



# Antecedent and consequence of using O2O delivery applications: social anxiety, loneliness, and a moderated mediation model

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## ABSTRACT

Online-to-offline delivery applications (ODAs), which link the mobile Internet to local physical businesses, offer prompt delivery of a wide range of items, including but not limited to food delivery. Frequent use of ODAs can be problematic. While the use of ODAs has been connected to physical health issues (e.g., unhealthy diet and sedentary behavior), its association with mental health concerns (e.g., social anxiety and loneliness) remains insufficiently addressed. Consequently, this study aims to explore the relationships among ODA usage, social anxiety, and loneliness by developing and validating a moderated mediation model. Data were derived from a three-phase online survey and subsequently analyzed applying partial least squares structural equation modeling alongside PROCESS analyses. The results show that social anxiety positively predicts ODA usage, and that such usage in turn positively predicts loneliness. Furthermore, ODA usage mediates the relationship between social anxiety and loneliness, and this indirect effect is moderated by living arrangement — being significantly stronger among consumers living alone. This study expands the scope of problematic technology use while providing nuanced practical insights for understanding consumer behavior and their psychological well-being.

## 1. Introduction

Online-to-offline (O2O) commerce establishes a linkage between the Internet (i.e., online) and brick-and-mortar business entities (i.e., off-line), prioritizing the local retail and service businesses (Yao et al., 2022). Localization is one of the key attributes that distinguish O2O commerce from conventional e-commerce (Lee et al., 2022). The advent of mobile Internet has given rise to online-to-offline delivery applications (ODAs), which offer instant delivery of a wide array of items, thereby propelling the growth of O2O commerce. The ODA, with meal ordering as its earliest and most common use case, allows consumers to order various food products and necessities via their mobile devices. In contrast to conventional e-commerce platforms, where perishable products and urgent necessities are not applicable due to the absence of timely delivery, ODAs significantly enhance and enrich consumers' lives by providing access to locally available items.

Despite these conveniences, frequent use of ODAs can be problematic. A growing body of evidence has emerged linking the utilization of food delivery applications, a form of ODA, to adverse physical health issues, such as unhealthy dietary patterns, sedentary lifestyles, and chronic disease risks (Jia et al., 2023; Tham et al., 2023; Yao & Li, 2024).

Apart from physical health aspects, the reliance on ODA may also be associated with mental health problems. Previous research has confirmed the relationship between mental health aspects (e.g., social anxiety and loneliness) and problematic technology use, such as usage of smartphones, social media, and conversational artificial intelligence (Hu et al., 2023; O'Day & Heimberg, 2021; Zhou & Shen, 2024), which is generally considered hedonistic in nature. However, the psychological costs of ODA usage remain underexplored. In particular, the literature has yet to clarify whether a predominantly utilitarian application like ODA might be associated with similar mental health concerns (i.e., social anxiety and loneliness). This leaves a critical gap in our understanding of how social anxiety and loneliness interrelate with ODA usage.

Addressing this gap is important because ODAs have been rapidly taken up globally and become ubiquitous in modern urban life, and their hidden psychological costs may undermine consumer well-being. By examining the interrelationships among social anxiety, ODA usage, and loneliness, this study not only extends the problematic technology use paradigm into a utilitarian context, contributing to both technology use and consumer well-being literature, but also provides actionable insights for consumers and mental health professionals, guiding self-

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regulation strategies and intervention designs to balance ODA usage and meaningful social engagement.

Accordingly, to fill the research gap, the current study develops and validates a moderated mediation model, in which ODA usage (the mediator) serves both as a coping mechanism for social anxiety (the antecedent) and a contributing factor to loneliness (the consequence), with living arrangement (the moderator, i.e., living alone versus living with others) treated as a boundary condition.

## 2. Literature review and hypotheses

### 2.1. Social anxiety and ODA usage

Social anxiety, described as “anxiety resulting from the prospect or presence of personal evaluation in real or imagined social situations” (Schlenker & Leary, 1982), is a widespread anxiety disorder even among normal (non-clinical) populations (Ohayon & Schatzberg, 2010). As a relatively enduring personality trait, social anxiety among consumers shapes their unique behaviors and preferences (Zalinska & Agopian, 2023). For example, in an offline environment, consumers experiencing social anxiety may be disinclined to employee-to-customer and customer-to-customer interactions (Becker & Pizzutti, 2017; Shang & Li, 2024). By contrast, in an online customer service context, socially anxious consumers may show a preference for a self-service option and an anthropomorphized chatbot (Jin & Youn, 2021; Zalinska & Agopian, 2023).

A distinctive characteristic of socially anxious individuals is an amplified sensitivity to social threats, expressed as pervasive fear and avoidance of social interactions, and they usually alleviate their discomfort by avoiding such social threats (Jin & Youn, 2021). It is reasonable to believe that they would choose a life pattern of avoiding face-to-face social interactions, which makes them feel more comfortable. Empirical evidence has shown that individuals with social anxiety tend to maintain a greater interpersonal distance from others (Givon-Benjo & Okon-Singer, 2020) and generally prefer online communication channels (Lacombe et al., 2024). This means that, in a conventional (offline) shopping task, consumers with social anxiety would prefer an online-to-offline (O2O) method, as the ODA enables them to access the necessities of life while largely avoiding social interactions. From another perspective, social anxiety has been demonstrated to be associated with frequent or problematic use of specific information technologies, such as smartphones, social media, and conversational artificial intelligence (Hu et al., 2023; Wei et al., 2023; Wu et al., 2024). Therefore, consumers with high levels of social anxiety are more likely to use ODAs, and the following hypothesis is developed:

**H1.** Social anxiety (SA) positively predicts consumers' ODA usage (OU).

### 2.2. ODA usage and loneliness

Loneliness is a subjective emotional state of distress that arises when an individual perceives their social connections and relationships to be unfulfilling or inadequate (Matthews et al., 2016). This is a pervasive phenomenon that has the potential to manifest at any stage of an individual's lifespan (Wongpakaran et al., 2020). In contemporary society, loneliness is also linked to consumer behavior, with reduced social connection, technology use, and individual traits shaping consumer loneliness (Huang & Li, 2023). In terms of shopping channels (online versus offline), lonely consumers may choose the offline channel because interpersonal interactions serve to alleviate their feelings of loneliness (Wang, 2023). The key question, however, is whether consumers who favor Internet-related platforms (e.g., ODAs) will maintain higher levels of loneliness.

Morahan-Martin and Schumacher (2003) summarized two sides of the argument: (1) information technology (i.e., the Internet) usage leads

to loneliness, and (2) information technology attracts lonely individuals. These perspectives are not mutually exclusive; rather, technology may both attract lonely individuals and contribute to sustained loneliness. To illustrate, the benefits of ODAs attract lonely consumers, and ODA usage in turn maintains or increases their loneliness. Existing literature has indicated that the use of specific information technologies, such as the Internet, smartphones, and social media (Alheneidi et al., 2021; Costa et al., 2019; MacDonald & Schermer, 2021), is associated with users' feelings of loneliness. When employed to escape social activities, Internet-related applications can result in an increase in feelings of loneliness (Nowland et al., 2018). Consumers with higher levels of social anxiety employ ODAs to proactively reduce social interactions, while for those with lower social anxiety, ODA usage objectively diminishes their interactions with the real world. Whatever the case, the frequent use of ODAs may lead to increased loneliness due to decreased interpersonal interaction. Accordingly, we develop the following hypothesis:

**H2.** ODA usage (OU) positively predicts consumers' loneliness (LL).

### 2.3. Social anxiety and loneliness

A substantial body of research has demonstrated that social anxiety is a predictor of loneliness (Eres et al., 2021; Lim et al., 2016; Oren-Yagoda et al., 2022). Nonetheless, the mechanisms involved remain to be elucidated. Earlier studies have examined the potential mediation mechanisms between social anxiety and loneliness, such as the mediating roles of cognitive distortions and social networks (Petak, 2024; Sun et al., 2024). In the current context, the objective is to investigate the mediating effect of ODA usage. Socially anxious consumers are more likely to use ODAs frequently, and such use may, in turn, intensify feelings of loneliness. Thus, ODA usage may mediate the relationship between social anxiety and loneliness.

In addition, single-person and multi-person households display distinct attitudes toward ODAs (Cho et al., 2019), suggesting that living arrangement (i.e., living alone versus living with others) may shape the extent to which socially anxious individuals rely on these services. ODAs enable socially anxious consumers to procure daily necessities with minimal contact with strangers — a benefit especially prized by those living alone. In contrast, individuals who live with others often have alternative options — for daily meals, they can prepare food at home or dine out with their family members or housemates — that reduce their reliance on delivery applications. Empirical studies have revealed that individuals living alone or remaining single exhibit higher frequencies of using food delivery applications (Roh & Park, 2019, 2023). Hence, for socially anxious individuals, living alone may intensify their propensity to engage with ODAs, thereby further diminishing real-world social interactions and amplifying feelings of loneliness.

The following hypotheses are accordingly proposed:

**H3.** ODA usage (OU) mediates the relationship between social anxiety (SA) and loneliness (LL).

**H4.** The indirect effect of social anxiety (SA) on loneliness (LL) via ODA usage (OU) is moderated by living arrangement (LA), with the effect being stronger for consumers living alone.

### 2.4. Control variables and research model

Following the ODA and mental health literature (Bao & Zhu, 2022; Bu et al., 2020), demographic variables (i.e., age, gender, and educational background) are included in the current study as global controls. Income is not considered because its level and thresholds vary by region in a nationwide survey. Furthermore, according to the information systems literature, habit constitutes a robust antecedent of usage behavior, particularly among experienced users (Venkatesh et al., 2023). Therefore, this study includes habit (HB) as a control variable when examining ODA usage. In addition, living alone has been

empirically linked to heightened loneliness (Caro et al., 2022; Carrasco et al., 2024; Currin et al., 2023), and thus another demographic variable, living arrangement (LA), is incorporated as a control for loneliness. Synthesizing all previous discussions, a research model is proposed as illustrated in Fig. 1.

### 3. Methodology

#### 3.1. Data collection

A quantitative design with a survey method was applied in the present study. The survey was conducted in China, where ODAs are prevalent and respondents are easily recruited. We employed a purposive sampling technique. Specifically, respondents (1) must have used the O2A within the last six months and (2) must have used more than two types of O2O delivery services (rather than just the food delivery service). Data collection proceeded in three sequential phases through an online survey platform, with each phase occurring approximately one month apart. This approach can reduce common method bias (CMB) and strengthen causal inference to some extent. The first-phase survey was conducted in June 2024 to collect data on social anxiety (SA) and habit (HB). Responses failing to meet inclusion criteria or attention checks were automatically rejected, yielding 600 records. During the second-phase survey, we re-contacted the 600 respondents who participated in the first-phase survey to collect information on their ODA usage (OU) via the same platform, garnering 473 responses. Following a similar procedure, we captured respondents' feelings of loneliness (LL) in the third-phase survey, obtaining 381 responses. After eliminating suspicious responses, the final dataset comprised 358 valid cases. Table 1 presents an overview of the respondents' information, including their gender, age, educational background, and living arrangement.

#### 3.2. Measures

The research instrument was developed based on existing literature (see Appendix A). Measurement items for social anxiety (SA) were drawn and adapted from the Social Phobia Inventory (Connor et al., 2000), and this approach has been shown to be effective (Jin & Youn, 2021). Specifically, SA was measured employing a five-item scale ranging from 1 ("Not at All") to 5 ("Extremely"), with elevated sum scores suggesting elevated levels of social anxiety. ODA usage (OU) applied a three-item scale, of which items were drawn from Pascual-Miguel et al. (2015) and Lin et al. (2022), ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree"). Loneliness (LL) was measured employing the abbreviated UCLA Loneliness Scale (Xu et al., 2018), a six-item scale ranging from 1 ("Never") to 4 ("Often"), with higher sum

**Table 1**  
Sample demographics (N = 358).

| Fields             | Category                            | N   | Percentage |
|--------------------|-------------------------------------|-----|------------|
| Gender             | Female                              | 183 | 51.12 %    |
|                    | Male                                | 175 | 48.88 %    |
| Age                | 18–27 (Gen Z)                       | 172 | 48.04 %    |
|                    | 27–43 (Gen Y)                       | 153 | 42.74 %    |
|                    | 44–59 (Gen X)                       | 33  | 9.22 %     |
|                    |                                     |     |            |
| Education          | High school or equivalent and below | 28  | 7.82 %     |
|                    | College Diploma                     | 96  | 26.82 %    |
|                    | Bachelor Degree                     | 159 | 44.41 %    |
|                    | Master Degree and higher            | 75  | 20.95 %    |
| Living Arrangement | Living alone                        | 187 | 52.23 %    |
|                    | Living with others                  | 171 | 47.77 %    |

scores reflecting stronger feelings of loneliness. In addition, habit (HB) was measured utilizing a three-item, five-point scale adapted from Venkatesh et al. (2023). A pre-test was conducted to ensure item clarity and preliminary reliability.

Demographic variables included living arrangement during the previous six months (LA; coded 1 = living alone, 0 = living with others), gender (GD; coded 1 = male, 0 = female), age (AG; ordinally coded 1 = generation Z through 3 = Generation X), and education (ED; ordinal scale from 1 = lowest level to 4 = highest level).

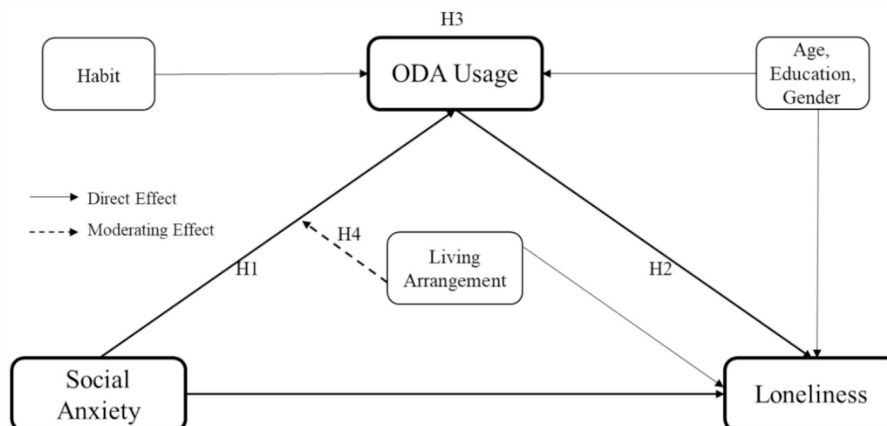
#### 3.3. Data analysis

To test the base framework proposed, the partial least squares structural equation modeling (PLS-SEM) was utilized. According to the psychological literature, social anxiety and loneliness are usually estimated using sum scores (Connor et al., 2000; Xu et al., 2018), and hence the weighting models of SA and LL were specified as equal weights in PLS-SEM. The remaining constructs (i.e., OU and HB) are typically considered to be measured reflectively and thus were specified as Model A in the current model (Hair et al., 2022). Subsequently, Chin et al.'s (2003) two-stage approach was applied to create the interaction term (i.e., LA\*SA), and the PROCESS analyses were employed to further examine the moderated mediation. Furthermore, the mentioned analyses were implemented through the SmartPLS software (Version 4).

### 4. Results

#### 4.1. Data examination

We examined the distributional properties of our data, confirming that kurtosis and skewness values for all indicators fell within the acceptable range of  $-2$  to  $+2$ , thus meeting the requirement for data



**Fig. 1.** The proposed model.

analysis in PLS-SEM (Hair et al., 2022). Additionally, to detect potential CMB, we adopted the full collinearity method proposed by Kock and Lynn (2012), which addresses bias arising from using a single method to measure multiple constructs. A random variable was introduced to calculate the variance inflation factor (VIF) value for SA, OU, LL, and HB. Given that all values of VIF were below the threshold of 3.33, we concluded that the CMB was not a significant concern (Kock, 2015).

#### 4.2. Measurement models

To evaluate the measurement models, reliability and validity assessments were performed. Indicator reliability was examined through outer loadings, with values exceeding 0.70 considered acceptable. Internal consistency reliability was examined by calculating Cronbach's alpha (Alpha) and composite reliability (i.e., Rho\_a and Rho\_c), all of which were required to surpass the 0.70 threshold. Convergent validity was gauged according to the average variance extracted (AVE), with acceptable values being greater than 0.50. Discriminant validity was determined utilizing the heterotrait-monotrait (HTMT) ratio, which should be significantly below 0.85. As presented in Table 2 and Table 3, all evaluation criteria were satisfied.

#### 4.3. Structural models

The proposed hypotheses were tested as the structural model was assessed. The initial step is to ascertain that the construct-level collinearity is not a critical issue. To this end, the VIF value for each predictor in the model was examined, and all values were found to be less than 3.00. Subsequently, a bootstrapping approach (10,000 sub-samples) was applied to examine the path coefficient ( $\beta$ ) in each model. As indicated in Table 4, the paths of SA–OU and OU–LL were significant, and hence the hypotheses proposed in H1 and H2 were supported. Furthermore, the bootstrapping method was also employed to test for the mediating effect (Hair et al., 2022). In the current model, considering the LA moderation, both direct (SA–LL) and indirect (SA–OU–LL) effects were found to be significant positive (see Table 4), thereby supporting hypothesis H3.

Control variables were also examined in the structural model. For the dependent variable OU, HB showed a significant positive association and emerged as the strongest predictor among all included variables; AG was found to be negatively related to OU, while ED and GD did not display significant effects; notably, moderator LA exhibited a significant positive relationship with OU. Regarding LL as the endogenous construct, AG and ED both showed significant negative relationships, whereas GD was not significant; LA exhibited a significant positive effect on LL and was the strongest factor among the control variables.

**Table 2**  
Reliability assessment.

| Constructs | Indicator | Outer Loading | Alpha | Rho_a | Rho_c |
|------------|-----------|---------------|-------|-------|-------|
| SA         | SA1       | 0.885         | 0.925 | 0.925 | 0.943 |
|            | SA2       | 0.893         |       |       |       |
|            | SA3       | 0.885         |       |       |       |
|            | SA4       | 0.845         |       |       |       |
|            | SA5       | 0.876         |       |       |       |
| HB         | HB1       | 0.796         | 0.765 | 0.766 | 0.865 |
|            | HB2       | 0.857         |       |       |       |
|            | HB3       | 0.822         |       |       |       |
| OU         | OU1       | 0.918         | 0.884 | 0.886 | 0.928 |
|            | OU2       | 0.903         |       |       |       |
|            | OU3       | 0.881         |       |       |       |
| LL         | LL1       | 0.836         | 0.886 | 0.886 | 0.913 |
|            | LL2       | 0.816         |       |       |       |
|            | LL3       | 0.807         |       |       |       |
|            | LL4       | 0.803         |       |       |       |
|            | LL5       | 0.702         |       |       |       |
|            | LL6       | 0.822         |       |       |       |

**Table 3**  
Validity assessment.

| Constructs | AVE   | HTMT  |       |       |    |
|------------|-------|-------|-------|-------|----|
|            |       | SA    | HB    | OU    | LL |
| SA         | 0.769 |       |       |       |    |
| HB         | 0.681 | 0.349 |       |       |    |
| OU         | 0.812 | 0.425 | 0.671 |       |    |
| LL         | 0.638 | 0.416 | 0.296 | 0.463 |    |

Note: All HTMT ratios were significantly less than 0.85 ( $\alpha = 0.05$ ).

#### 4.4. Moderated mediation

The path of LA\*SA–OU was found to be significant (see Table 4), suggesting that LA moderated the SA–OU relationship. To further assess the moderated mediation, Hayes's (2015) index was introduced. As presented in Table 5, the index was significantly not equal to zero, confirming the existence of a moderated mediation. Consequently, the hypothesis H4 was supported. Additional details are presented in Fig. 2 and Table 6. For those living alone (LA at one), the SA–OU relationship had a steeper slope, and the indirect effect of SA on LL via OU was stronger.

### 5. Discussion

Over-reliance on a utilitarian technology (e.g., the ODA) can lead to problematic usage. The current study set out to explore how social anxiety predicts ODA usage and how, in turn, such usage predicts subsequent loneliness by positing a moderated mediation model and conducting a three-phase survey.

#### 5.1. Discussion of findings

The results of the present study offer several nuanced insights into the interplay among social anxiety, ODA usage, and loneliness. Firstly, social anxiety was found to positively predict the use of ODA — a primarily utilitarian application—which extends extant literature that has predominantly linked social anxiety to problematic engagement with hedonic technologies. For instance, a meta-analysis by Wu et al. (2024) reported a strong positive correlation between social anxiety and the problematic use of social media. Wei et al. (2023) similarly identified social anxiety as a risk factor for problematic smartphone use, and Hu et al. (2023) observed a comparable association with the problematic use of conversational AI. Rather than driven by hedonism, socially anxious consumers may adopt ODAs to avoid the perceived risks of interpersonal interaction. Jin and Youn (2021) noted that individuals with greater anxiety around social exposure usually view social interactions as threatening. They may be inclined to choose a self-perceived comfortable routine. This perspective echoes previous research in which socially anxious individuals have been shown to favor greater interpersonal distance and prefer online (rather than face-to-face) communication (Givon-Benjio & Okon-Singer, 2020; Lacombe et al., 2024). Building on these insights, our study argues that ODAs — while designed for utilitarian purposes — offer a comparably low-risk avenue for fulfilling daily needs without engaging in socially threatening situations. Consequently, ODA adoption among socially anxious consumers functions not only as a convenience strategy but also as a coping mechanism that reinforces the avoidance tendencies characteristic of social anxiety.

Furthermore, our analysis confirms that ODA usage positively predicts loneliness. In other words, frequent reliance on ODAs can supplant casual interpersonal interactions and thereby heighten subjective feelings of isolation. This observation aligns with Nowland et al.'s (2018) argument that frequent use of technology (e.g., the Internet) can lead to increased loneliness when it is employed to escape the real world. In line with this perspective, Costa et al. (2019) found that problematic Internet

**Table 4**

Assessment of structural models.

| Path         | VIF   | $\beta$  | p-value | Confidence Interval | $f^2$ | $R^2$ |
|--------------|-------|----------|---------|---------------------|-------|-------|
| H1: SA-OU    | 2.373 | 0.144**  | 0.008   | [0.045, 0.240]      | 0.014 | 0.394 |
| HB-OU        | 1.103 | 0.480**  | <0.001  | [0.416, 0.546]      | 0.345 |       |
| AG-OU        | 1.013 | -0.111** | 0.006   | [-0.184, -0.039]    | 0.020 |       |
| ED-OU        | 1.013 | -0.038   | 0.181   | [-0.107, 0.029]     | 0.002 |       |
| GD-OU        | 1.009 | 0.066    | 0.215   | [-0.075, 0.201]     | 0.002 |       |
| LA-OU        | 1.006 | 0.213**  | 0.005   | [0.075, 0.349]      | 0.018 |       |
| LA*SA-OU     | 2.293 | 0.177**  | 0.013   | [0.044, 0.308]      | 0.013 | 0.259 |
| H2: OU-LL    | 1.212 | 0.277**  | <0.001  | [0.194, 0.358]      | 0.085 |       |
| SA-LL        | 1.188 | 0.266**  | <0.001  | [0.183, 0.347]      | 0.080 |       |
| AG-LL        | 1.021 | -0.107** | 0.009   | [-0.182, -0.033]    | 0.015 |       |
| ED-LL        | 1.014 | -0.086** | 0.029   | [-0.158, -0.010]    | 0.010 |       |
| GD-LL        | 1.007 | 0.061    | 0.252   | [-0.089, 0.210]     | 0.001 |       |
| LA-LL        | 1.024 | 0.241**  | 0.004   | [0.091, 0.390]      | 0.019 |       |
| Mediation    |       |          |         |                     |       |       |
| H3: SA-OU-LL |       | 0.040**  | 0.011   | [0.012, 0.069]      |       |       |

Note:

\*\* = significant ( $\alpha = 0.05$ ).**Table 5**

Assessment of Hayes's index.

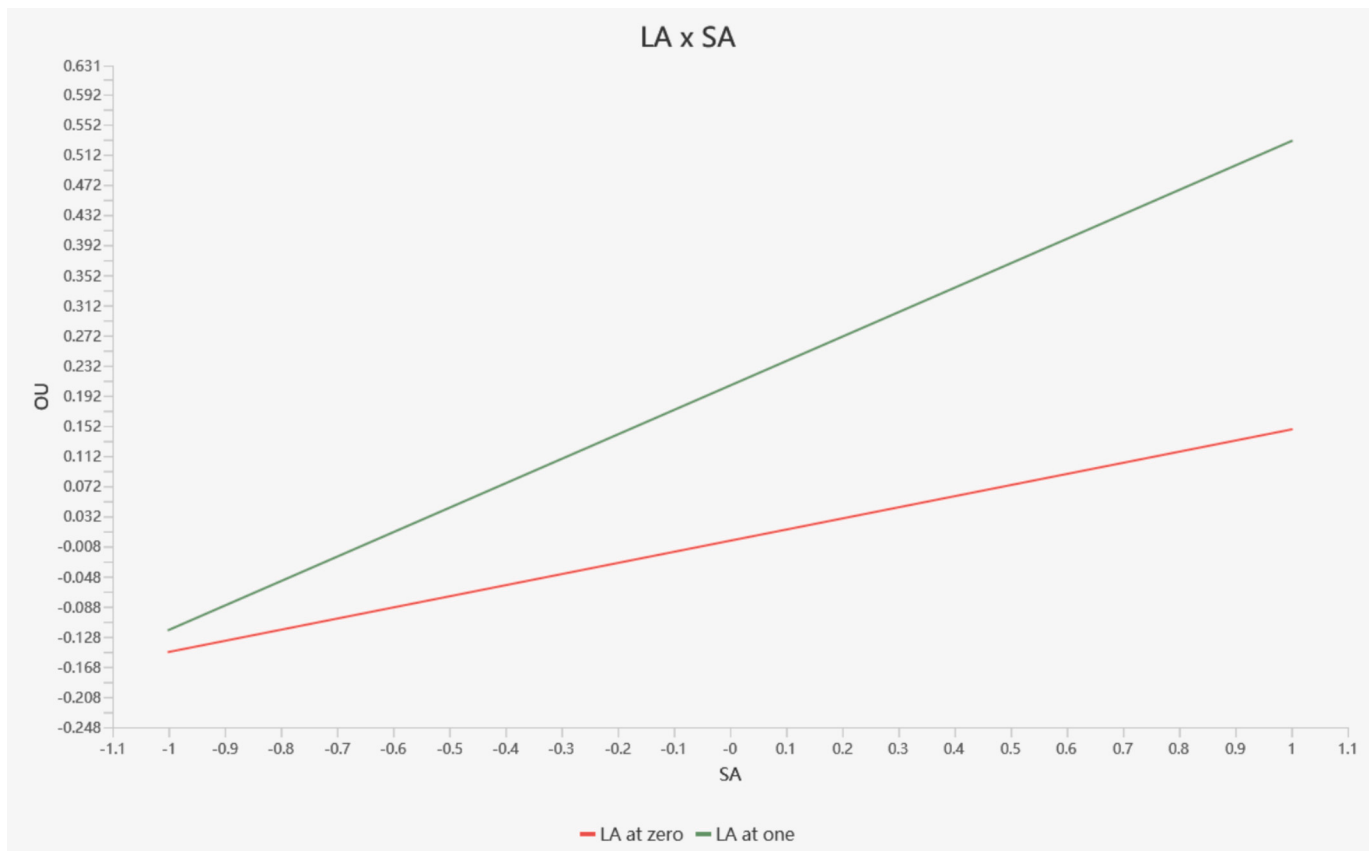
| Mediation | Moderator | Index   | p-value | Confidence Interval |
|-----------|-----------|---------|---------|---------------------|
| SA-OU-LL  | LA        | 0.034** | 0.022   | [0.008, 0.064]      |

Note: \*\* = significant ( $\alpha = 0.05$ ).

use predicted loneliness independently of social support indicators such as family functioning and romantic involvement. Similarly, [Alheneidi et al. \(2021\)](#) demonstrated a dose-response relationship between problematic Internet use and loneliness during COVID-19 lockdowns, indicating that greater online hours exacerbate feelings of loneliness.

[MacDonald and Schermer \(2021\)](#) reported that higher smartphone screen time and social media app use are positively correlated with loneliness, even when controlling for personality traits like neuroticism and communication apprehension. Compared with these studies, our finding demonstrates that even utilitarian applications — such as ODAs — can carry similar psychological costs. Collectively, this body of evidence extends research on loneliness by showing that efficiency-driven technologies, not solely hedonic ones, can contribute to sustained or increased loneliness.

Crucially, ODA usage was found to mediate the relationship between social anxiety and loneliness, providing empirical support for a mechanism through which an antecedent psychological trait translates into

**Fig. 2.** Moderating effect of LA on SA-OU.

**Table 6**  
Conditional indirect effect of SA on LL via OU.

| Mediation | Moderator                      | Effect  | p-value | Confidence Interval |
|-----------|--------------------------------|---------|---------|---------------------|
| SA-OU-LL  | LA at one: Living alone        | 0.061** | <0.001  | [0.037, 0.088]      |
|           | LA at zero: Living with others | 0.026** | 0.013   | [0.008, 0.046]      |

Note:  
\*\* = significant ( $\alpha = 0.05$ ).

an adverse emotional outcome. Although social anxiety alone has been widely proven to be directly associated with feelings of loneliness (Eres et al., 2021; Lim et al., 2016; Oren-Yagoda et al., 2022), previous research has also identified specific mediating mechanisms. For instance, Petak (2024) demonstrated that interpersonal cognitive distortions partially mediate the link between social anxiety and loneliness among university students. In another distinct demographic, Sun et al. (2024) showed that reduced social network connections act as a conduit linking social anxiety to loneliness in older adults. Unlike these cognitive and network-based pathways, our study uniquely positions ODA usage — a utilitarian technology usage — as the behavioral channel that perpetuates social withdrawal. Specifically, the propensity of socially anxious consumers to overuse ODAs — driven by their desire to avoid social threats — serves to perpetuate or intensify feelings of loneliness.

Finally, the moderated mediation analysis indicates that the indirect effect of social anxiety on loneliness through ODA usage is significantly conditioned by living arrangement (i.e., living alone versus living with others). Among individuals living alone, social anxiety exerts a stronger relationship with ODA usage, echoing prior evidence that household composition shapes the use of delivery applications. For instance, Cho et al. (2019) reported that single-person households place greater assign greater importance on convenience attributes in food delivery applications than multi-person households, and Roh and Park (2019) further demonstrated that single individuals are more likely to convert these convenience-seeking tendencies into actual application adoption. Moreover, Roh and Park (2023) showed that unmarried users depend more heavily on food delivery services in a single-portion context. For socially anxious individuals, living alone amplifies their reliance on ODAs for daily necessities. Consequently, this amplified dependence, coupled with reduced spontaneous interpersonal interactions, further exacerbates their vulnerability to loneliness.

5.2. Theoretical implications

This study offers three key theoretical contributions. First, it enhances the theoretical understanding of problematic technology use by demonstrating that a utilitarian technology (i.e., ODA) was interconnected with negative mental health concerns (i.e., social anxiety and loneliness). Prior investigations have predominantly situated problematic use within hedonistic contexts, where overuse of hedonic technologies stems from pleasure-seeking impulses and allows individuals to alleviate negative moods or escape from the real world. By showing that socially anxious consumers can similarly develop an overreliance on a utilitarian technology (i.e., ODA) and that such reliance can, in turn, increase their loneliness, we extend the problematic technology use paradigm from a hedonic domain into a utilitarian one.

Second, we delineate the dual role of ODA usage by identifying its antecedent and consequence. Building on our framework, this study identifies social anxiety as an antecedent and loneliness as a consequence of ODA usage, thereby illustrating a mechanism that demonstrates how individual traits translate into psychological outcomes. Crucially, we distinguish two simultaneous functions of ODA engagement: (1) as a coping mechanism, through which socially anxious individuals leverage the platform's self-service, low-interaction affordances to mitigate real-world social threats; and (2) as a

contributing factor, in which sustained reliance on instant delivery erodes spontaneous interpersonal contact and, in turn, intensifies feelings of isolation. By outlining a two-stage process — whereby ODA usage initially serves to alleviate social discomfort but subsequently reinforces behavioral patterns that heighten isolation — we contribute a more nuanced theoretical lens to the research on problematic technology use: utilitarian technologies provide short-term relief from anxiety while sowing the seeds of longer-term psychological distress.

Third, we introduce living arrangement as a boundary condition that refines our understanding of how individual traits translate into maladaptive behaviors via technology use. While social anxiety has long been linked to both increased technology engagement and loneliness, our moderated mediation model clarifies that the strength of this indirect pathway depends on the individuals' residential context. Specifically, those living alone exhibit a magnified effect of social anxiety on ODA usage — and consequently greater loneliness — compared to those cohabiting with others. This nuanced insight underscores the importance of incorporating environmental and contextual moderators in models of technology adoption and psychological outcomes. In doing so, we offer a more granular theoretical account of when and for whom utilitarian technologies exacerbate social isolation, thereby charting new directions for research on personalized interventions and the interplay between consumer circumstances and digital behavior.

5.3. Practical implications

This study also brings practical insights for individual consumers, healthcare providers, and policymakers. For consumers — particularly those experiencing social anxiety, loneliness, or living alone — awareness of their ODA usage patterns is paramount. By recognizing that frequent reliance on ODAs may inadvertently reduce real-world social interactions and exacerbate isolation, individuals can strive to balance convenience with opportunities for face-to-face engagement. Practical self-regulation strategies might include setting daily or weekly limits on delivery orders, intentionally integrating in-person social activities (such as sharing meals with friends or family), and monitoring emotional responses before and after using ODAs to ensure that such services serve genuine needs rather than function as a means of avoidance. Moreover, the broader population can benefit from adopting a mindful approach to ODA use. Even consumers without marked social anxiety or loneliness may advantageously engage in periodic self-reflection on their ODA habits to prevent the gradual erosion of spontaneous social interactions and to maintain holistic well-being.

For healthcare providers, the incorporation of ODA usage patterns into routine mental health assessments can function as an early indicator of maladaptive coping strategies. Clinical psychologists may employ standardized inquiries concerning the frequency, context, and motivations for ODA engagement within diagnostic interviews and self-report inventories. Based on these insights, practitioners are equipped to propose bespoke interventions, including cognitive restructuring exercises aimed at challenging avoidance beliefs, social skills training to promote in-person engagement, and graded exposure tasks that methodically reintroduce patients to face-to-face scenarios. Collaborative goal setting, wherein patients and providers co-create a “digital wellness plan” with personalized usage thresholds and scheduled social activities, has the potential to further reinforce adaptive behavior change and mitigate loneliness arising from overreliance on delivery applications.

Policymakers and O2O platform developers can collaborate to address the psychological risks associated with ODA dependence by incorporating actionable support mechanisms within the user experience and policy framework. Delivery applications have the potential to introduce context-sensitive prompts that activate when users approach or exceed predefined order limits. These prompts could encourage brief self-reflection or recommend nearby community events. Public health agencies should collaborate with platform operators to incorporate direct links to mental health resources, such as counseling hotlines, peer

support groups, and local social programs, within the app interface. Furthermore, the implementation of digital literacy initiatives that underscore balanced technology engagement, emotional self-regulation, and the significance of spontaneous social interaction will empower consumers to navigate the trade-off between convenience and interconnectedness. This, in turn, will safeguard collective psychological resilience and nurture environments where technology serves to augment, rather than supplant, tangible social connections.

#### 5.4. Limitations and future directions

The present study is subject to at least two limitations that should be noted. First, the sample was drawn exclusively from a specific country (i.e., China), a market with highly developed O2O infrastructure, extensive platform penetration, and culturally specific attitudes toward social interaction. Consequently, the generalizability of our findings to regions with different commercial ecosystems or social norms remains uncertain. To illustrate, in the current context, mature technological infrastructure and relatively low delivery costs reduce the barriers to frequent ODA usage, leading socially anxious consumers to adopt ODAs more readily than their counterparts in less developed markets — potentially amplifying the observed relationships. Future research should employ cross-national or cross-cultural sampling strategies to assess whether the proposed relationships hold in diverse contexts. Second, use behavior was measured subjectively, which is susceptible to recall bias and social desirability effects, potentially distorting the true magnitude of use. Subsequent studies would benefit from using objective data, such as usage logs or in-app analytics, to capture real-time usage patterns and validate self-report findings.

Furthermore, additional directions for future research can be suggested. Although the current study utilized a three-phase survey design to investigate the antecedent (i.e., social anxiety) and consequence (i.e., loneliness) of ODA usage, causality and underlying mechanisms remain open to multiple interpretations. Future work can employ experimental designs to identify new causal (or reciprocal causal) relationships among variables, or apply qualitative designs to understand the mechanisms inherent in the relevant consumer behavior or psychology. In addition, our focus on living arrangement (i.e., living alone versus living with others) as the sole contextual moderator represents just one boundary condition, and future research is recommended to explore alternative moderators, such as personality traits or cultural background. For example, personality dimensions, such as extraversion or neuroticism, may differentially predispose consumers to seek online delivery as an avoidance strategy, thereby altering the strength of the mediated pathway. Likewise, cultural values, such as individualism versus collectivism, could influence how readily users substitute face-to-face interactions with app-based transactions.

## 6. Conclusion

While ODAs offer substantial utilitarian benefits to consumers, excessive reliance on ODAs can foster problematic use. In addition to well-documented physical health risks, ODA usage also poses mental health challenges. By integrating a moderated mediation model, the present study demonstrates that consumers experiencing higher levels of social anxiety are more likely to increase their use of ODAs, which subsequently amplifies their feelings of loneliness. Moreover, living arrangement emerges as a boundary condition: the indirect effect of social anxiety on loneliness via ODA usage is significantly stronger for individuals living alone. Despite some limitations, these findings advance the theoretical understanding of problematic technology use — traditionally framed as hedonistic — by linking the mental health antecedent and consequence to utilitarian ODA usage. Practically, the study may inform strategies to identify consumer mental health risks and promote comprehensive consumer well-being. Moreover, while the findings are derived from a specific market, they provide actionable

insights for other markets, particularly in emerging ones, where ODA platforms are rapidly developing. Understanding the potential psychological costs of ODA usage can help global practitioners tailor interventions and platform features to their local service ecosystems.

## CRedit authorship contribution statement

**Pinyi Yao:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yongheng Meng:** Writing – review & editing, Supervision, Resources, Project administration, Methodology. **Wenjing Fan:** Writing – review & editing, Validation, Conceptualization.

## Research ethics statement

The study was conducted in accordance with relevant laws and institutional guidelines, and has been approved by the Ethics Committee (the Office of Scientific Research and Discipline Construction) of Nanjing University. Written informed consent was not applicable because the survey was conducted online, and the participants needed to declare their consent to the survey before they could proceed with the online questionnaire.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.actpsy.2025.105381>.

## Data availability

Data will be made available on request.

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