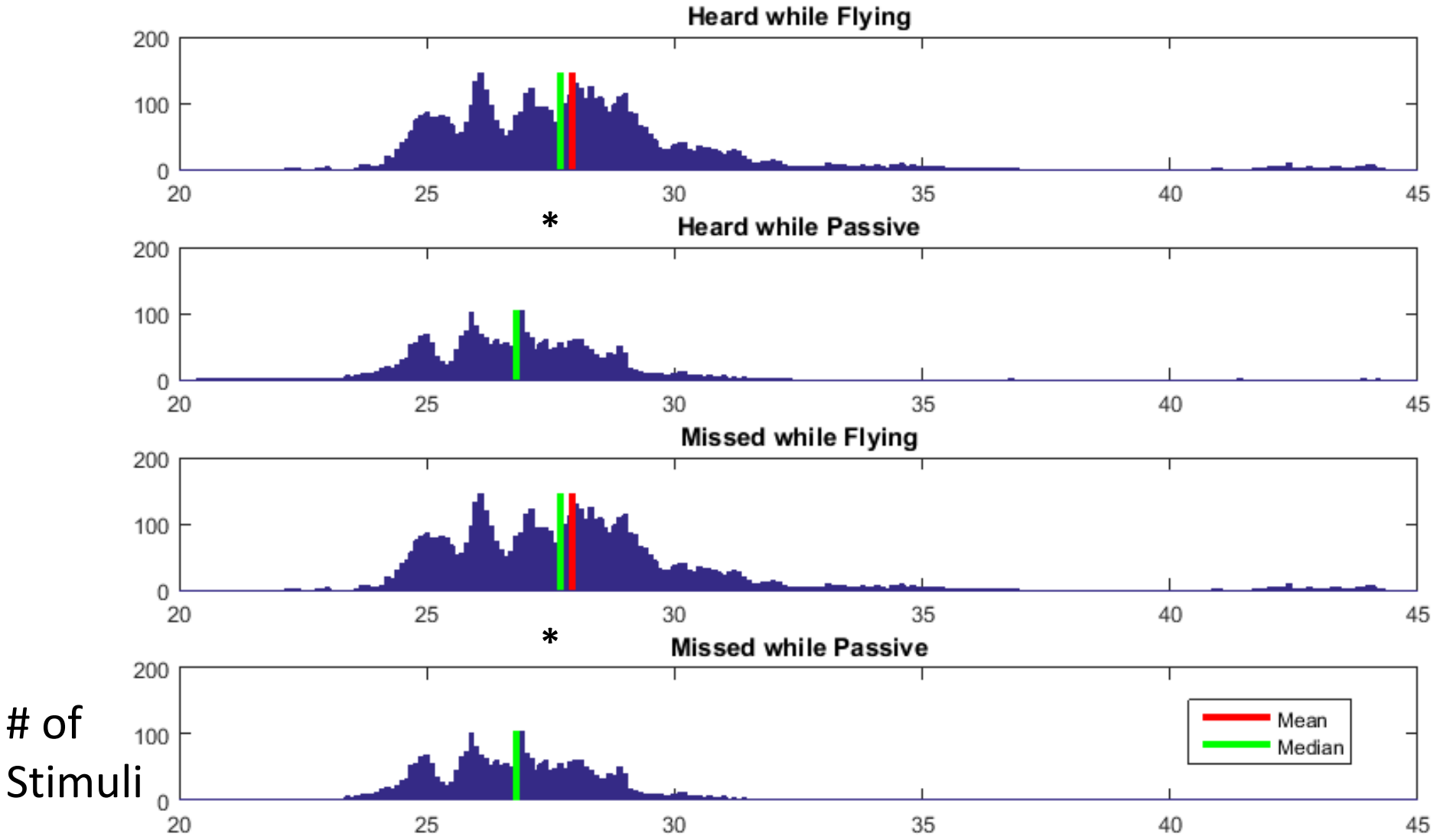
Target plane

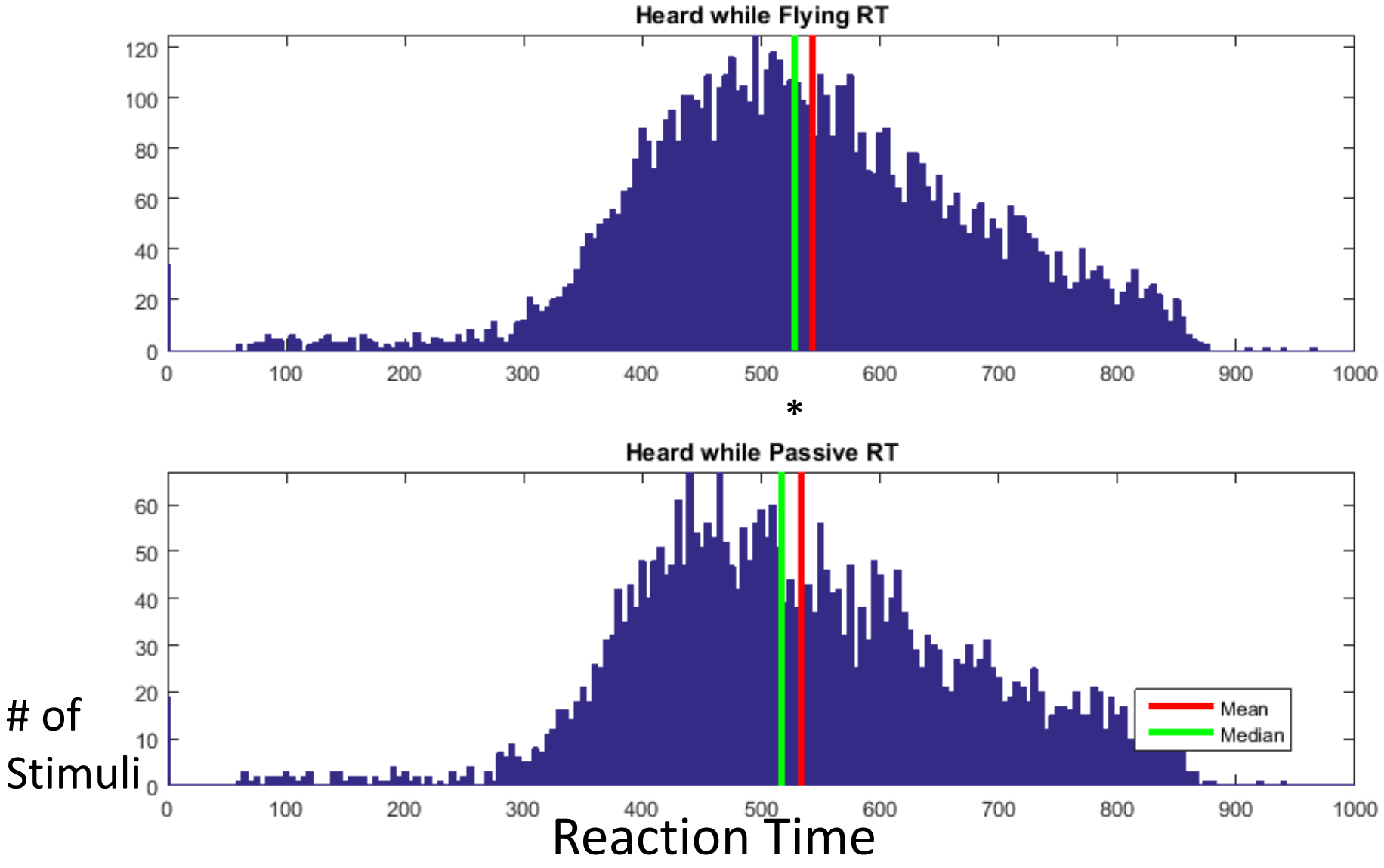


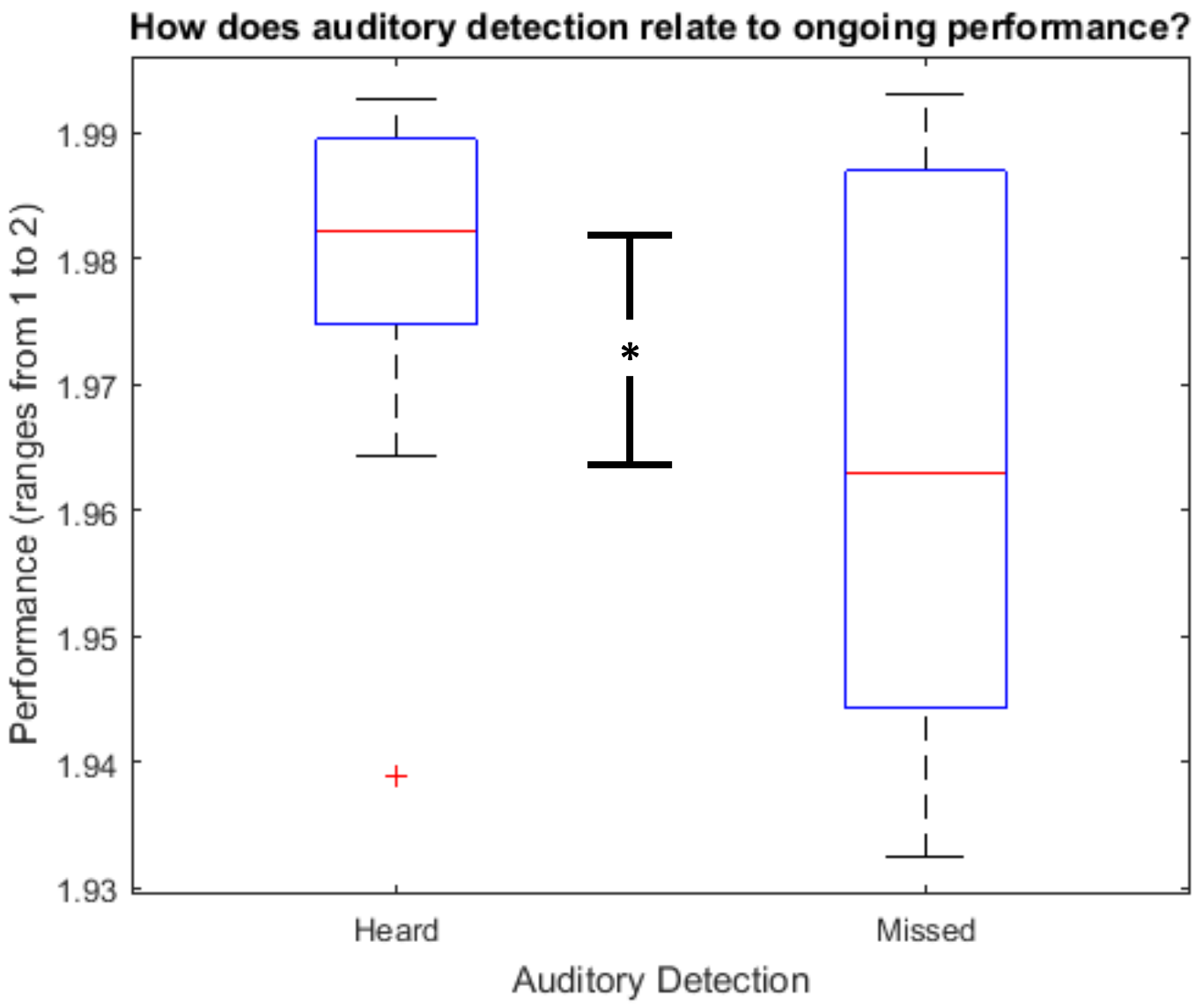
N = 17, half glider pilots, half novices

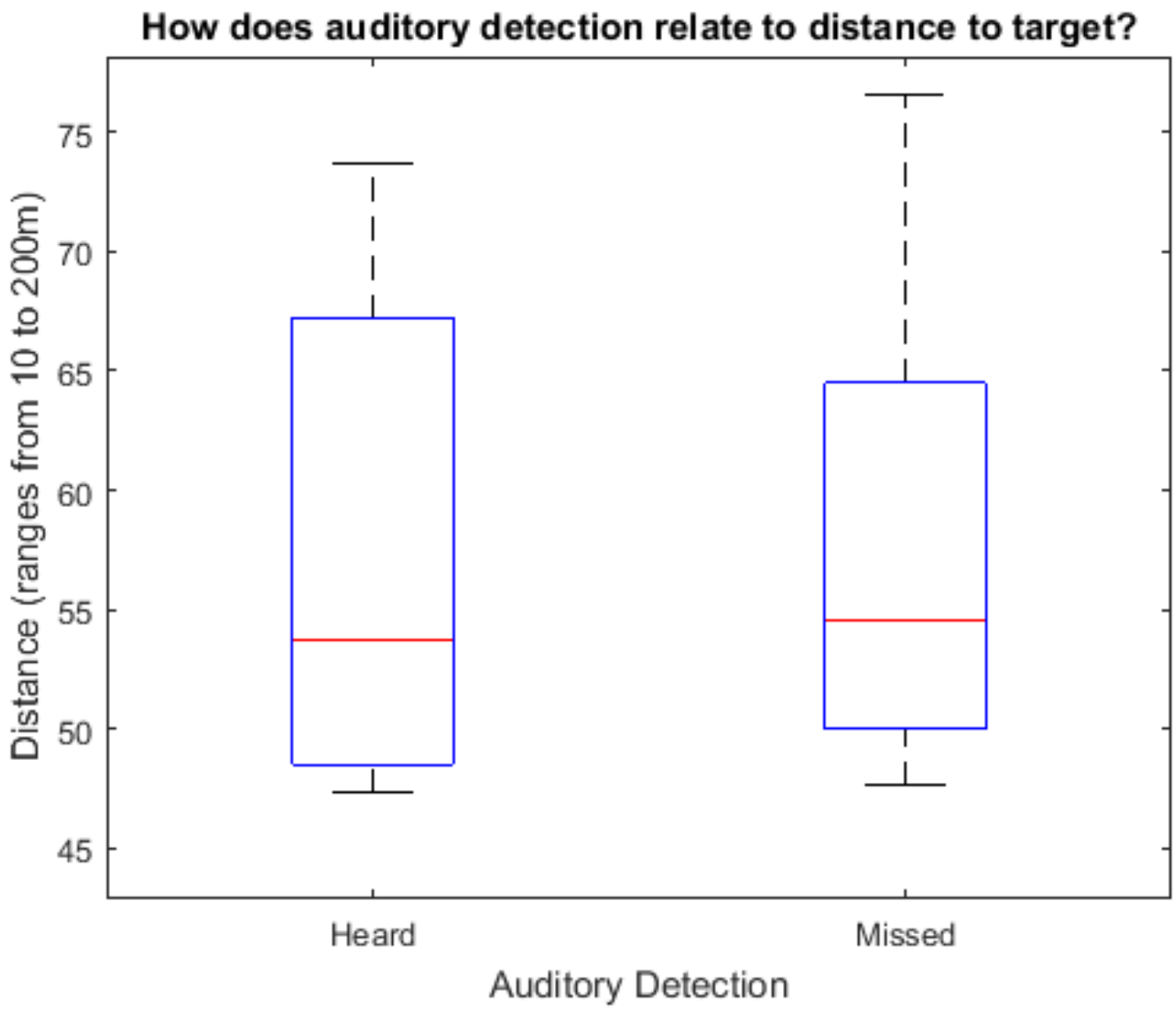
MEG EEG+MEG

fMRI


Heard while Flying
Heard while Passive
Missed while Flying
Missed while Passive
*
*
200
100
0
20
25
30
35
40
45
Mean
Median
# of Stimuli
Auditory Stimulus Volume


Heard while Flying RT
120
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
900
1000
*
Heard while Passive RT
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
Mean
Median
# of Stimuli
Reaction Time


How does auditory detection relate to ongoing performance?
Performance (ranges from 1 to 2)
1.99
1.98
1.97
1.96
1.95
1.94
1.93
Heard
Missed
Auditory Detection


How does auditory detection relate to distance to target?
Distance (ranges from 10 to 200m)
75
70
65
60
55
50
45
Heard
Missed
Auditory Detection

Behavioral Results Summary

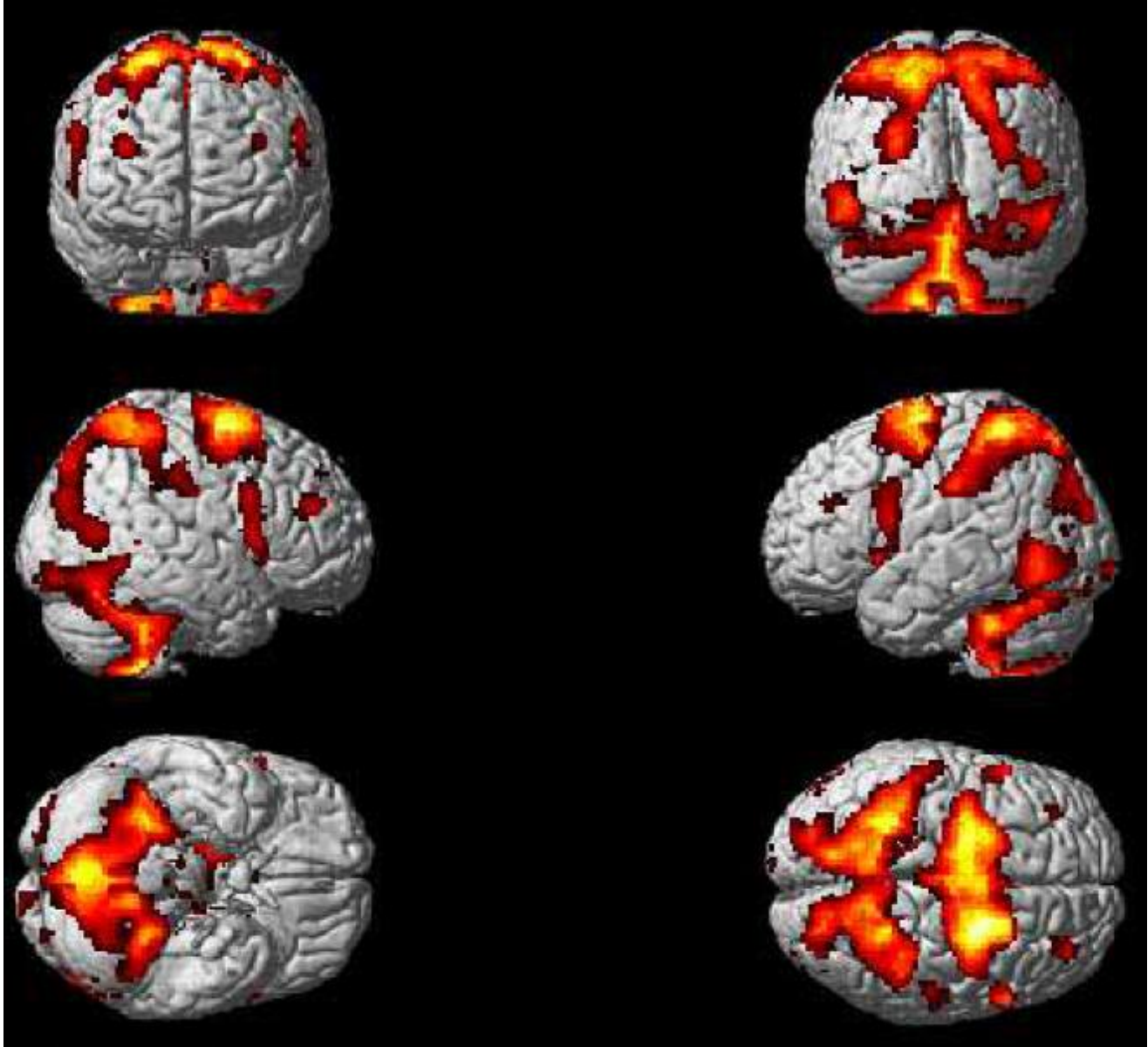
The flying task makes auditory detection harder, i.e. induces inattentional deafness

Worse performance on the flying task makes the auditory task even harder

No effect of distance manipulation on detection

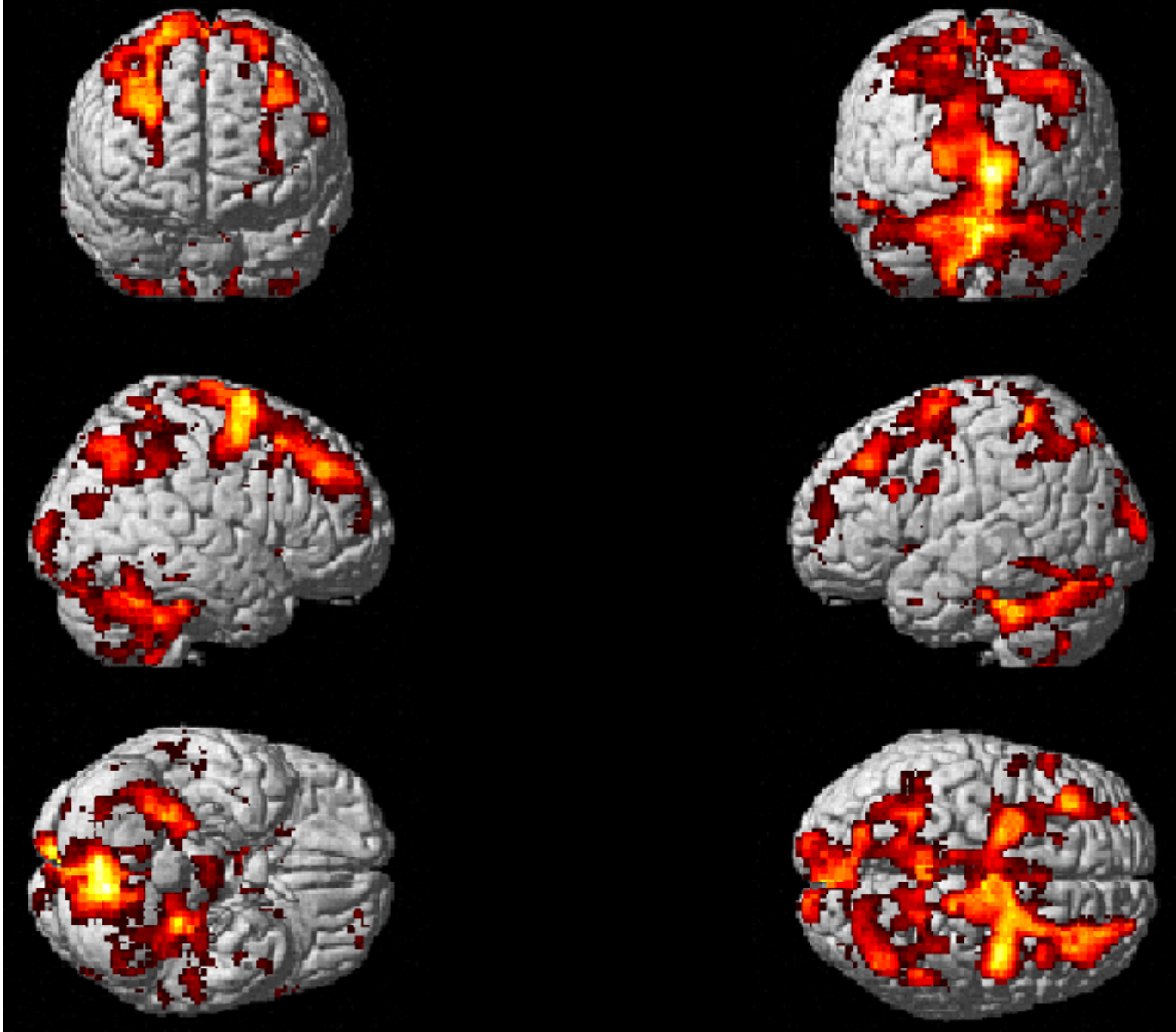
Block

Flying Task



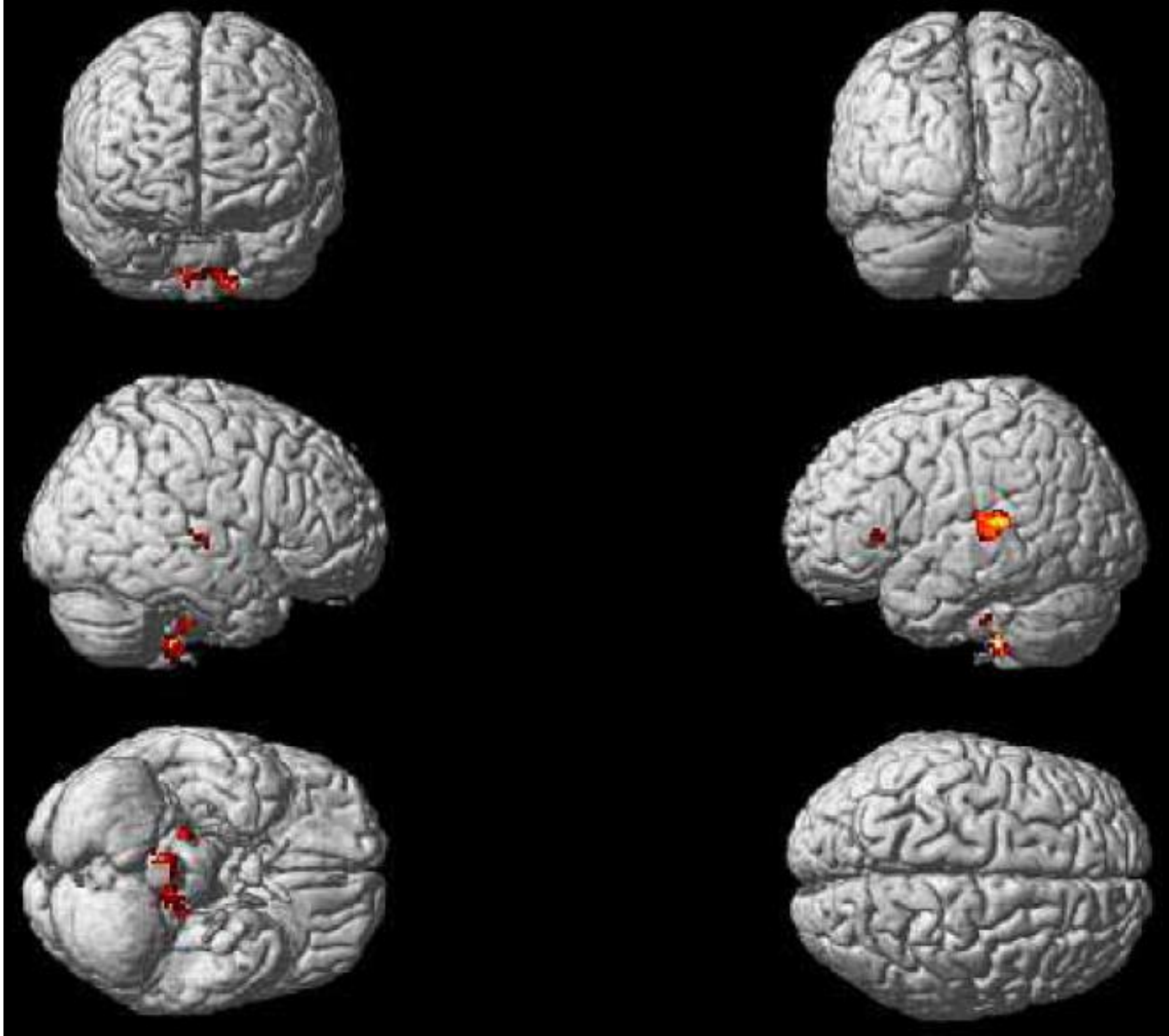
Event

Flying
>
Passive



Block

Auditory Task

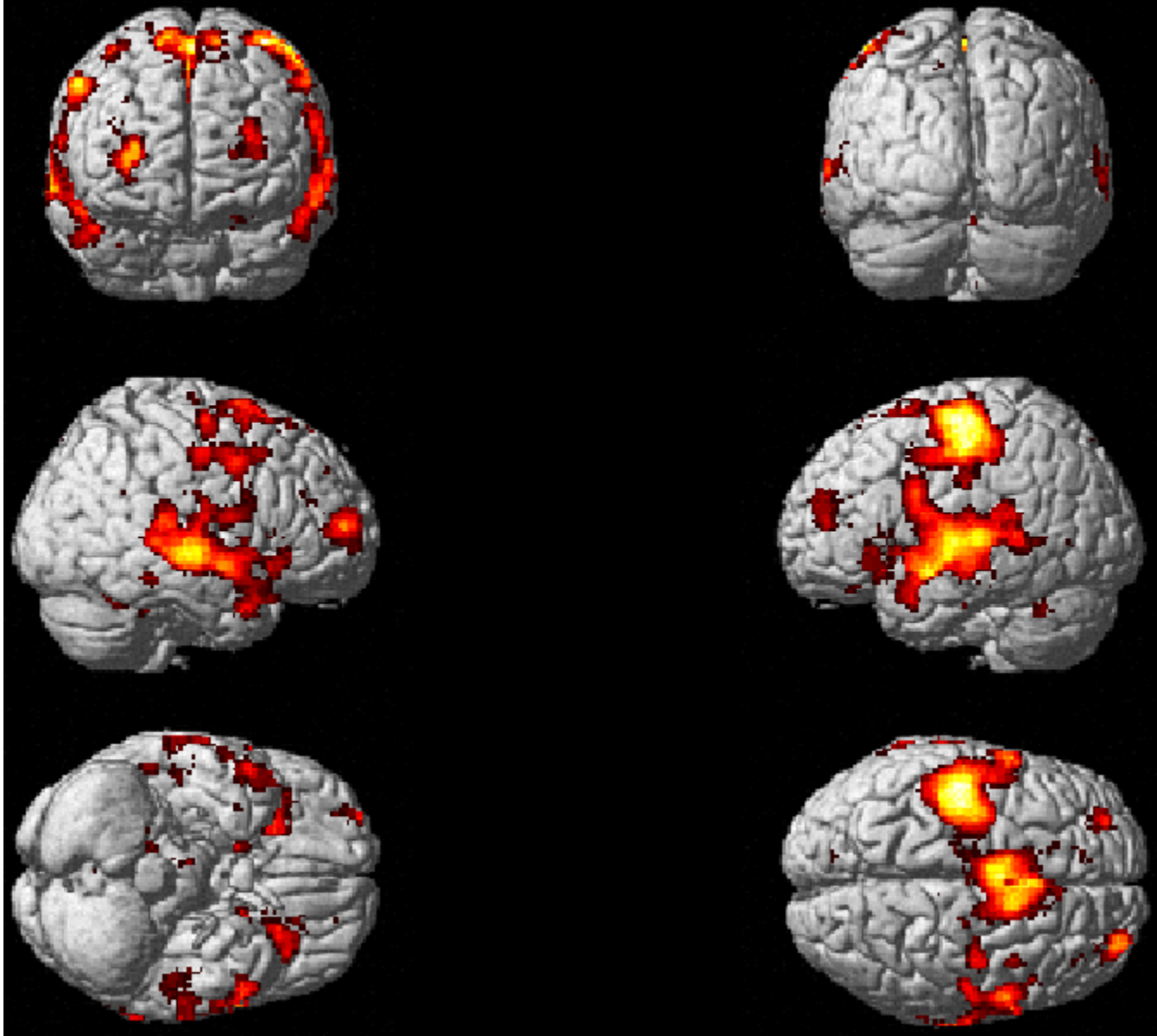


Event

Heard

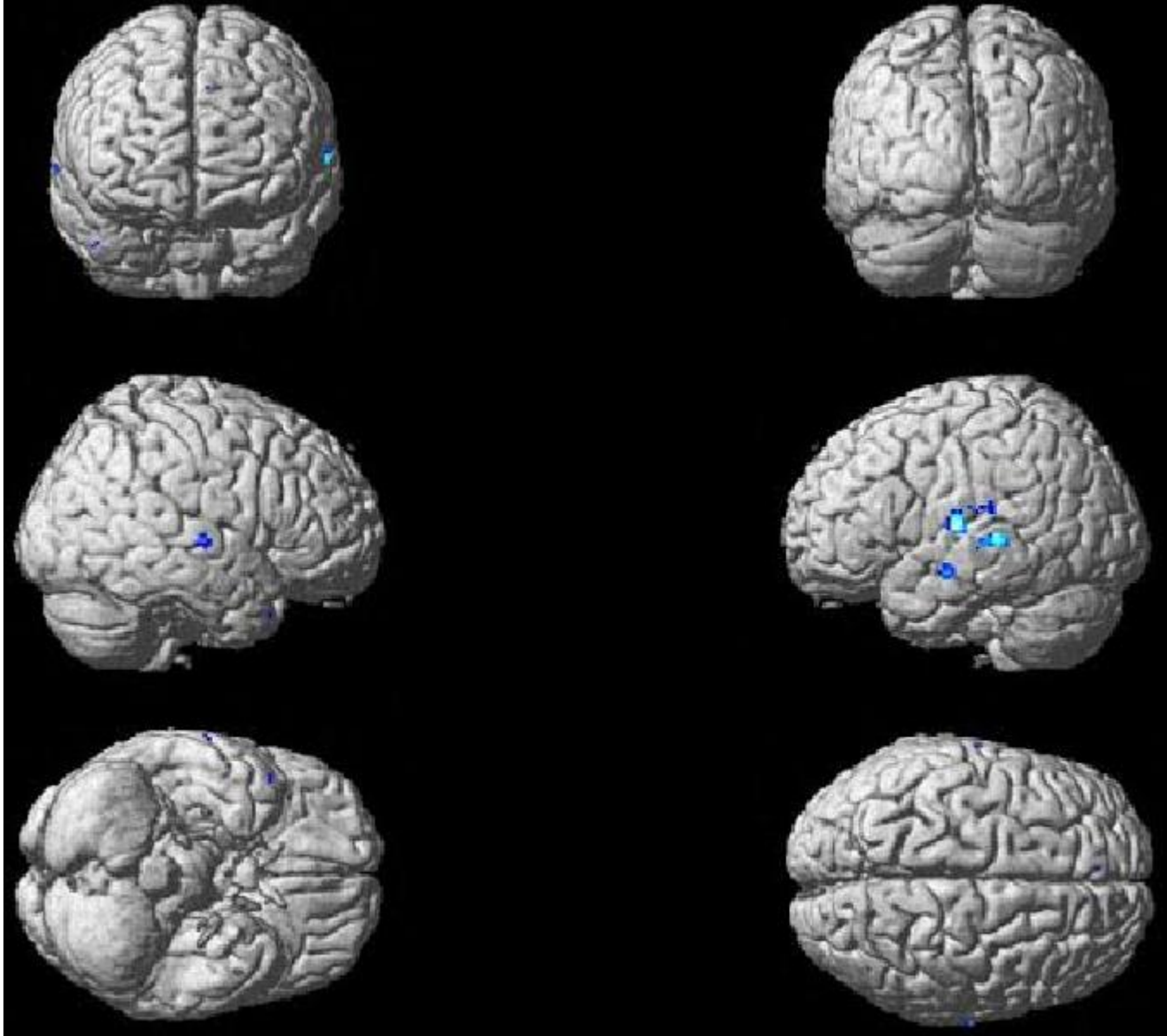
>

Missed



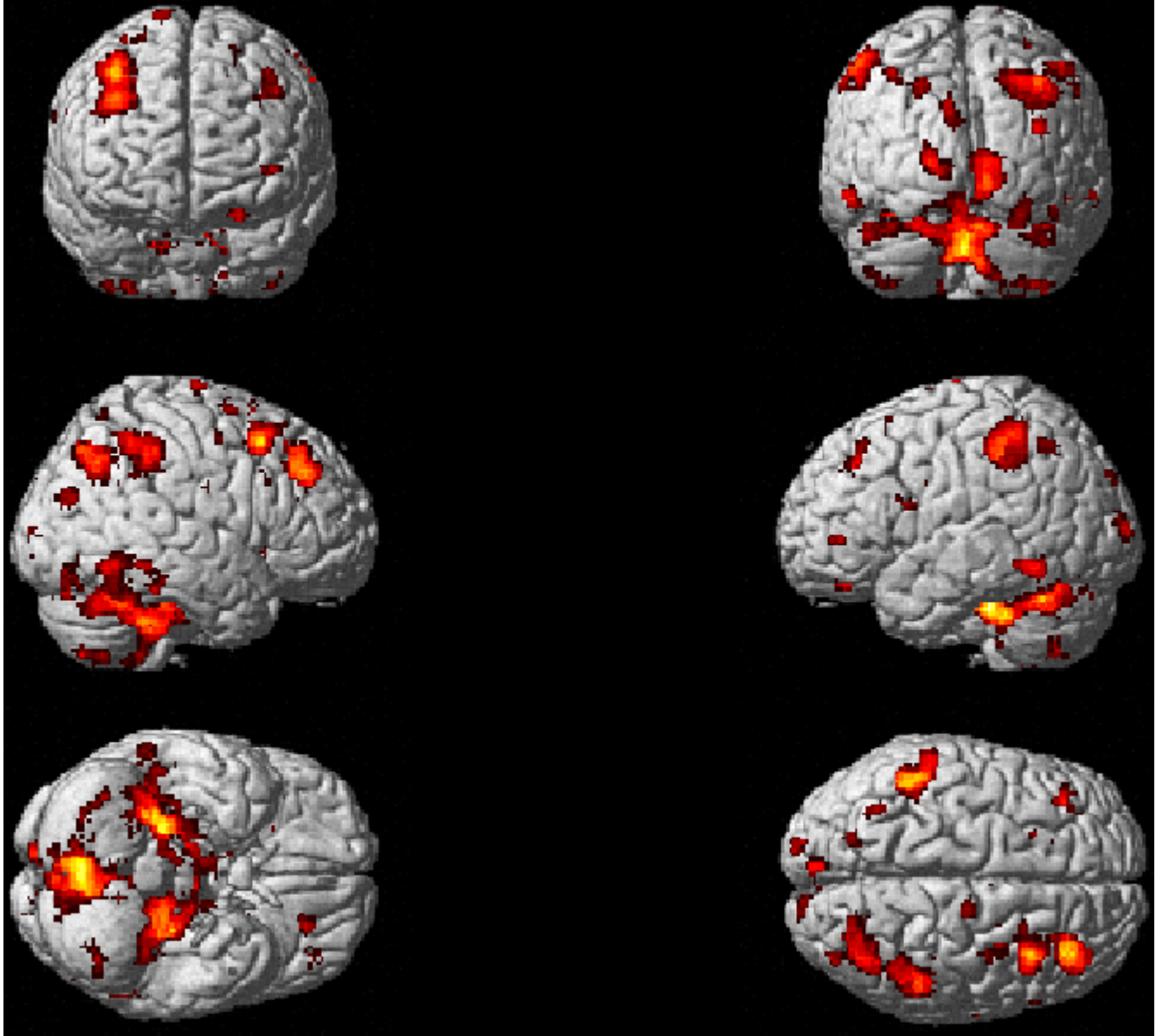
Event

Passive
>
Flying
&
Missed



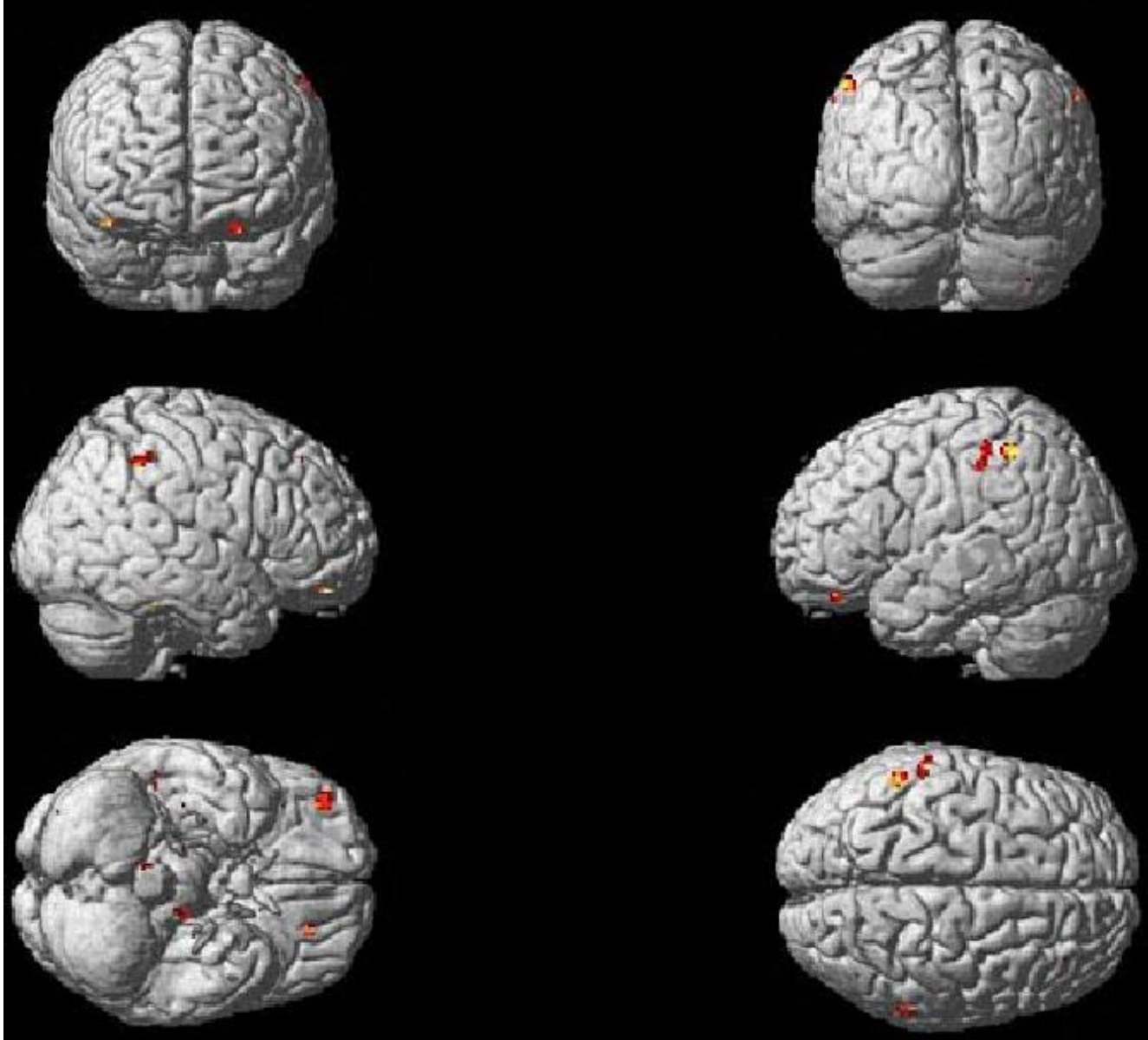
Event

Flying
>
Passive
&
Missed



Event

Flying
>
Passive
&
Missed
>
Heard



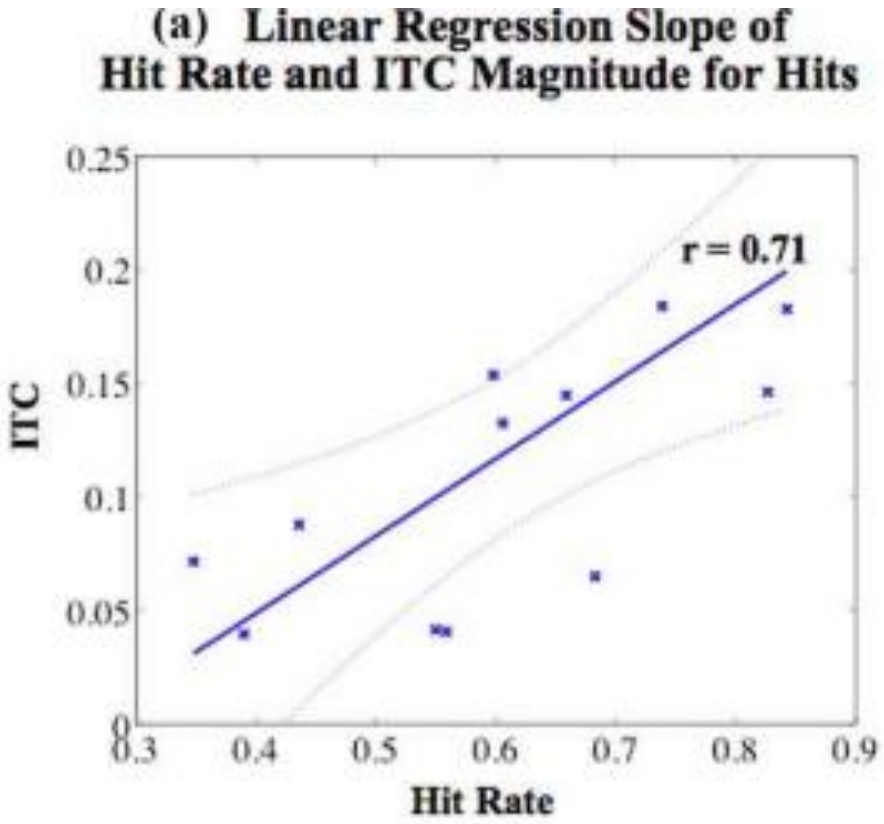
fMRI Results Summary

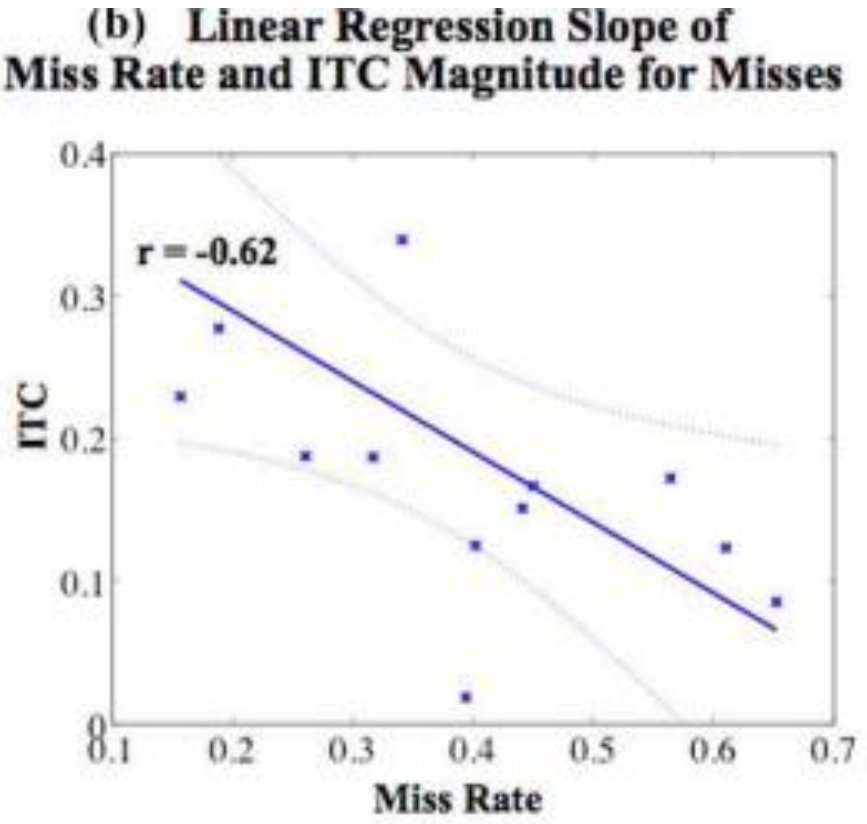
Inferior frontal gyrus
suppresses auditory regions
during high workload/low performance
to focus on non-auditory primary task

Implies an attentional bottleneck

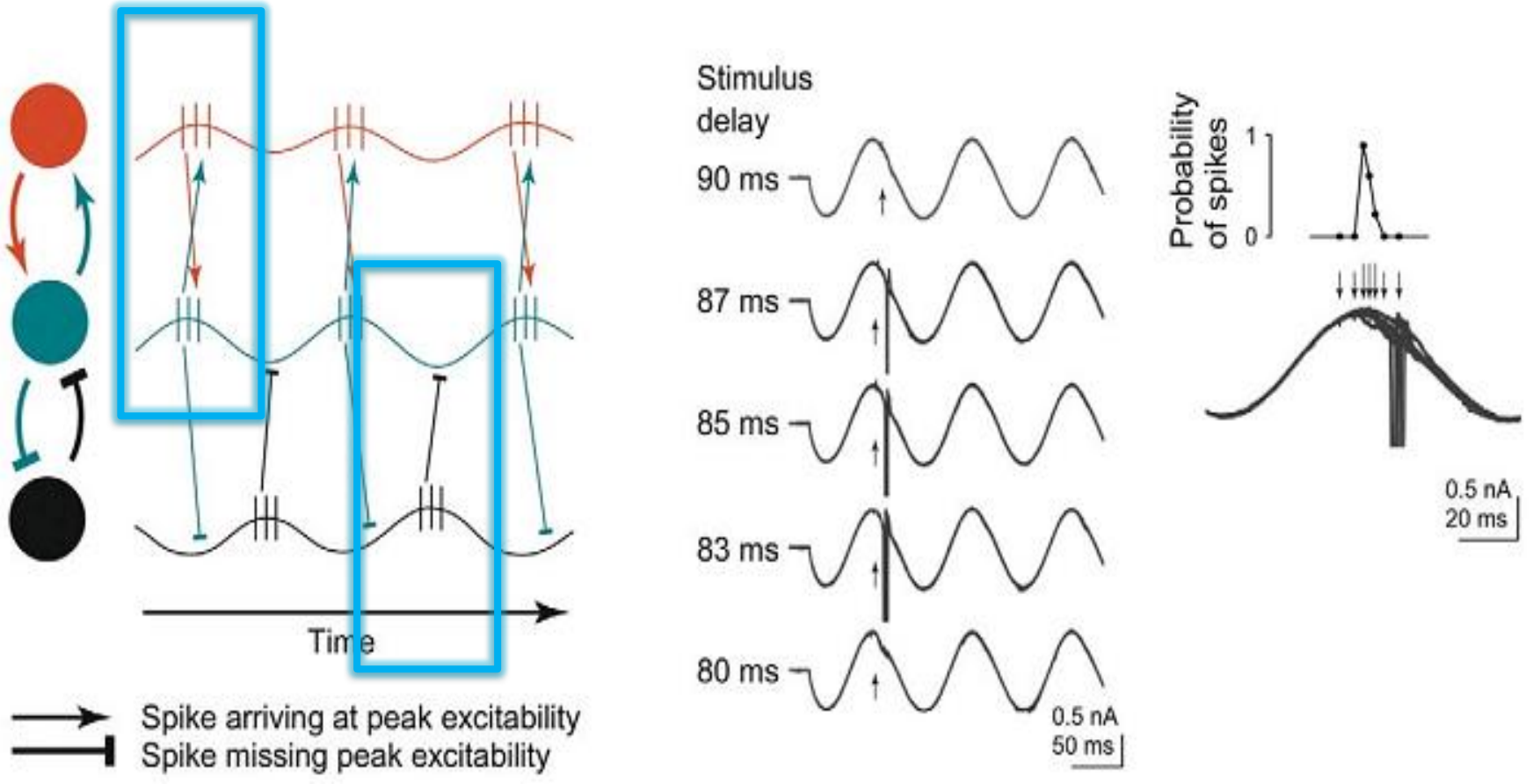
PPI connectivity analysis pending

Phase synchrony

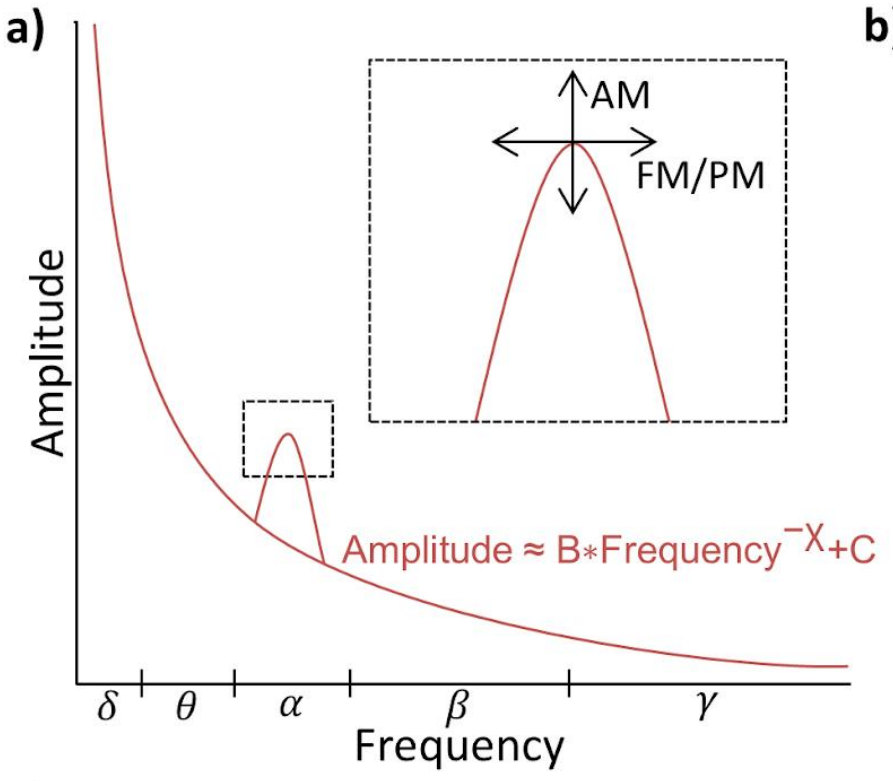


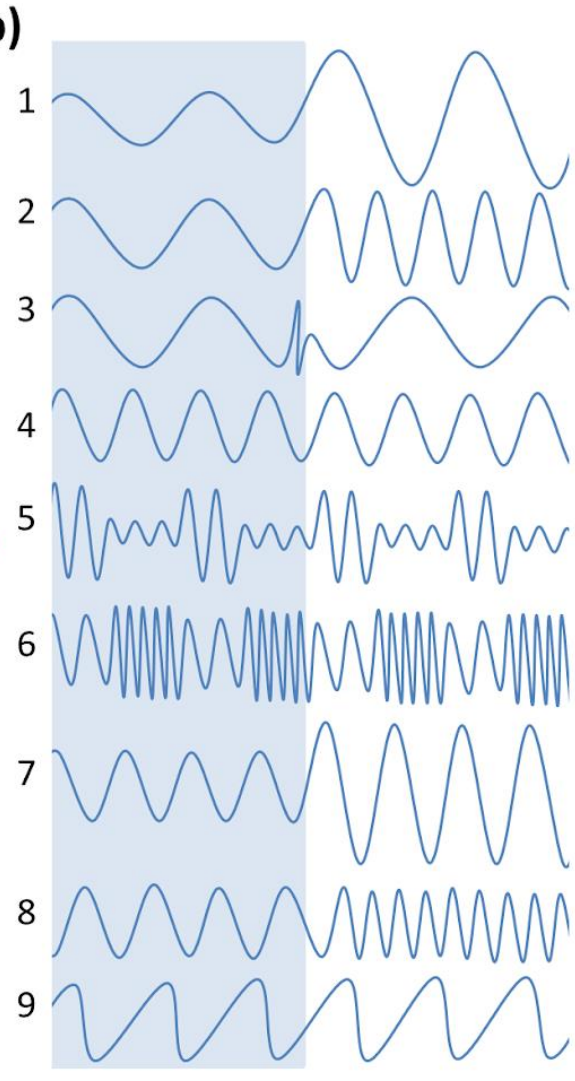


Callan, D. E., Gateau, T., Durantin, G., Gonthier, N., Dehais, F. (2018). Disruption in neural phase synchrony is related to identification of inattentional deafness in real-world setting. *Human brain mapping, 2018,* 1-13.

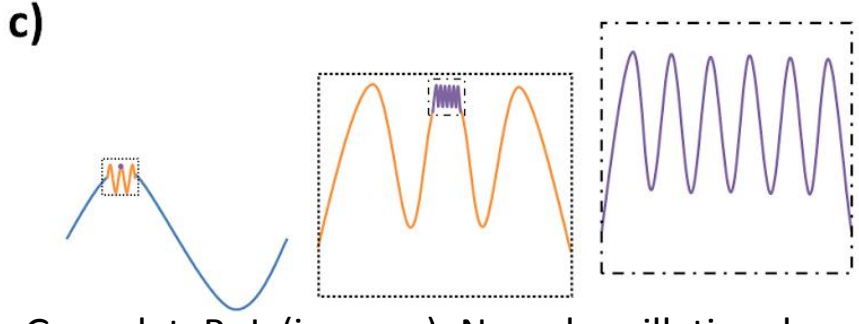


Fries, P. (2005). A mechanism for cognitive dynamics: neuronal communication through neuronal coherence. *Trends in cognitive sciences*, *9*(10), 474-480.





Dynamic	Rhythms
AM	1, 5, 7
FM	2, 6, 8
PM	3
PPC	1+4, 4+7
PAC	1+5
PFC	1+6
AAC	1+7
AFC	1+2, 1+8
FFC	1+8
Shape	9



Gougelet, R. J. (in press). Neural oscillation dynamics of emerging interest in neuroergonomics. Invited chapter for Elsevier book Neuroergonomics: The Brain at Work in Everyday Life.

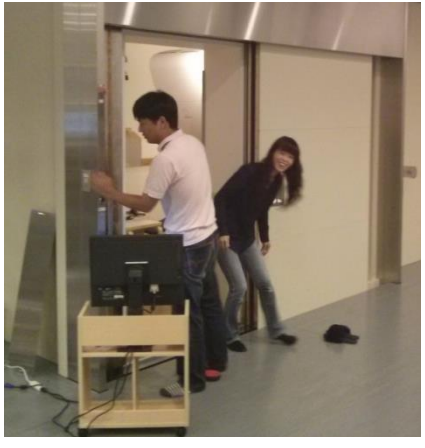
Next steps…

Determine if
IFG-auditory, frontal-posterior interaction
is mediated by alpha inhibition driven
by cross-frequency coupling

Extend findings
to neuroergonomic contexts
and applications

THANKS!

Cengiz Terzibas



Nishimoto-san & Otsuka-san

Daniel E. Callan

Bradley Voytek

NATIONAL SCIENCE FOUNDATION
EAST ASIA AND PACIFIC SUMMER INSTITUTES
FOR U.S. GRADUATE STUDENTS PURSUING SCIENCE AND ENGINEERING