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Neural and Parasympathetic Mechanisms of Momentary and Chronic Loneliness During Social Information Processing

[Neuronalne i przywspółczulne mechanizmy chwilowej i chronicznej samotności podczas przetwarzania informacji społecznych]

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Abstract

Loneliness, defined as subjective, distressing feelings of one's relationships not being sufficient in relation to their social needs, has been associated with deleterious health outcomes. One of the most prominent theories, proposed to explain the mechanisms linking psychophysiological mechanisms observed in loneliness to short- and long-term consequences, is the Evolutionary Theory of Loneliness (ETL). According to the ETL, loneliness is associated with increased bottom-up social threat perception, which in turn might impact top-down processing of social information. Therefore, the investigations regarding neural correlates of loneliness have focused on functioning of the brain structures associated with threat perception (amygdala; AMY), and mentalizing (the medial prefrontal cortex; mPFC, the temporoparietal junction; TPJ). Associations between these structures are also essential for adaptive responding to environmental demands, as posited by the Neurovisceral Integration Model (NIM). Importantly, the NIM emphasizes the role of heart rate variability (HRV) as a marker of context-sensitive responding, hence providing a framework for integrating neural and parasympathetic responses, and examining their associations in relation to loneliness.

The available results of the studies regarding cognitive mechanisms associated with loneliness are predominantly based on the cross-sectional investigations of participants characterized by the high and low levels of chronic loneliness. However, the examination of the impact of momentary loneliness on physiological responses might further extend the understanding of the trajectories underlying mechanisms observed in chronically lonely individuals. Therefore, this dissertation aimed at investigating parasympathetic and neural responses to social information in relation to momentary and chronic loneliness. Consequently, three studies were conducted. The first two studies used an experimental manipulation to investigate causal influence of momentary loneliness on parasympathetic (study 1 and 2) and neural (study 2) correlates of social information processing. In turn, the third study aimed at examining associations between parasympathetic and neural responses to social information, and chronic loneliness. We hypothesized that momentary and chronic loneliness will be linked to 1) increased negative affect and decreased positive affect, 2) decreased vagal flexibility, as indicated by the HRV task-related changes, which in turn will be associated with 3) decreased social brain activity. Furthermore, we expected to observe decreased task-related connectivity between the social brain structures and the AMY in chronically lonely compared to non-lonely participants.

In the first study, 128 individuals were randomly assigned to either future alone (FA) or future belong (FB) condition, and were asked to complete a social information processing task, while their changes in HRV were measured. In the second study, 63 participants were subjected to a corresponding experimental manipulation procedure during a neuroimaging session while their parasympathetic and neural responses to a social information processing task were recorded. The third study included 104 individuals with either high- or low-levels of chronic loneliness who completed a social information processing task while their neural and cardiac responses were measured. Additionally, in each of the studies, affect ratings were collected during the procedure.

Across all three presented studies, we observed hypothesized differences in affect ratings during the corresponding procedures. Additionally, in both studies which utilized the induction of loneliness, a decreased pattern of vagal flexibility was observed in the FA in comparison to the FB group, which might indicate reduced task mobilization as the result of momentary loneliness. While no significant between-group differences in activation of the main regions linked to the 'social brain' were found, a positive correlation was observed between vagal flexibility and the left TPJ activation in the second study, which may suggest a need for compensatory processing of socioaffective information as the result of momentary loneliness. Despite the absence of the hypothesized findings, we observed tentative evidence for differences between lonely and non-lonely individuals in the processing of social information at early stages of the visual pathway in the exploratory analysis.

Taken together, the presented results were only partly congruent with the hypotheses. Thus, this work emphasizes that mechanisms accompanying momentary loneliness do not extend to chronic loneliness. As these findings do not support the psychophysiological mechanisms suggested by the ETL, a different conceptualization for investigating mechanisms underlying loneliness might be required.

Keywords: functional magnetic resonance imaging, heart rate variability, loneliness, social information processing