

# Individual Differences in Social Media Use Are Reflected in Brain Structure

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## Abstract

Online social media has become an integral part of our social lives. Online social interactions are distinct from face-to-face interactions. Different social media types have enabled novel forms of social exchanges to take place. Individuals vary greatly in their online behaviors and preferences. The current research argued for the significance of understanding individual differences in social media behaviors from brain structure variability. Using a novel approach that combined methodologies from personality and neuroscience, this research found that variations in social media behaviors and preferences were reliably reflected in brain structure. Interestingly, the general preference for an online mode of social interaction reflected decreased volumes of grey matter in regions involved in facial and speech processing. The associations between patterns of media behaviors and brain structure obtained in this research had demonstrated the feasibility of adopting a neuroscience approach to explain the complex differences in media behaviors.

## Introduction

Recently, online social media has proliferated as a vibrant platform for human social interactions to take place. Individuals vary greatly in terms of their preferences and behaviors when engaging the social media. Social exchanges via the online social media have important characteristics that distinguish them from traditional face-to-face interactions (Bargh & McKenny, 2004). Thus, people can differ in the preference for an online versus an offline mode of interaction. Also, the various social media types each have distinctive functions that allow unique

forms of social interactions to take place. Consequently, individuals differ in how they use the social media and their associated functions. Individual patterns of social media behaviors and preferences reflect one's personality traits (Ross et al., 2009), cognitive abilities (Small et al., 2009), and even genetic make-up (Kirzinger et al., 2012). Hence, they can serve as informative sources about a user's psychological dispositions.

This research forwards the perspective that brain structure provides a useful substrate to link patterns of online behaviors and preferences to an individual's psychological characteristics. Firstly, brain structure is plastic and sensitive to effects of training and experience (Boyke et al, 2008). As such, brain structure variability can capture both the genetic and environmental influences that moderate online behaviors. Secondly, converging neuroscience research (reviewed in Kanai and Rees, 2011) has shown that brain structure differences i.e. local volumes of grey and white matter predicted individual differences in a wide range of cognitive functions including: basic abilities such as perception and attention; and higher order abilities such as social cognition and decision-making. By examining links between brain structure variability and online behaviors and preferences, inferences could be made about the underlying cognitive mechanisms behind these individual differences. Lastly, brain structure was found to predict differences in complex behavioral traits that are traditionally related to online preferences and behaviors e.g. the Big Five personality traits (DeYoung et al., 2010) and self-esteem (Frewen et al., 2012). Taken together, brain structure provides a vital link between complex online behaviors, personality traits, and cognitive functions.

## Method

To elucidate this, the current study adopts a novel approach that combines methodologies from personality and neuroscience research: A questionnaire, Social Media Questionnaire (SMQ) was designed to obtain self-reported measures of behaviors and preferences when using the common forms of social media (Email, Online Messaging, and Facebook). Using Principal Component Analysis (PCA), reliable factors corresponding to patterns of online behaviors and preferences were extracted. A total of six factors were obtained – 4 factors for Facebook and 1 each for Email and Online Messaging. Email Factor 1 (E1) consisted of items about a preference for communication via email than face-to-face. Similarly, Online Messaging Factor 1 (OM1) had items about a preference for online messaging over real-life conversations. Facebook Factor 1 (F1) corresponded to the tendency to check notifications, comment and reply to comments frequently. The second factor (F2) reflected items about a willingness to disclose and share personal information via Facebook. Factor 3 (F3) mainly included behaviors about using Facebook to exchange information for a social purpose. The last factor (F4) was mainly about the tendency to use Facebook to extend one's social network and included behaviors such as adding strangers as friends etc.

These factors were further correlated with trait measures and with grey matter volume via Voxel-Based Morphometry (VBM) to illuminate the relationships between online behaviors, personality traits and brain structure.

## Main Findings

### Preference for an online mode of social interaction versus face-to-face

The preference to engage in social interaction via online rather than face-to-face was consistently associated with decreased grey matter volumes in brain regions implicated in processing faces and spoken language across the 3 media types: Decreased volumes in the left superior temporal gyrus (STG) and right occipital-temporal fusiform regions were associated with preferences for communicating via email (E1) and online messaging (OM1) over face-to-face interactions. F1 corresponded to a tendency to check and reply to comments and notifications on Facebook and also reflected a preference for online social interactions. This factor was significantly related to smaller regions in the lingual gyrus and the middle occipital gyrus. These results suggest that people who prefer online interactions in general had decreased volumes

in areas associated with facial and spoken language processing. These functions are features typical of face-to-face interactions that were absent in online interactions. Thus, our results suggest that the preference for online interactions may be due to reduced ability to cope with demands in real-life interactions.

The preference for online interactions over face-to-face also related to larger volumes in the middle temporal gyrus (MTG) which was involved in more general aspects of language production and comprehension such as processing the meanings of words and sentences, understanding metaphors etc. (Cabeza et al., 2000 & Just et al., 1996).

This suggested that individuals who prefer online interactions were not less predisposed to process language in general but only aspects of spoken language. Instead, they could be better in processing language. This might explain their preference for an online mode of interaction that generally relied more on understanding and producing language in a written format.

### Tendency to engage in social activities through online social media

Much of research about media and the Internet use had been focused on examining the impacts of the engaging in online social activities (McKenna and Bargh, 2004). There had been much debate with regards to whether online interactions have negatively or positively impacted our social lives. The “negative” camp argues that online interactions are “impoverished and sterile” compared to real-life interactions and was associated with loneliness and depression (McKenna and Bargh, 2000). Since people could just communicate from the comfort of their homes, online interactions might lead to weakening of social ties between people. On the other hand, other scholars have argued that online interactions had provided a new platform that facilitated social exchanges (Kraut et al., 2002), forming of groups (Katz et al., 2001) and improved connectivity between people (Howard et al., 2001).

Pertaining to this debate, our research provided an alternative perspective by looking at how the self-reported tendency to engage in social activities was reflected in brain structure. F3 and F4 both reflected tendencies to share and obtain social information through Facebook and to use Facebook as a means of meeting new people respectively. As such, both factors reflected tendencies towards engaging in socializing activities through the online media. Interestingly, both factors reflected a similar pattern of neural correlations: decreased grey matter volumes in the bilateral insula and anterior cingulate cortex. These regions are implicated in a whole range of

social cognitive processes such as the regulation of emotions, processing and integration of social information and even higher order processes such as empathy and social-decision making. From this result, it seemed that a higher tendency towards using online media for socializing in general reflected decreased regions involved in higher order social processes.

### Tendency towards online self-disclosure

Another interesting factor obtained from the study reflected a tendency towards disclosing and sharing of personal information online (F2). The present study found that this tendency was positively correlated with traits of extraversion and openness to experience. This research further revealed possible underlying mechanisms behind this relationship. It was found that increased grey matter volumes in the orbitofrontal cortex (OFC) and posterior MTG reliably predicted the tendency to engage in the sharing of personal information via Facebook. The OFC was commonly implicated in the encoding and processing of rewards (Kringelbach, 2005) and the integration of social and emotional information in decision-making (Bechara et al., 2000) while the posterior region of the MTG was implicated in the processing of social and emotional information from faces and other visual cues (Critchley, 2000 and Allison, 2000). This suggested that the tendency towards self-disclosure online was related to the ability to process social information and rewards. Furthermore, studies had found associations between OFC and extraversion (Omura et al., 2005; Rauch et al., 2005) DeYoung et al. (2010) further found that the size of the OFC was positively related to extraversion and postulated that extraversion related to an increased ability to experience rewards from social interactions. Taken together, these findings suggested extroverts tend towards online self-disclosure because they are predisposed to experience feelings of reward from the social affiliation afforded by it.

### Conclusion

Using a novel approach that combined research methodologies from personality psychology and neuroscience, the current study had yielded important insights into the individual differences in online media preferences and behaviors that could otherwise not be obtained solely from a personality approach. This study advanced the perspective that neuroscience enabled a means to bridge individual differences in complex behaviors such as media behaviors to more basic cognitive mechanisms. The significant and meaningful associations between patterns of media behaviors and brain structure obtained in project had demonstrated the feasibility and

effectiveness of adopting a neuroscience perspective to explain more complex differences in behaviors.

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