Exploring active and passive interactions in social networking services: a psychological needs perspective

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Abstract

Purpose – People's socializing behavior in social networking services (SNS) presents dramatically different features, forming differentiated online social interaction patterns (DOSIP) in SNS. This study aims to explore the relationships between users' multidimensional psychological needs and multiple social interaction patterns in SNS.

Design/methodology/approach – Based on Maslow's hierarchy of needs and use and gratifications (U&G) theory, the authors develop the research model to examine the effects of psychological needs on DOSIP. A survey is used to collect the data of SNS users' social interaction. The authors adopt structural equation modeling–neural network (SEM-NN) integrated method to examine the research model.

Findings – Need to belong, need for self-esteem, need for social contact, need for emotional expression, need for cognition, and need for external-esteem have significant influences on both active and passive social interactions respectively.

Originality/value – Based on the categorization of DOSIP into six types in terms of the level of activity and disclosure of social interaction, the authors construct an integrated research model of multidimensional psychological needs to multiple social interaction patterns and validate the antecedents of DOSIP from the perspective of psychological needs.

Keywords Psychological needs, Social networking services, Need to belong, Self-esteem, Active interaction, Passive interaction, Structural equation modeling, Neural network

Paper type Research paper

1. Introduction

Online social interaction has been one of the essential parts of people's daily life (Cingel et al., 2022). Social networking services/sites (SNS), such as Twitter, Facebook, WeChat, Weblog, QQ, YouTube, Whatsup, and Instagram, are increasingly popular nowadays, and they are examples of web-based services that allow people to establish a public or semipublic connection network (Boyd and Ellison, 2007). The purpose of SNS is to establish an online platform for people's social interaction networks by which people can contact with others, post

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their opinions, update statuses, build friendships, or gain knowledge. Since SNS have been weaved into many people's lives, they can keep checking their SNS accounts almost constantly and many do. In addition, people can present their offline life more abundantly via SNS, which faithfully reflects users' objective living status, ideas, and thinking (Yang et al., 2019).

Further development in the usage of SNS makes online social interactions show dramatic differences, which forms differentiated features (Buccafurri et al., 2015; Lin et al., 2017). For instance, some users frequently post opinions, some rarely express their opinions (either due to a lack of usage or a preference to be passive observers); and some prefer to post opinions (through different levels of controlled exposure to different groups if desired). These different forms of social interaction in SNS are regarded as differentiated online social interaction patterns (DOSIP) in this study. They refer to users' typical manners of social interaction with others, reflecting differences in the level of activity and disclosure in SNS (Burke et al., 2010; Reich and Vorderer, 2012; Valkenburg et al., 2022). DOSIP uncover how users of SNS react to online posts, which reveals many characteristics that may not be observed in classical offline social interaction contexts.

Firstly, DOSIP may vary according to the level of activity initiated by SNS users. User interactions could be either active or passive interactions in terms of the direction of interaction initiation (Reich and Vorderer, 2012; Valkenburg et al., 2022). Active interactions refer to direct communication with other users, such as posting content, commenting on posts, initiating chat and other activities directed to user(s) (groups) in SNS (Reich and Vorderer, 2012; Ding et al., 2017; Tobin et al., 2020). On the other hand, passive interactions refer to consuming or browsing information in SNS without direct communicating with other specific user(s) (groups), for example, viewing hot news, browsing content posted by friends, etc. (Reich and Vorderer, 2012; Ding et al., 2017; Tobin et al., 2020). Active and passive interactions are distinguished by the method in which users communicate with others – direct and indirect, respectively.

Secondly, DOSIP may also vary according to the level of disclosure chosen by SNS users. User interactions could either be public, selective public, or private interactions according to the range of interactions audience (Reich and Vorderer, 2012; Valkenburg et al., 2022). Public interaction means that information is published on a public platform, and anyone can view and interact with users. Selective public interaction imposes control of visibility of user-generated content (UGC) and/or interactions to certain individuals (and/or groups) chosen by the user. Private interaction refers to one-to-one chat between users, which is more intimate and more commonly used than public interaction (Reich and Vorderer, 2012; Valkenburg et al., 2022).

Therefore, all interaction patterns can be classified via the activity and disclosure dimensions described above. Consequently, active interactions can be classified into active public, active selective public, and active private interactions. Passive interactions are classified into passive public, passive selective public, and passive private interactions. The systematic classification of interactions is conducive to understanding users' socializing behavior in SNS.

The relationships between psychological factors and the use of SNS are widely examined in extant studies which validate the prediction of self-esteem (Huang et al., 2015; Saiphoo et al., 2020), need to belong (Gangadharbatla, 2008), psychological cognition (Gangadharbatla, 2008), psychological discomforts (Jo, 2022), emotional expression (Zhao et al., 2021), and so on. Besides, use and gratifications (U&G) theory suggest the significant effects of psychological factors on users' behavior in SNS (Reich and Vorderer, 2012; Huang et al., 2015; Ifinedo, 2016; Mantymaki and Islam, 2016; Zadeh et al., 2022). These studies provide the base for us to investigate the users' social interactions from the perspective of psychological needs. It is proved that users tend to interact variably in SNS to fulfill different psychological needs such as need to belong, self-esteem, social contact (Winter et al., 2014; Cao and Meng, 2020; Zhao et al., 2021). However, the relevant investigations only focus on the relationships between certain psychological needs and several social interaction patterns, and are scattered in many studies (Macrynikola and Miranda, 2019; Zhao et al., 2021). There is a research gap for a unified

theoretical framework to examine the relationships between the multi-dimensional psychological needs and multiple social interaction patterns in SNS. To fill the gap, we try to explain DOSIP in SNS from the intrinsic motivation of users' psychological needs in a more systematic and comprehensive research model based on Maslow's hierarchy of needs and U&G theory. Therefore, we propose the research question: How do the multi-dimensional psychological needs of users affect DOSIP in SNS? The findings will answer which specific psychological needs incur certain typical social interaction patterns in SNS.

The theoretical contribution is to provide a unified framework by validating the motivations of users' multi-dimensional psychological needs on social interaction patterns in terms of activity and disclosure. The findings also reveal the intensity and importance of the effects of various needs on different interaction patterns in SNS, which advances the studies on users' social interactions in SNS. In practice, based on the findings of this research, SNS designers may better customize their portfolio to meet various psychological needs, and public opinion management sectors can also recognize and understand users' featured social interaction patterns in SNS.

2. Related studies

We firstly review the effects of psychological factors on SNS use, and then discuss the studies about social interactions in SNS. Thereafter, we summarize the main advances and research weaknesses in this area.

2.1 Psychological factors and the use of SNS

Considerable studies highlight the motivation of psychological factors to SNS use. Gangadharbatla (2008) confirms that Internet self-efficacy, "need to belong," and self-esteem positively influence users' attitude to SNS. Zhang et al. (2011) suggest that psychological traits such as self-esteem, emotional openness, and communication apprehension strongly affect Facebook usage. Some recent extant studies report that emotional expression, self-esteem, and psychological feeling are essential predictors of SNS usage (Choi and Kim, 2016; Saiphoo et al., 2020; Jo, 2022). For example, Saiphoo et al. (2020) verify the internal relationship between self-esteem and the frequency/intensity of SNS use. Jo (2022) finds that psychological discomfort affects the intensity of SNS use. Furthermore, U&G theory, as the theoretical foundation, is widely used to explain the prediction of psychological factors to the use of SNS (Baek et al., 2014; Huang et al., 2015; Ifinedo, 2016). For instance, Huang et al. (2015) confirm that there a positive correlation between self-esteem and Facebook use.

2.2 Social interactions in SNS

Various social interaction activities in SNS are empirically examined. Burke et al. (2010) propose the active and passive communication in SNS for the first time. Subsequently, Pagani et al. (2011) find that self-identity and social identity expression have positive impacts on the active posting, and innovativeness positively affects passive viewing. Reich and Vorderer (2012) confirm "need to belong" as an effective predictor of social interaction in SNS, such as active personal/public interaction and passive personal/public interactions. Mantymaki and Islam (2016) suggest that social enhancement is link with active participation and passive following. Gerson et al. (2017) suggest that reward reactivity is positively correlated with Facebook active and passive use based on the reinforcement sensitivity theory. Zhang et al. (2021) find that emotion expression positively affected distress disclosure on SNS. Zadeh et al. (2022) confirm the impact of psychological predictors on social media information sharing, responsible behavior, and personal interaction based on the U&G theory. The frequency of interactions also varies according to the type of interaction. For example, the active private interaction is twice as frequent as active public interaction (Valkenburg et al., 2021),

2.3 Summary of literature

We summarize the subjects, relevant independent and dependent variables, and methodology of extant studies into Table 1.

The above discussion in Sections 2.1-2.2 and summarization in Table 1 suggest that the prediction of psychological factors to users' behavior in SNS are effectively validated with empirical methodology. The popular psychological factors consist of need to belong, self-esteem, need for cognition, need for emotional expression, need for social relation, and psychological discomforts. Users' behavior in SNS includes general use of SNS, specific use o

Subjects	Psychological factors/Independent variables	Dependent variables	Methodology and data sources	Sources
The use of SNS	Need to belong, self-esteem, need for cognition	Attitude toward SNS	Regression analysis/Survey	Gangadharbatla (2008)
	Collective self-esteem, emotional openness	Facebook use	Regression analysis/Online survey	Zhang et al. (2011)
	Need to belong/ satisfaction	SNS continuance intention	SEM/Survey	Lin et al. (2014)
	Self-esteem	Facebook game use	Regression analysis/Survey	Huang et al. (2015)
	Social gratification, hedonic gratification	WeChat continuance intention	SEM/Survey	Gan and Li (2018)
	Self-esteem	SNS use frequency, intensity	Meta-analysis	Saiphoo et al. (2020)
	Psychological discomforts	SNS usage intensity	SEM/Survey	Jo (2022)
Social interaction in SNS	Well-being	Active/passive communication	Regression analysis/Survey	Burke et al. (2010)
	Self-identity, social identity expression, innovativeness	Active posting/passive viewing	SEM/Survey	Pagani et al. (2011)
	Need to belong	Active interaction/ Passive interaction	Regression analysis/Survey	Reich and Vorderer (2012)
	Need to belong, need for popularity	Facebook status update	Regression analysis/Survey	Winter et al. (2014)
	Need for cognition	Spontaneous and reflective information processing behavior	Regression analysis/Survey	Fleischhauer et al. (2015)
	Social enhancement, interpersonal connectivity	content production (active participation), content consumption (passive following)	SEM/Survey	Mantymaki and Islam (2016)
	Reward reactivity	Facebook active use/ passive use	Regression analysis/Survey	Gerson et al. (2017)
	Thwarted belongingness	Active private/public interaction	Regression analysis/Survey	Macrynikola and Miranda (2019)
	Emotion expression	Distress disclosure on SNS	Regression analysis/Survey	Zhao et al. (2021)
	Need to belong	Participation behavior in social media	SEM/Survey	Zadeh et al. (2022)

Table 1.
The summary of relevant studies

Source(s): Author's own creation/work

SNS, and social interactions in SNS (Gangadharbatla, 2008; Gan and Li, 2018; Saiphoo et al., 2020). Extant literature paves a solid foundation and provide insights for this study.

We focus attention on the subsets of psychological factors and the use of mainly SNS psychological needs and social interactions, by exploring the prediction of the former to the latter in SNS. The current studies just examine the effects of certain needs such as need to belong (Reich and Vorderer, 2012) on some of the interaction patterns or certain specific use such as posting or disclosure (Pagani et al., 2011; Winter et al., 2014; Zhao et al., 2021), and are scattered in several articles. Furthermore, the classification of social interactions is not comprehensive, for example, selective public interaction is not identified (Gerson et al., 2017; Macrynikola and Miranda, 2019). And as one of the important psychological factors, the need for external esteem is not tested as well (Van Osch et al., 2020). Thus, there is a need for research on systematical exploration of the relationships between multiple psychological needs and multiple social interaction pattern under a unified theoretical framework, by which we can comprehensively explain the motivation of all social interactions from the perspective of multiple psychological needs.

Additionally, via the review of methodology in previous studies, it is found that structural equation model (SEM) and regression analysis are mainly adopted, both of which examines the linear relationship between users' needs and interaction (Sharma, 2019; Ding et al., 2019; Zhou et al., 2022). As a supplement, neural network (NN) can be utilized to rank the importance of the effects of psychological needs on social interaction behavior (Zhou et al., 2022). Therefore, we try to adopt a two-stage method, namely structural equation modeling–neural network (SEM-NN) that combines the advantages of the two methods, to validate the research model.

3. Theoretical development and hypotheses

3.1 Research model

Maslow's hierarchy of needs and extant studies provide insights for us to identify the main dimensions of psychological needs to be fulfilled by social interactions. We use "need to belong," "need for social contact," and "need for emotional expression" to reflect social needs, "need for self-esteem" and "need for external esteem" to reflect esteem needs (Wu et al., 2020; Van Osch et al., 2020; Zhao et al., 2021; Krämer et al., 2022). Physiological needs and safety needs have limited relevance with social interactions, thus they are excluded in the research model. Self-realization need is more associated with individual's subjective active efforts rather than social interaction. We use "need for cognition" to stand for the desire to obtain more knowledge and information, partially reflecting self-actualization need, which could be relevant to social interaction (Verplanken et al., 1992; Fleischhauer et al., 2015). Therefore, we regard "need to belong," "need for self-esteem," "need for social contact," "need for emotional expression," "need for cognition," and "need for external esteem" as the antecedents of DOSIP in the research model (Gangadharbatla, 2008; Houghton et al., 2020; Van Osch et al., 2020; Saiphoo et al., 2020; Zhao et al., 2021). Additionally, U&G theory suggests that in order to meet some specific psychological needs, SNS users conduct different online interactions (Gan and Li, 2018), which lay the theoretical foundation for the relationships between psychological needs and DOSIP. The research model we developed for this study is shown in Figure 1. We categorize social interactions into two types and six patterns which are treated as the dependent variable in the model, while treat psychological needs as explanatory variables.

3.2 Research hypotheses

3.2.1 Need to belong

"Need to belong" is a primary, universal, and practical motivation for forming relationships and maintaining interpersonal networks (Baumeister and Leary, 1995).

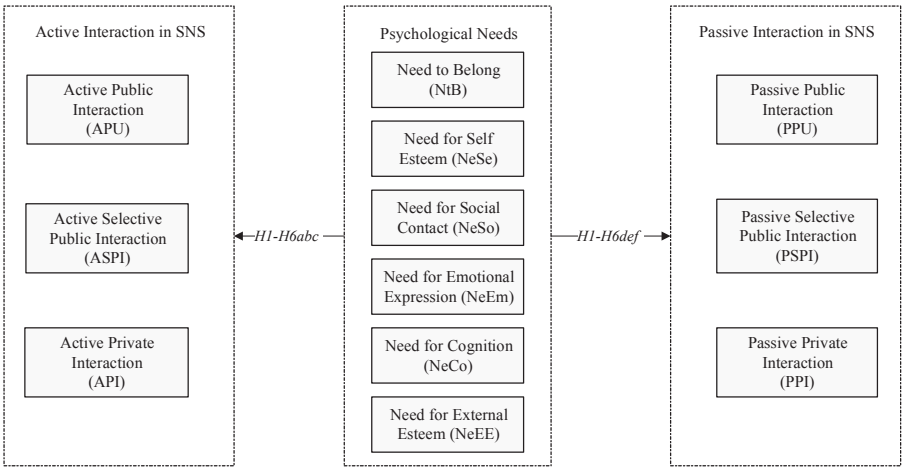

Figure 1.
Research model

Source(s): Authors' own creation/work

The sense of belonging emphasizes the personal feeling that an individual is accepted by a group; it is the internal connection between individuals and the group to which they belong (Nadkarni and Hofmann, 2012). Users may satisfy their "need to belong" via social interactions in SNS. Users with a high "need to belong" are more likely to post comments in their social circles rather than to interact publicly. Hence, we hypothesize that

H1a. "Need to belong" has a negative effect on active public interaction.

Prior studies show that the "need to belong" is a crucial factor affecting SNS usage and positively impacts the usage attitude (Gangadharbatla, 2008). Furthermore, users with high "need to belong" also have stronger willingness to present themselves in social circles (Kim and Jang, 2019). "Need to belong" can stimulate users to actively engage in social interactions in selective scopes of SNS. Therefore, we hypothesize that

H1b. "Need to belong" has a positive effect on active selective public interaction.

With the higher demand of users' need to belong, they prefer to use interactive functions with strong privacy in SNS (Reich and Vorderer, 2012) and the more private the information they disclose in status updates (Winter et al., 2014). Therefore, users may increase more active private interaction in SNS due to the "need to belong." Thus, the following hypothesis are proposed.

H1c. "Need to belong" has a positive effect on active private interaction.

"Need to belong" not only has an impact on stable interpersonal relationships and frequent interactions but also has an important impact on emotional and cognitive processes (Baumeister and Leary, 1995). SNS development has dramatically changed individuals' perceptions of other people's lives. Users with a higher "need to belong" are more afraid to miss the useful experience of other users in the network (Yin et al., 2019). Users with a high sense of "need to belong" increase passive public interaction in order not to miss other users' information or satisfy daily SNS use. Thus, we propose the hypothesis as follows:

H1d. "Need to belong" has a positive effect on passive public interaction.

"Need to belong" has salient effects on passive interactions, especially when "need to belong" is not satisfied (Reich and Vorderer, 2012). In our study, passive selective interactions mean

the interactions are conducted in a smaller disclosure scope than passive public interactions. Therefore, we believe that users' unsatisfied "need to belong" may lead to passive selective public interaction, and then we propose the following hypothesis:

H1e. "Need to belong" has a positive effect on passive selective public interaction.

Users' "need to belong" is positively correlated with the routine use of SNS, such as messaging or browsing (Utz et al., 2012). Furthermore, Passive private interaction mainly involves browsing messages or comments sent by friends or acquaintances (Valkenburg et al., 2022). The private interactions between friends can enhance the user's sense of belonging (Davies et al., 2016). Therefore, users with high "need to belong" may conduct more passive private interactions. We hypothesize the following:

H1f. "Need to belong" has a positive effect on passive private interaction.

3.2.2 Need for self-esteem. Self-esteem is an individual's subjective evaluation of themselves (Coopersmith, 1967), which is one part of self-concept. As an intrinsic motivation, self-esteem can significantly affect the use of SNS, whereas it has different positive or negative effects on the more nuanced divided SNS usage (Cingel et al., 2022). Positive self-esteem enables users to express themselves more confidently in SNS (Shchebetenko, 2019). Such users have a low need for self-esteem. Therefore, users with low need for self-esteem can develop social network relationships through active public interaction. On the contrary, users with high need for self-esteem have less active interaction in SNS. Hence, we propose the following hypothesis:

H2a. "Need for self-esteem" has a negative effect on active public interaction.

Previous studies find that users with higher self-esteem are associated with more SNS usage positively (Valkenburg et al., 2017). A high level of self-esteem indicates a less demand for self-esteem. Therefore, users with high "needs for self-esteem" have a corresponding decrease in their selective interactions. Consequently, we proposed the following hypothesis:

H2b. "Need for self-esteem" has a negative effect on active selective public interaction.

Users with high self-esteem have excellent interpersonal relationships and high self-recognition and still use SNS with a positive attitude and pattern (Valkenburg et al., 2017). Users with high self-esteem, that is, their "need for self-esteem" is nearly met, and their "need for self-esteem" is correspondingly reduced, but they still maintain a positive attitude towards using SNS. Therefore, we hypothesize that users with high "need for self-esteem" have reduced active private interaction:

H2c. "Need for self-esteem" has a negative effect on active private interaction.

Self-esteem is an integral part of the self, and individuals maintain a certain level of self-esteem by constantly maintaining a favorable opinion of themselves (Gailliot and Baumeister, 2007). However, it is also found that users with low self-esteem view and click more posts on SNS than users with high self-esteem (Triệu et al., 2021). Therefore, users with high "need for self-esteem" can achieve their value judgments via passive public interaction. Thus, the following hypothesis is proposed:

H2d. "Need for self-esteem" has a positive effect on passive public interaction.

Recent study finds that users' browsing content generated by popular influencers may result in negative emotions and lower self-esteem (Parsons et al., 2021). Therefore, users with high demand for self-esteem may reduce browsing UGC in SNS, which lowers their self-esteem. Based on this, users with high "need for self-esteem" selectively engage in passive interaction to maintain their self-esteem. Thus, we hypothesize:

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H2e. "Need for self-esteem" has a positive effect on passive selective public interaction.

Individuals with low self-esteem generally encounter more problems in social interactions, they have a higher need for self-esteem accordingly (Zheng et al., 2021). SNS provides platforms for users to maintain solid personal relationships to improve their self-esteem (Wilcox and Stephen, 2013). Therefore, users with high "need for self-esteem" may conduct passive private interactions to maintain more personal relationships, avoid exclusion, and enhance self-esteem. Hence, we propose the following:

H2f. "Need for self-esteem" has a positive effect on passive private interaction.

3.2.3 Need for social contact. Social contact is an inherent need for individuals, and it is a common and basic interaction (Hofer and Hagemeyer, 2018). "Need for social contact" is a crucial part of Maslow's hierarchy of needs, which includes the breadth and depth of social interactions. Individuals can deepen mutual understanding and recognition through social interaction and finally become a member of the interpersonal network (Williams, 2006). When users encounter communication difficulties in offline life, they also conduct social communication via SNS to obtain adequate compensation for offline relationships (Indian and Grieve, 2014). The status updates, comments, and other active public interaction in SNS can help users establish social relationships in the virtual network, and these interactions fulfill users' social contact needs. Thus, we propose the hypothesis as follows:

H3a. "Need for social contact" has a positive effect on active public interaction.

Online interaction has the same function as offline interaction, which can satisfy users' internal social needs, and SNS online group interaction can also make up for offline long-distance interaction (Cao and Meng, 2020). Active selective interaction provides users a way to interact within groups, which enables users to have the alternatives of the scopes of disclosure in interactions. Users with the "need for social contact" can enhance their social interaction in this way. Hence, we propose the following:

H3b. "Need for social contact" has a positive effect on active selective public interaction.

Users with high "need for social contact" are also inclined to initiates one-to-one communications and promotes the interpersonal relationships in SNS (Valkenburg et al., 2022). Therefore, we hypothesize:

H3c. "Need for social contact" has a positive effect on active private interaction.

Human beings have the need to establish social contact inherently (Hofer and Hagemeyer, 2018), but the need for face-to-face social contact is different in daily life. Some people like to stay with others, whereas others enjoy less offline social contact that can improve the life satisfaction (Kämer et al., 2022). According to the social compensation hypothesis, the development of SNS makes better social options available to the unsociable people in the real world (Weidman et al., 2012; Zywica and Danowski, 2008). Passive interaction of SNS avoids embarrassing behavior that tends to occur in the real social interaction and there the former meets the need for social contact. The interaction behavior of individuals with higher social contact needs in offline life to still reflected in SNS. Therefore, users satisfy their need for social contact through passive public interaction in SNS, such as browsing contacts. Passive selective interactions give users more choices, and users can accept these interactions to fulfi a higher "need for social contact." Passive private interactions satisfy users' "need for social contact," achieving interactive behavior and information exchange. Users with a high "need for social contact" are willing to engage in passive private interactions. Thus, we hypothesize as follows:

H3d. "Need for social contact" has a positive effect on passive public interaction.

H3e. "Need for social contact" has a positive effect on passive selective public interaction.

H3f. "Need for social contact" has a positive effect on passive private interaction.

3.2.4 Need for emotional expression. Emotional expression is a vital aspect of the social interaction process, which is conducive to communication and contact among people (Parkinson, 2005). The need for emotional expression is conscious emotional communication and is used to achieve the final desired psychological state of an individual (Geddes and Lindebaum, 2020). "Need for emotional expression" in SNS could be reflected in active public, selective, and private interactive behavior. Previous studies point out that users produce more SNS interactive behaviors by pursuing emotional support in SNS (Zhao et al., 2021). Specifically, the higher openness of the SNS, the more likely users are to seek support from SNS and obtain emotional support from more people (Rains and Brunner, 2018). Users produce more frequent and spontaneous active public interactions to obtain emotional support and social recognition from SNS. With the scopes of disclosure varying in SNS, users perceive different intimacy with their audience, and the manners they express their emotions also change. Selective public interactions allow users to feel more intimate and actively seek emotional support. Users are more inclined to share their emotions with intimate people, and the more negative emotions they express (Zhao et al., 2021). Therefore, users with high "need for emotional expression" are more likely to confide their feelings through active private interaction. Hence, we propose the following:

H4a. "Need for emotional expression" has a positive effect on active public interaction.

H4b. "Need for emotional expression" has a positive effect on active selective public interaction.

H4c. "Need for emotional expression" has a positive effect on active private interaction.

"Need for emotional expression" is one of the most basic needs of individuals (Parkinson, 2005). People are inclined to share their emotion with intimate people (Bazarova et al., 2015). Users can find emotional resonance by browsing the SNS content they are interested in or by passively interacting with other users who are more relevant to them (Geddes and Lindebaum, 2020). To sum up, we can infer that user can express their emotions through passive public interactions to meet their emotional needs. With the increase of content visibility in SNS, users feel less intimate and their emotional expressions will decrease accordingly (Zhao et al., 2021). Therefore, users will choose a more passive and private interaction channel in SNS, that is, passive selective public interaction. Private interaction has more privacy than selective public interaction, increasing users' tendency to disclose negative emotions (Zhao et al., 2021). Therefore, we propose the following hypotheses:

H4d. "Need for emotional expression" has a positive effect on passive public interaction.

H4e. "Need for emotional expression" has a positive effect on passive selective public interaction.

H4f. "Need for emotional expression" has a positive effect on passive private interaction.

3.2.5 Need for cognition. The "need for cognition" is a tendency for individuals to engage or enjoy cognitive endeavors effortfully (Cacioppo et al., 1984). "Need for cognition" is an essential factor in processing information, which is used to research users' information-seeking behavior in SNS (Das et al., 2003). Moreover, individuals with high "need for cognition" have more persuasive ideas and arguments (Wu et al., 2014). At the same time, "need for cognition" positively affects information behaviors such as creating content or sharing information (Nam and Hwang, 2021). Therefore, users with high "need for cognition" may publish and share their views on the SNS via active public interactions. Users with high

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"need for cognition" acquire knowledge and information in various ways. Such users can selectively engage in public interactions to improve their cognition. "Need for cognition" also affect users' ability to search for information (Fleischhauer et al., 2015); thus, such users are more likely to initiate conversations and obtain needed information through active private interactions. Therefore, we hypothesize the following:

H5a. "Need for cognition" has a positive effect on active public interaction.

H5b. "Need for cognition" has a positive effect on active selective public interaction.

H5c. "Need for cognition" has a positive effect on active private interaction.

"Need for cognition" reflects how individuals process and think about information (Barbaro et al., 2015). "Need for cognition" serves as the primary motivation for challenging cognitive motivation. It shows that "need for cognition" has a significant positive relationship with interactions related to cognitive thinking on the internet (Tuten and Bosnjak, 2001). SNS passive interactions reflect users seeking information and browsing information in the network so the higher the need for cognition, the more their passive interactions. Moreover, users with high "need for cognition" pursues curiosity and challenge; their attention is focused on passive interaction in SNS. Higher "need for cognition" encourages users to spend more time on SNS obtain information (Amichai-Hamburger et al., 2007). Therefore, users with high "need for cognition" can achieve their goal of obtaining information through passive public interaction. Passive selective public interaction and Passive private interaction also provide ways to seek and obtain information. Therefore, we hypothesize the following.

H5d. "Need for cognition" has a positive effect on passive public interaction.

H5e. "Need for cognition" has a positive effect on passive selective public interaction.

H5f. "Need for cognition" has a positive effect on passive private interaction.

3.2.6 Need for external esteem. External esteem is different from self-esteem, which is more social and relates to an individual's overall sense of value at the level of social significance (Van Osch et al., 2020). Individuals with a high level of "need for external esteem" have a low level of internal evaluation, that is, low self-esteem. They believe in their own value through feedback from the external environment, such as recognition and support from others (Karajala, 1977). Therefore, such users pay more attention to the evaluation of other users when using SNS. Users' active public interaction, active selective interaction, or active private interaction with other users in SNS have different effects on their image (either good or bad). Users with high need for external esteem in order to enhance their image and gain the respect of others will deliberately control their active public, selective public, and private interactions. Thus, we propose the following hypothesis:

H6a. "Need for external esteem" has a negative effect on active public interaction.

H6b. "Need for external esteem" has a negative effect on active selective public interaction.

H6c. "Need for external esteem" has a negative effect on active private interaction.

On the one hand, individuals with a high need for external esteem need to constantly improve and express themselves in order to gain the respect of others. Moreover, research shows that self-improvement is an essential motivation for Internet use (Joinson, 2003). On the other hand, compared to SNS active interaction, SNS passive interaction involves less direct communication between users and cannot affect others' evaluation of themselves. Users obtain network information via passive behavior. Users with high "need for external esteem" determine their personal value based on feedback received from others (Karajala, 1977).

Passive interactions can provide users with sufficient information to identify external feedback. Public, selective public, and private interactions all provide users with needed information. Therefore, we hypothesize users with high "need for external esteem" have more passive interaction:

H6d. "Need for external esteem" has a positive effect on passive public interaction.

H6e. "Need for external esteem" has a positive effect on passive selective public interaction.

H6f. "Need for external esteem" has a positive effect on passive private interaction.

4. Research methodology

4.1 Measurement development

We designed a questionnaire to capture psychological needs and SNS behaviors. The questionnaire constructs are derived from existing research and consist of three parts. The first part involves demographic variables such as gender and age. The second part includes the psychological needs of the respondents, such as "need to belong," "need for self-esteem," and "need for social contact." The third part elicits data on the respondents' SNS active, passive, public, selective and private interaction. The survey uses a seven-point Likert scale to measure the constructs. Respondents were incentives of 10–20 CNY randomly if they filled questionnaires completely. The details of the questionnaire are listed in Appendix 1.

4.2 Sample and data collection

We distributed the online questionnaire link to SNS users via Weibo, WeChat, and QQ, adopting the method of convenient sampling. We deleted the data filled by respondents who rarely use SNS and those who provided the nearly same answers to all questions. As a result, the online survey collected 414 valid responses, and the descriptive analysis is shown in Table 2. More than half of the respondents use Weibo and WeChat. Furthermore, most of the respondents are 18–30, which is consistent with the previous report (CINIC, 2022; DataReportal, 2022). Since there are twelve constructs in the research model, the quantity of the respondents is adequate according to the suggestions from Hair et al. (2014), Ringle et al. (2015), and Hair et al. (2019). Therefore, the sample data is suitable for this study in terms of representativeness and quantity.

5. Data analysis and results

We combine Structural Equation Modeling (SEM) and neural network analysis to verify the impact of psychological needs on users' behavior in SNS. SEM is a causal modeling technology, which can estimate the causal effect in the research model, and is used to verify the research hypotheses. Nevertheless, SEM can only discover the model's linear relationship without considering the process's complexity (Ding et al., 2019; Liu et al., 2021; Zhou et al., 2022). On the other hand, neural network modeling (NN) can capture some other relationships between variables, which has higher complexity than SEM. Thus, we adopt a SEM-NN two-stage analysis method to test our proposed research model.

Firstly, we conduct an exploratory factor analysis to assess the factor's structure with SPSS 20.0. Secondly, SmartPLS 3 is used to test the reliability and validity of the measurement model, and test the structural model (Ringle et al., 2015). Finally, the significant predictors in the SEM analysis results are used as the input variables of the neural network model to rank the importance of the influencing factors. MATLAB (2018) is used in neural network analysis (Mole, 2004).

Variables	Frequencies	Percentages (%)
Gender		
Male	206	49.8
Female	208	50.2
Age		
Less than 18	14	3.4
18–30	352	85.0
31–40	34	8.2
Greater than 40	14	3.4
Education		
Master degree or upper	21	5.1
Graduate	25	6.0
Undergraduate	43	10.4
Junior college	278	67.1
High school below	47	11.4
Weiblog		
No	108	26.1
Yes	306	73.9
Wechat		
No	25	6.0
Yes	389	94.0

Source(s): Author's own creation/work

Table 2. Descriptions of samples

5.1 Common method bias analysis

We use Harman single factor test to check whether there is a common method bias in the data. The result of common method bias analysis is shown in Appendix 2. The maximum explained variance of the extraction factor is 23.276% (<40%), indicating that the common method bias in the sample data is not severe and can be analyzed in depth (Zhou et al., 2019).

5.2 Factor analysis

We conduct exploratory factor analysis via SPSS 20.0 to assess the factor's structure (Zhang and Liu, 2021). We use Kaiser-Meyer-Olkin (KMO) and Bartlett's spherical test to check whether the data suit for factor analysis first. The KMO is 0.884, and Bartlett's test is significant. Therefore, the data is suitable for factor analysis (Hair et al., 2010).

The factor analysis results are shown in Appendix 3. All components are loaded on the salient factor and explain 76.413% cumulative variance. The items' loading to the factor is higher than 0.5, which meets the standard proposed by (Hair et al., 2010). Moreover, the loading of the corresponding index is higher than the cross-loadings, which means the factor structure is clear.

5.3 Reliability and validity

Composite reliability (CR) and Cronbach's alpha were used to test the reliability of the constructs in the scale. As shown in Table 3, the CR values are higher than 0.7, and the value of Cronbach's alpha are higher than 0.7, means that the scale's reliability is acceptable (Fornell and Larcker, 1981). Average variance extracted (AVE), the square roots of AVEs, and the constructs' correlations are used to test the validity of the constructs. According to Table 4, the whole AVEs values are higher than 0.4, which indicates the scale has convergent validity; the square roots of AVEs values are higher than the constructs' corresponding

Variable	Item	Standard loading	α	CR
Active public interaction (APU)	APU1	0.930	0.880	0.882
	APU2	0.846		
Active private interaction (API)	API1	0.711	0.852	0.853
	API2	0.822		
	API3	0.802		
	API4	0.741		
Active selective public interaction (ASPI)	ASPI1	0.840	0.842	0.841
	ASPI2	0.636		
	ASPI3	0.820		
	ASPI4	0.709		
Need for emotional expression (NeEm)	NeEm1	0.712	0.764	0.763
	NeEm2	0.635		
	NeEm3	0.647		
	NeEm4	0.677		
Need for external esteem (NeEE)	NeEE1	0.860	0.902	0.903
	NeEE2	0.937		
	NeEE3	0.807		
Need for cognition (NeCo)	NeCo1	0.981	0.848	0.847
	NeCo2	0.738		
	NeCo3	0.675		
Need for self-esteem (NeSe)	NeSe1	0.793	0.913	0.914
	NeSe2	0.908		
	NeSe3	0.869		
	NeSe4	0.836		
Need to belong (NtB)	NtB1	0.866	0.803	0.804
	NtB2	0.725		
	NtB3	0.681		
Passive private interaction (PPI)	PPI1	0.890	0.896	0.897
	PPI2	0.900		
	PPI3	0.796		
Passive public interaction (PPU)	PPU1	0.779	0.876	0.875
	PPU2	0.793		
	PPU3	0.933		
Passive selective public interaction (PSPI)	PSPI1	0.812	0.843	0.845
	PSPI2	0.882		
	PSPI3	0.711		
Need for social contact (NeSo)	NeSo1	0.724	0.884	0.885
	NeSo2	0.837		
	NeSo3	0.879		
	NeSo4	0.798		

Source(s): Author's own creation/work

Table 3.
Scale properties

coefficients, demonstrating the discriminative validity is appropriate (Fornell and Larcker, 1981; Lin et al., 2017, 2022; Mao et al., 2021). Furthermore, the heterotrait-monotrait (HTMT) ratio is employed to test the discriminative validity. As indicated in Appendix 4, the HTMT ratios of constructs are lower than 0.85, indicating that discriminant validity is fitting.

Furthermore, we also use standard loading of items to examine the convergent validity, and the result is shown in Table 3. The loadings of all items are higher than 0.6, which signifies that the convergent validity is acceptable (Hair et al., 2010).

5.4 Hypothesis testing

Before the hypothesis testing, we use Variance Inflation Factor (VIF) to assess the multicollinearity of the model. As shown in Appendix 5, the model does not suffer from

Table 4.
Correlation matrix and the square root of the AVE

Constructs	AVE	APU	API	ASPI	NeEm	NeEE	NeCo	NeSe	NtB	PPI	PPU	PSPI	NeSo
APU	0.790	0.889											
API	0.594	0.468	0.770										
ASPI	0.572	0.122	0.123	0.756									
NeEm	0.447	0.526	0.672	0.109	0.668								
NeEE	0.756	0.222	0.405	0.104	0.481	0.870							
NeCo	0.655	0.372	0.318	0.087	0.413	0.489	0.809						
NeSe	0.727	0.228	0.316	0.052	0.390	0.592	0.578	0.853					
NtB	0.580	0.220	0.097	0.275	0.148	0.043	0.200	0.189	0.761				
PPI	0.745	0.269	0.006	0.455	0.104	0.069	0.192	0.060	0.317	0.863			
PPU	0.702	0.188	0.167	0.539	0.203	0.060	0.055	0.026	0.258	0.554	0.838		
PSPI	0.647	0.339	0.655	0.069	0.558	0.387	0.270	0.386	0.019	0.050	0.142	0.805	
NeSo	0.659	0.483	0.592	0.084	0.593	0.540	0.532	0.528	0.099	0.092	0.024	0.424	0.812

Source(s): Author's own creation/work

multicollinearity problems (Hair et al., 2014). We used SmartPLS 3 to verify the research model (Ringle et al., 2015). The results are depicted in Figure 2. From the perspective of the active interaction in SNS, H1b, H2a, H3a–c, H4a and H4c, H5a, and H6b are supported. From the perspective of the passive interaction in SNS, H1d and H1f, H2d–f, H3e–f, and H4e are supported. Furthermore, we compare the research hypotheses and analysis results in Appendix 5.

5.5 Neural network analysis

We use artificial neural network to rank the importance of the significant factors in SEM. A typical neural network consists of input layer, hidden layer, and output layer.

In our study, the input layer includes the critical influencing factors in SEM analysis, such as the "need to belong" and "need for self-esteem." The output layer is SNS interactive behavior. The six neural network models are tested and verified by MATLAB (2018) (Moler, 2004). We comprehensively analyze the number of neurons in the input and output layers, and set the number of neurons in the hidden layer as 3. We use ten-fold cross-validation to avoid the over-fitting problem of neural network model. The ratio of training data to test data is 8:2. We use root mean square error (RMSE) to evaluate the accuracy of the model (Zhou et al., 2022). The results are shown in Table 5. The RSME results in Table 5 show that the reliability and accuracy of our research model are acceptable. Specifically, this model can accurately predict the relationship between psychological needs and social interaction.

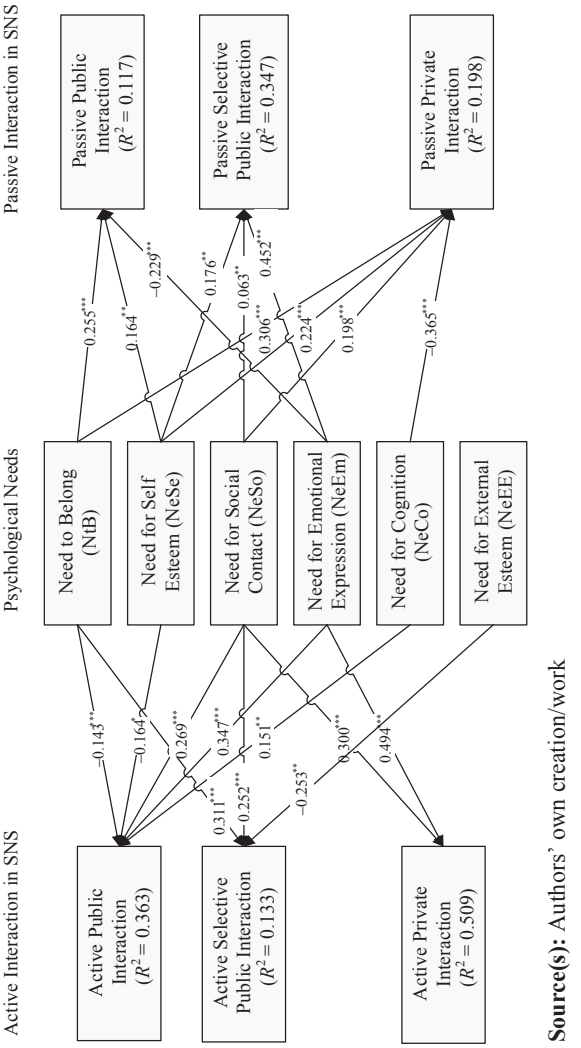
As shown in Table 6, we calculated the importance of psychological needs to social interactions. It can be found that "need for emotional expression" is the most vital predictor of active public interaction, followed by "need for social contact." In terms of passive interaction, "need for emotional expression" is the greatest influencing predictor of passive selective public interaction, followed by "need for self-esteem," and "need for social contact." The biggest factor affecting passive private interaction is "need for cognition." Furthermore, we rank the importance and compare it with the SEM results. We find that the SEM results are mostly consistent with the neural network analysis results. Whereas there are some inconsistencies between the significant levels of path coefficients obtained by SEM and the importance rank of the predictors obtained by the neural network analysis. For example, NN analysis results show that "need for external esteem" is the most important influencing factor of active selective public interaction, while the SEM results indicate that "need to belong" is the most effective predictor. The reason behind the difference is that NN model detects more complex relationships (called black box) between variables (Zhou et al., 2022; Liebana-Cabanillas et al., 2018), while SEM only tests linear relationships.

6. Discussions and implications

6.1 Result discussions

"Need to belong" is the most basic individual need in addition to physiological needs and security needs. The result shows that "need to belong" significant impacts the active and passive selective interaction, and passive public interaction in SNS. However, users with high need to belong have less active public interaction. This is most likely because the core function of "need to belong" is to stabilize group interpersonal relationships, and active public interaction has less connection with maintaining the stability in SNS. The results of NN show that "need to belong" has the same effect on active and passive interactions, and the degree of importance is also small.

The research results on self-esteem and SNS use are inconsistent in the extant literature. This study provides a possible explanation for the existing inconsistency in the literature. Users with low self-esteem develop more SNS relationships via active public interactions



Source(s): Authors' own creation/work

Figure 2.
Hypothesis results

Networks	Inputs: NtB, NeSe, NeSo, NeEm, NeCo Outputs: APU	Inputs: NtB, NeSo, NeEE Outputs: ASPI	Inputs: NeSo, NeEm Outputs: API	Inputs: NtB, NeSe, NeEm Outputs: PPU	Inputs: SE, NeSo, NeEm Outputs: PSPI	Inputs: NtB, NeSe, NeSo, NeCo Outputs: PPI
1	1.203	1.326	1.011	1.516	1.044	1.502
2	1.189	1.296	0.998	1.295	1.144	1.477
3	1.189	1.339	1.006	1.349	1.130	1.411
4	1.167	1.306	1.048	1.270	1.035	1.575
5	1.188	1.307	1.036	1.404	1.299	1.370
6	1.169	1.442	1.026	1.449	1.159	1.435
7	1.108	1.469	0.984	1.328	1.086	1.396
8	1.135	1.347	1.032	1.351	1.019	1.539
9	1.192	1.367	1.027	1.353	1.131	1.426
10	1.196	1.261	1.027	1.381	1.112	1.407
Average	1.174	1.346	1.020	1.370	1.116	1.454
SD	0.029	0.062	0.018	0.069	0.077	0.063

Source(s): Author's own creation/work

Table 5. RMSE for neural network models

because these users rely on the recognition of others and are more sensitive to interpersonal relationships. They hope to gain more recognition from the outside world by publishing content and information publicly. On the contrary, users with high self-esteem have a good psychological state through social comparison and maintain interpersonal relationships through passive interaction in SNS. Moreover, "need for self-esteem" is the second important predictor of passive public, selective public, and private interaction based on NN analysis. "Need for self-esteem" has stronger impacts on passive disclosure rather than active disclosure behaviors.

"Need for social contact" is a vital factor in the process of using SNS. For example, some users like to actively communicate with others at any time, while others are more passive in network interaction. No matter what type of users, the higher their need for social contact, the more corresponding social interactions they will have. Therefore, "need for social contact" is a potentially important motivation in the usage of SNS. In situations such as lockdowns during the pandemic period, it's possible that majority of users will resort to SNS to fulfill their "need for contact" as there is simply no more convenient option. Furthermore, the "need for social contact" is the second crucial predictor to active interaction, suggested by NN analysis. This result further validates the outcomes of SEM, indicating that "need for social contact" is an essential interaction predictor to active interactions.

Need for emotional expression has a significant negative impact on the passive public interaction, which may be because the passive public interaction is mainly reflected in information consumption behaviors such as browsing. Although users can get emotional resonance to a certain extent, they cannot meet their need for emotional expression. Moreover, the passive public interaction reduces the intimacy between users, thereby reducing the desire of users to express their emotions. Therefore, the higher degree of need for emotional expression of users, the lower their passive public behavior. On the other hand, users get emotional support from others via social interactions, tend to express their emotions to intimate others (Rime, 2009), and vent their emotions through public interactive platforms (Zhao et al., 2021). Thus, "need for emotional expression" is significantly related to users' active interaction. According to the results of neural network analysis, the importance of "need for emotional expression" on APU, API, PPU, and PSPI is 100, which means that "need for emotional expression" is the most critical predictor.

Table 6.
Importance of constructs

Networks	Output:APU					Output:ASPI				Output:API				Output:PPU				Output:PSPI				Output:PPI			
	NtB	NeSe	NeSo	NeEm	NeCo	NtB	NeSo	NeEE	NeSo	NeEm	NtB	NeSe	NeEm	NeSe	NeSo	NeEm	NtB	NeSe	NeSo	NeEm	NtB	NeSe	NeSo	NeCo
1	0.224	0.073	0.165	0.292	0.246	0.101	0.131	0.768	0.073	0.927	0.336	0.237	0.427	0.340	0.328	0.333	0.139	0.202	0.111	0.548				
2	0.253	0.206	0.158	0.284	0.099	0.274	0.566	0.159	0.403	0.597	0.224	0.149	0.627	0.295	0.504	0.202	0.069	0.284	0.177	0.470				
3	0.156	0.010	0.400	0.399	0.035	0.071	0.514	0.414	0.988	0.012	0.060	0.018	0.921	0.163	0.336	0.501	0.418	0.184	0.211	0.188				
4	0.049	0.167	0.383	0.169	0.232	0.190	0.250	0.560	0.694	0.306	0.199	0.075	0.726	0.313	0.231	0.456	0.158	0.258	0.125	0.459				
5	0.192	0.199	0.104	0.294	0.212	0.092	0.325	0.583	0.705	0.295	0.175	0.403	0.422	0.166	0.174	0.660	0.075	0.325	0.542	0.059				
6	0.072	0.048	0.483	0.155	0.243	0.586	0.130	0.284	0.305	0.695	0.170	0.050	0.780	0.251	0.288	0.461	0.437	0.190	0.022	0.351				
7	0.058	0.009	0.320	0.507	0.105	0.643	0.313	0.044	0.933	0.067	0.251	0.498	0.251	0.775	0.094	0.131	0.242	0.170	0.010	0.577				
8	0.611	0.209	0.072	0.046	0.063	0.405	0.225	0.370	0.186	0.814	0.063	0.309	0.628	0.167	0.401	0.432	0.137	0.563	0.175	0.124				
9	0.150	0.222	0.106	0.450	0.072	0.245	0.410	0.345	0.072	0.928	0.175	0.373	0.452	0.341	0.200	0.459	0.277	0.471	0.012	0.240				
10	0.125	0.207	0.327	0.161	0.180	0.158	0.605	0.236	0.176	0.824	0.083	0.005	0.912	0.354	0.166	0.481	0.192	0.142	0.440	0.226				
Average	0.189	0.135	0.252	0.276	0.149	0.276	0.347	0.376	0.454	0.546	0.174	0.212	0.615	0.316	0.272	0.411	0.215	0.279	0.182	0.324				
Importance	68.58	48.96	91.32	100	53.92	73.43	92.19	100	83.00	100	28.27	34.45	100	76.91	66.12	100	66.18	86.04	56.26	100				

Source(s): Author's own creation/work

"Need for cognition" is a stable individual difference and a strong predictor of information processing and decision-making behavior. Users with high "need for cognition" have a positive attitude towards the content with novelty and complexity. Consequently, "need for cognition" have a positive influence on active public interaction, which has a variety of large amount of information. In contrast, it has a significant negative impact on passive private interaction, and NN analysis shows that it is the foremost predictor to the passive private interaction. This is because "need for cognition" is positively correlated with online information seeking behavior. However, when passive private interaction typically involves (although in some social media it is possible to take place in one-many or many–many modes when groups are involved) one-to-one interaction, the information and content involved have certain limitations.

Surprisingly, there is no significant relationship between "need for external esteem" and passive interaction. The plausible explanation may be that all kinds of news and information are widely disseminated via SNS. No matter whether users' "need for external esteem" is high or low, we expect that they obtain real-time information and news for most high publicity news. Therefore, need for external esteem will not significantly affect the passive interaction of users in SNS. However, "need for external esteem" can only be fulfilled by active selective public interaction. Moreover, the importance of "need for external esteem" on active selective public interaction is highest based NN analysis, which also verifies the outcomes of SEM.

Finally, we summarize the intensity and importance of the influences of psychological needs on DOSIP in SNS. The results are shown in Appendix 6.

6.2 Theoretical Implications

Above all, the unified theoretical framework of multi-dimensional psychological needs to multiple social interaction patterns overcomes the weaknesses of extant studies, fill the research gap, and advances the research about users' social interaction behavior in SNS (Reich and Vorderer, 2012; Macrynikola and Miranda, 2019; Tobin et al., 2020; Valkenburg et al., 2022).

The examination of the research model validates the intrinsic causation of each specific interaction pattern from psychological needs' perspective, which explain the various phenomena of users' certain social interaction activities. Hypotheses H1b, H2d, H3a–c, H3e–f, H4a, H4c–e, H6b are originally validated in empirical research, which provide insights for future studies and indicates the novelty of this study.

The systematic classification of social interaction patterns according to the level of activity and disclosure, namely six categories of DOSIP, which advances the work of Reich and Vorderer (2012). The categorization based on the two dimensions covers all social interaction activities of users, which is of relevance for fully understanding users' information behavior in SNS. This provides a base for further investigation about the antecedents and consequents of DOSIP in more extensive perspectives.

6.3 Practical Implications

The findings also provide meaningful managerial insights for SNS platforms. SNS designers can develop different interaction modules or provide different content recommendation portfolios consistent with users' needs, so as to increase the attractiveness and improve user stickiness of SNS. At the same time, SNS platforms can promote and publicize UGC to satisfy their psychological needs and promote the diversified development of platforms.

From the view of active social interactions, active public interaction is affected by "need to belong," "need for self-esteem," "need for emotional expression," and "need for cognition." Therefore, to popularize the diversity of UGC, the SNS platforms are supposed to cater to the variety of users' psychological needs. For example, in the light of the motivation of need for

social contact to public interaction, SNS platforms may establish a highly interactive public interaction module so that users can feel comfortable communicating with others and establishing friendly relations via using SNS. Since need for emotional expression also has a positive impact on active public interaction, SNS platforms can exploit the power of artificial intelligence to communicate and interact with users in a realistic way such as to enable/evoke users to express their emotions and satisfy their social contact need at the same time. For example, in the near future, we do anticipate that immersive experiences in social networks will become more commonplace.

From the view of passive social interaction, the scale of registered user of SNS platforms can be enlarged by increasing the frequency of users' passive social interactions. For example, SNS platforms can push the customized content that users are interested in to improve their sense of belonging, so as to cultivate user stickiness. They can also push certain knowledgeable content for users with high need for cognition to keep a higher user retention rate. Platforms can also create libraries of more innovative personalized (animated) emoticons that users can readily draw on such resources for passive communications.

Public sentiment management sectors can also obtain relevant insights from this study. DOSIP play different roles in the different stages in the evolution of public opinions (Fang et al., 2019). Generally, active social interactions are critical for the generation of public opinions at the beginning, and passive social interactions may boost the surge of public opinions in sequential stages (Sude et al., 2019; Soffer, 2019). Our findings are favorable to understanding the motivations of social interaction behavior in different stages of public sentiment development, which facilitates public sentiment governance for business organizations and public sectors.

6.4 Limitations and directions of future studies

First, although our study includes six main patterns of social interaction in SNS, our sample data are only obtained from China, and the observed SNS behaviors may be affected by culture, custom, and other factors. And the age range of the respondents is limited as well. Future studies may adopt the samples with a wider age range from multicultural background to verify the research model. Second, we employ the Harman single factor test to assess common method bias, which is another limitation of this study. Furthermore, as users' interactive behaviors may be also affected by users' personalities and external situations, future research can focus on the interaction of psychological needs and personalities, or incorporate users' situations into the research model as a moderate variable. Finally, with the prosperity and development of SNS, different genre of social platforms emerges, such as metaverse services which provide more unique functions to attract users. Therefore, scholars can track the frontier of SNS development and explore users' psychological motivations to participate in metaverse world.

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(The Appendix follows overleaf)

Appendix 1

Construct	Scale items	Source
Need to Belong (NtB)	In reality, I do not mind whether others accept me or not (reverse question) I seldom mind whether others care me or not (reverse question) If not accepted, I feel nothing needed to concern about (reverse question)	Gangadharbatla (2008)
Need for Self-esteem (NeSe)	I have a positive evaluation on me I feel that I am a person of worth I feel that I have a number of good qualities On the whole, I am satisfied with myself	Rosenberg (1965)
Need for Social Contact (NeSo)	I prefer using SNS to contact with my friends I like using SNS to share my living status To share things I considered interesting or meaningful Feel connected to others	Bonds-Raacke (2013), Reich and Vorderer, (2012)
Need for Emotion Express (NeEm)	Forums or post bars provide me opportunities with freely expressing my own opinions Anonymous forums fit me better to post something relaxing Freely posting in public SNS sites does not influence others' perceptions about me in reality Self-expression in SNS sites makes me release the bad mood	Zhao et al. (2021)
Need for Cognition (NeCo)	I prefer complex to simple problems Thinking is not my idea of fun Learning new ways to think excites me very much	Cacioppo et al. (1984)
Need for External Esteem (NeEm)	It is important for me to get other's respect and recognition I feel other's appreciation to me is critical I feel other's positive comments on me is important	Heatherton and Polivy (1991)
Active Public Interaction (APU)	I generally post opinions upon some public topics via public blogs, forums and bars I generally post my comments upon other opinions via public blogs, forums and bars	Pagani et al. (2011), Verduyn et al. (2015)
Active Selective Public Interaction (ASPI)	I seldom post photos in group discussions in SNS apps I seldom post interesting things in group discussions in SNS apps I seldom post my status on my pages of SNS apps I seldom post short videos in group discussions or personal webpages of SNS sites	
Active Private Interaction (API)	I prefer to start a private talking with friends I frequently check messages sent by others via SNS apps I generally give comments upon friend's updated statuses at first time I generally give feedbacks upon other's comments on my status as soon as possible	

Table A1.
Measures of constructs

(continued)

Construct	Scale items	Source
Passive Public Interaction (PPU)	I seldom learn other's opinions on economics and society topics via Weiblogs, blogs, and forums (reverse question) I seldom browse other's comments about some public topics posted on blogs and forums (reverse question) I seldom learn some professional knowledge via public SNS sites (reverse question)	Chen et al. (2016), Ding et al. (2017), Verduyn et al. (2015), Reich and Vorderer (2012)
Passive Selective Public Interaction (PSPI)	I generally click messages sent by others in groups of SNS Apps I generally browse some news posted in groups posted I generally click videos posted in groups	
Passive Private Interaction (PPI)	I seldom check my SNS messages unless something needs to be contacted with others (reverse question) I seldom check other's status in SNS apps (reverse question) I seldom read other's comments on my posted status in SNS apps (reverse question)	

Source(s): Author's own creation/work

Table A1.

Appendix 2

Component	Initial eigenvalue Sum	Percent variance	Cumulative %
1	16.759	23.276	23.276

Source(s): Author's own creation/work

Table A2. The result of Harman single factor test

Table A3.
Rotated component matrix

Items	Components 1	2	3	4	5	6	7	8	9	10	11	12
NtB_1	0.063	0.044	0.169	0.030	0.111	0.209	0.007	0.001	0.052	0.000	0.804	0.081
NtB_2	0.044	0.064	0.019	0.100	0.079	0.072	0.114	0.054	0.074	0.031	0.842	0.012
NtB_3	0.120	0.012	0.059	0.011	0.079	0.023	0.081	0.052	0.008	0.104	0.822	0.067
NeSe_1	0.819	0.185	0.062	0.089	0.004	0.005	0.030	0.074	0.080	0.197	0.126	0.040
NeSe_2	0.821	0.219	0.247	0.067	0.027	0.028	0.034	0.092	0.107	0.172	0.036	0.024
NeSe_3	0.828	0.232	0.189	0.023	0.032	0.078	0.013	0.092	0.098	0.129	0.020	0.057
NeSe_4	0.780	0.261	0.121	0.091	0.010	0.001	0.035	0.058	0.114	0.156	0.110	0.015
NeSo_1	0.202	0.251	0.731	0.107	0.041	0.070	0.008	0.129	0.112	0.177	0.027	0.068
NeSo_2	0.166	0.116	0.771	0.240	0.124	0.041	0.017	0.165	0.065	0.146	0.008	0.150
NeSo_3	0.195	0.194	0.705	0.184	0.133	0.157	0.066	0.149	0.144	0.126	0.047	0.207
NeSo_4	0.149	0.207	0.744	0.259	0.013	0.025	0.043	0.149	0.042	0.163	0.037	0.089
NeEm_1	0.188	0.056	0.120	0.235	0.034	0.019	0.000	0.670	0.102	0.104	0.023	0.214
NeEm_2	0.001	0.098	0.257	0.067	0.081	0.078	0.060	0.707	0.190	0.007	0.072	0.068
NeEm_3	0.065	0.153	0.009	0.159	0.022	0.091	0.102	0.777	0.088	0.081	0.049	0.122
NeEm_4	0.099	0.212	0.201	0.284	0.014	0.090	0.040	0.566	0.130	0.139	0.048	0.008
NeCo_1	0.153	0.198	0.110	0.038	0.015	0.197	0.018	0.096	0.042	0.752	0.124	0.132
NeCo_2	0.264	0.187	0.217	0.032	0.023	0.039	0.042	0.049	0.058	0.820	0.003	0.101
NeCo_3	0.293	0.176	0.228	0.134	0.027	0.039	0.003	0.142	0.050	0.750	0.060	0.004
NeEE_1	0.243	0.772	0.146	0.083	0.050	0.090	0.041	0.162	0.069	0.130	0.056	0.052
NeEE_2	0.239	0.838	0.110	0.124	0.042	0.014	0.009	0.140	0.117	0.125	0.032	0.052
NeEE_3	0.209	0.861	0.204	0.112	0.035	0.002	0.007	0.082	0.079	0.120	0.034	0.007
NeEE_4	0.234	0.775	0.212	0.147	0.063	0.003	0.037	0.109	0.102	0.190	0.040	0.029
APU_1	0.056	0.004	0.253	0.156	0.054	0.127	0.042	0.188	0.087	0.140	0.081	0.834
APU_2	0.056	0.103	0.148	0.173	0.024	0.151	0.052	0.174	0.123	0.079	0.075	0.855
ASPI_1	0.058	0.001	0.162	0.146	0.788	0.071	0.092	0.017	0.004	0.064	0.114	0.063
ASPI_2	0.041	0.046	0.036	0.017	0.744	0.353	0.175	0.023	0.035	0.107	0.015	0.086
ASPI_3	0.069	0.053	0.048	0.031	0.796	0.166	0.206	0.065	0.089	0.024	0.089	0.099
ASPI_4	0.104	0.067	0.034	0.027	0.812	0.014	0.179	0.020	0.100	0.049	0.075	0.023
API_1	0.130	0.088	0.214	0.725	0.069	0.093	0.044	0.199	0.082	0.053	0.030	0.012
API_2	0.035	0.133	0.240	0.724	0.075	0.070	0.007	0.194	0.256	0.108	0.038	0.019
API_3	0.052	0.143	0.087	0.752	0.007	0.004	0.073	0.196	0.239	0.111	0.077	0.267
API_4	0.047	0.107	0.158	0.760	0.025	0.041	0.151	0.102	0.218	0.059	0.079	0.132
PPU_1	0.002	0.048	0.065	0.013	0.229	0.195	0.832	0.058	0.054	0.013	0.059	0.080
PPU_2	0.015	0.054	0.039	0.050	0.210	0.170	0.863	0.046	0.034	0.005	0.100	0.000
PPU_3	0.063	0.030	0.010	0.085	0.218	0.301	0.777	0.086	0.046	0.021	0.076	0.014

(continued)

Table A3.

Items	Components 1	2	3	4	5	6	7	8	9	10	11	12
PSPI_1	0.212	0.103	0.089	0.278	0.078	0.010	0.022	0.108	0.788	0.070	0.040	0.028
PSPI_2	0.132	0.181	0.072	0.246	0.016	0.071	0.106	0.190	0.776	0.077	0.011	0.103
PSPI_3	0.054	0.060	0.116	0.177	0.041	0.004	0.014	0.163	0.809	0.002	0.069	0.140
PPI_1	0.027	0.066	0.066	0.055	0.203	0.801	0.238	0.049	0.041	0.093	0.125	0.089
PPI_2	0.026	0.062	0.026	0.007	0.178	0.861	0.243	0.014	0.031	0.112	0.095	0.095
PPI_3	0.038	0.013	0.055	0.040	0.115	0.852	0.155	0.050	0.016	0.049	0.101	0.080
Eigenvalues	10.389	5.327	3.056	2.362	1.894	1.488	1.357	1.285	1.147	1.059	1.022	0.944
% of Variance	25.339	12.992	7.453	5.762	4.620	3.629	3.311	3.134	2.798	2.583	2.492	2.302
Cumulative %	25.339	38.331	45.784	51.545	56.165	59.794	63.105	66.239	69.036	71.620	74.112	76.413

Note(s): Extraction MethodPrincipal Component Analysis
Source(s): Author's own creation/work

Appendix 4

Table A4. Heterotrait-Monotrait ratio (HTMT)

Factors	APU	API	ASPI	NeEm	NeEE	NeCo	NeSe	NtB	PPI	PPU	PSPI
API	0.470										
ASPI	0.118	0.121									
NeEm	0.527	0.671	0.123								
NeEE	0.223	0.405	0.105	0.481							
NeCo	0.373	0.329	0.100	0.423	0.507						
NeSe	0.228	0.317	0.094	0.386	0.594	0.601					
NtB	0.217	0.104	0.274	0.152	0.052	0.197	0.194				
PPI	0.271	0.066	0.462	0.132	0.068	0.181	0.059	0.315			
PPU	0.189	0.168	0.548	0.207	0.067	0.063	0.039	0.261	0.553		
PSPI	0.344	0.656	0.092	0.559	0.383	0.279	0.384	0.062	0.053	0.141	
NeSo	0.482	0.594	0.100	0.592	0.547	0.559	0.530	0.095	0.094	0.044	0.426

Source(s): Author's own creation/work

Appendix 5

Table A5. Variance inflation factor (VIF)

Factors	APU	API	ASPI	NeEm	NeEE	NeCo	NeSe	NtB	PPI	PPU	PSPI	NeSo
APU												
API												
ASPI												
NeEm	1.590	1.541								1.187	1.561	
NeEE			1.431									
NeCo	1.723								1.707			
NeSe	1.693								1.689	1.204	1.405	
NtB	1.060		1.023						1.052	1.044		
PPI												
PPU												
PSPI												
NeSo	1.962	1.541	1.442						1.557		1.837	

Source(s): Author's own creation/work

Appendix 6

Hypotheses	Hypotheses direction	Analysis results
need to belong → active public interaction (H1a)	negative	negative
need to belong → selective public interaction (H1b)	positive	positive
need to belong → active private interaction (H1c)	positive	\
need to belong → passive public interaction (H1d)	positive	positive
need to belong → passive selective public interaction (H1e)	positive	\
need to belong → passive private interaction (H1f)	positive	positive
need for self-esteem → active public interaction (H2a)	negative	negative
need for self-esteem → active selective public interaction (H2b)	negative	\
need for self-esteem → active private interaction (H2c)	negative	\
need for self-esteem → passive public interaction (H2d)	positive	positive
need for self-esteem → passive selective public interaction (H2e)	positive	\
need for self-esteem → passive private interaction (H2f)	positive	positive
need for social contact → active public interaction (H3a)	positive	positive
need for social contact → active selective public interaction (H3b)	positive	positive
need for social contact → active private interaction (H3c)	positive	positive
need for social contact → passive public interaction (H3d)	positive	\
need for social contact → passive selective public interaction (H3e)	positive	positive
need for social contact → passive private interaction (H3f)	positive	positive
need for emotional expression → active public interaction (H4a)	positive	positive
need for emotional expression → active selective public interaction (H4b)	positive	\
need for emotional expression → active private interaction (H4c)	positive	positive
need for emotional expression → passive public interaction (H4d)	positive	negative
need for emotional expression → passive selective public interaction (H4e)	positive	positive
need for emotional expression → passive private interaction (H4f)	positive	\
need for cognition → active public interaction (H5a)	positive	positive
need for cognition → active selective public interaction (H5b)	positive	\
need for cognition → active private interaction (H5c)	positive	\
need for cognition → passive public interaction (H5d)	positive	\
need for cognition → passive selective public interaction (H5e)	positive	\
need for cognition → passive private interaction (H5f)	positive	negative
need for external esteem → active public interaction (H6a)	negative	\
need for external esteem → active selective public interaction (H6b)	negative	negative
need for external esteem → active private interaction (H6c)	negative	\
need for external esteem → passive public interaction (H6d)	positive	\
need for external esteem → passive selective public interaction (H6e)	positive	\
need for external esteem → passive private interaction (H6f)	positive	\

Source(s): Author's own creation/work

Table A6. Comparison of research hypotheses and analysis results

Appendix 7

Table A7. Intensity and importance of psychological needs to social interaction patterns

Psychological needs	Path coefficients	Importance	Social interaction patterns
Need to belong	0.143***	68.58	Active public interaction
Need for self-esteem	0.164*	48.96	
Need for social contact	0.269***	91.32	
Need for emotional expression	0.347***	100	
Need for cognition	0.151**	53.92	
Need to belong	0.311***	73.43	Active selective public interaction
Need for social contact	0.252***	92.19	
Need for external esteem	0.253**	100	
Need for social contact	0.300***	83.00	Active private interaction
Need for emotional expression	0.494***	100	
Need to belong	0.255***	28.27	Passive public interaction
Need for self-esteem	0.164*	34.45	
Need for emotional expression	0.229***	100	
Need for self-esteem	0.176**	76.91	Passive selective public interaction
Need for social contact	0.063**	66.12	
Need for emotional expression	0.452***	100	
Need to belong	0.306***	66.18	Passive private interaction
Need for self-esteem	0.224***	86.04	
Need for social contact	0.198***	56.26	
Need for cognition	0.365***	100	

Source(s): Author's own creation/work

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