

Electrophysiological correlates of suicide risk in selective attention to mortality-related stimuli

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Introduction

- Suicide rates have risen by 30% in the past two decades (National Center for Health Statistics, 2022).
- Prognosis for suicidal attempts remains poor, highlighting the need for objective markers, such as MEG.
- Previous research has implicated attentional bias as a marker of suicide risk^{1&2}, and distinct frontal brain regions and networks are implicated in attentional bias within the context of suicide risk, including PFC and ACC^{3&4}.
- While prior research has focused on executive brain regions, earlier stages of sensory processing and integration, such as in the middle temporal gyrus (MTG)⁵, remain underexplored.
- Attentional bias can be measured using computerized cognitive tasks, such as the Dot Probe Task^{6&7}.
- This study (n=53) used magnetoencephalography (MEG) to investigate neurophysiological correlates of suicide risk during the suicide dot probe task in three groups: individuals with a history of suicide attempts or ideation (**SR**); individuals with mood or anxiety disorders but no history of suicidal behaviors (**CC**); and individuals with no psychiatric disorder or history of suicidal behaviors (**HC**).

Goals

- **HYP1:** The SR group is expected to show *faster* reaction time in response to death-related words and *no difference* in reaction time to life-related words, compared to the CC and HC groups.
- **HYP2:** The SR group would demonstrate *decreased source-level MEG power* in sensory processing brain regions like the MTG across various conditions, compared to the CC and HC groups: death- and life-related words.
- **HYP3:** Dynamic Causal Modeling (DCM) in SPM12 was used to explore the *effective connectivity* between the sensory processing brain regions.

M (SD) (total n=53)	Suicide Risk (SR; n=17)	Clinical Controls (CC; n=17)	Healthy Controls (HC; n=19)	F-value	p-value
Age	36.79 (11.41)	46.53 (16.59)	29.32 (6.87)	8.18	.001
Female	13 (76.47%)	11 (68.75%)	9 (47.37%)	3.30	.192
White(E.A.)	13 (76.47%)	12 (70.59%)	9 (47.37%)	3.76	.153
MADRS	20.60 (11.10)	22.80 (9.13)	1.11 (1.36)	18.90	<.001
C-SSRS: CSI	1.75 (2.27)	1.12 (1.78)	-	2.71	.080
C-SSRS: PSI	25.90 (8.68)	12.30 (9.88)	-	11.80	.001

Table 1. Depressive symptom and suicide severity scores in sample. MEG measures were collected up to 2 days after clinical scales assessments.

- **Statistical Comparisons:** 1) ANOVAs and chi-square tests to assess group differences in descriptive statistics, 2) **Linear mixed effects models in 3dLMEr (AFNI)** to evaluate group differences in oscillating source-based estimation of MEG power in each frequency band of interest (theta[4-8Hz], alpha[9-14Hz], beta[15-29Hz], and gamma[30-58Hz]), and 3) **Dynamic Causal Modeling in SPM12** to probe effective connectivity between the early visual cortex (VC), superior parietal lobule (SPL), entorhinal cortex (EC), and middle temporal gyrus (MTG), accounting for age and biological sex.

Results

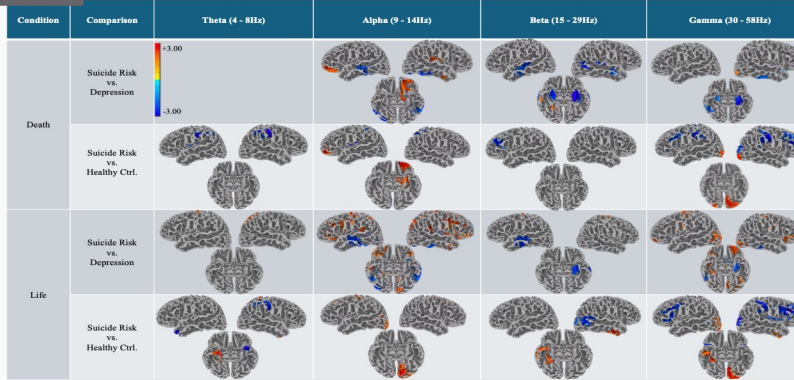


Figure 1. The Suicidal Risk (SR) group, compared to the CC and HC groups, showed reduced source-estimated MEG power across multiple bandwidths in the inferior/superior frontal gyrus, cuneus, postcentral gyrus, inferior/superior parietal lobule (SPL), entorhinal cortex (EC), and middle temporal gyrus (MTG), and increased MEG power in the inferior frontal gyrus, middle orbital gyrus, and cuneus in response to the death-related words ($p < 0.05$ voxel-wise corrected). Group differences were estimated while controlling for age and biological sex.

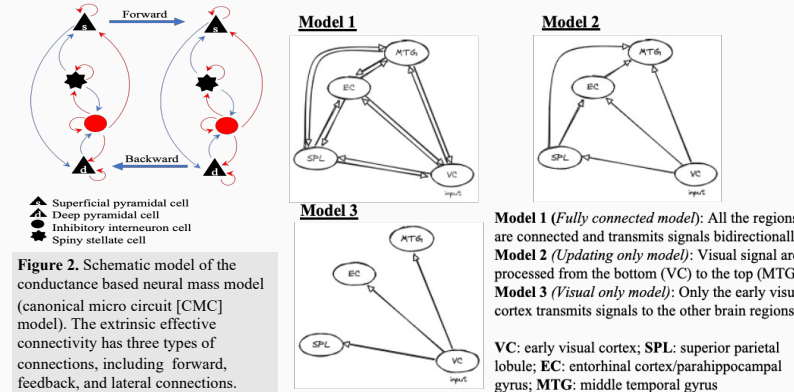


Figure 2. Schematic model of the conductance based neural mass model (canonical micro circuit [CMC] model). The extrinsic effective connectivity has three types of connections, including forward, feedback, and lateral connections.

Figure 3. DCM model specification: Different effective connectivity patterns were specified in three different models. DCMs were fitted using a wide frequency range from 1 to 40 Hz and temporal range from 1 to 200ms.

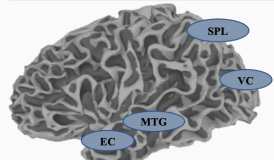


Figure 4. Bayesian Model Comparison (BMC) results. Model1 (fully connected model) showed the greatest negative free energy and was used for the following analyses.

Figure 5. DCM results. In response to death-related words, the SR group showed reduced feedforward connectivity from the early visual cortex to the EC, SPL, and MTG compared to the CC and HV groups. For life-related words, the SR group showed reduced connectivity from the MTG to the SPL compared to the CC and HV groups (Table 2).

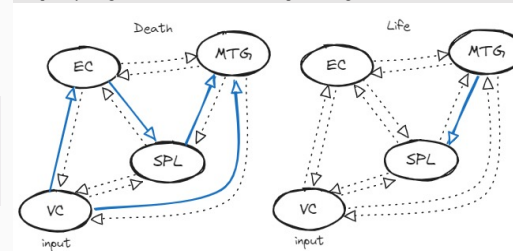


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SR group	From (to)	Death-related words				Life-related words			
		VC	SPL	EC	MTG	VC	SPL	EC	MTG
vs. CC group	VC			-0.384	-0.381				
	SPL				-0.470				
	EC			-0.317					
vs. HC group	MTG							-0.379	
	VC			-0.527	-0.562				
	SPL				-0.576				
	EC			-0.526					
MTG					-0.361	-0.479			

Table 2. Results of the DCM model (n=46), with *posterior p* > .95.

Results

- **HYP1:** There was no difference in reaction time was between the groups in any condition, with $ps < .05$.
- **HYP2:** The SR group, compared to the CC and HC groups, showed reduced source-estimated MEG power across multiple bandwidths, especially in the superior parietal lobule (SPL), entorhinal cortex (EC), and middle temporal gyrus (MTG), but also increased MEG power in a few brain regions in response to the death-related words, *voxel-wise corrected ps* < .05 (Fig. 1). In response to the life-related words, the direction of the MEG power in the SR group varied across different bandwidths in each comparison with the CC and HC groups.
- **HYP3:** In the death condition, the SR group showed decreased connectivity from the VC to the EC and MTG, and from the SPL to the MTG, compared to the CC and HC groups (*posterior p*=1). They also exhibited decreased connectivity from the EC to the SPL (*posterior p*=1) (Fig. 5)
- In the life condition, SR group demonstrated decreased connectivity from the MTG to the SP (*posterior p*=1).

Summary & Conclusion

- **HYP1: No significant reaction time differences** were observed among the groups.
- **HYP2:** The SR group showed *decreased source-level MEG power* for the death-related words and *variable MEG power* for life-related words across different brain regions, particularly the MTG, and bandwidths.
- The MTG may play critical role in signal processing and integration, particularly in the context of suicide^{8&9}. This suggests that individuals with suicide risk factors may experience *impaired sensory information integration when processing mortality cues*.
- **HYP3: Insufficient sensory processing and integration during mortality cue processing**, leading to impaired visual signal updating, may be a marker of the suicide risk.
- To better understand the relationship between ongoing sensory processing and suicide risk, computational modeling and longitudinal studies offer a promising approach.

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