

Perceived passenger invisibility, psychological distress, and interactional intentions among ride-hailing drivers in China: evidence from two surveys and a vignette-based study

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Article

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Abstract

Background

Ride-hailing drivers interact repeatedly with passengers, yet passengers may fail to acknowledge them as social participants. We examined perceived passenger invisibility, defined as drivers' experience of being insufficiently acknowledged by passengers, and its associations with psychological distress and with drivers' intended responses to passengers.

Methods

Three studies were conducted with ride-hailing drivers in China. Study 1 was a cross-sectional survey ($N = 272$) using a three-item measure of perceived passenger invisibility. Study 2 was a cross-sectional survey ($N = 338$) using an interview-informed measure of perceived passenger invisibility, fundamental psychological need threat, and psychological distress. Study 3 ($N = 328$) was a vignette-based study in which drivers read three scenarios designed to elicit the experience of being disregarded by a passenger and then rated perceived passenger invisibility, need threat, and their intended responses.

Results

Higher perceived passenger invisibility was associated with greater psychological distress in Study 1 ($r = .46, p < .001$) and Study 2 ($r = .48, p < .001$). In Study 2, fundamental psychological need threat mediated this association (indirect effect = .18, Boot $SE = .03$, 95% CI [.12, .24]), and belonging threat and meaningful-existence threat were significant mediators, whereas self-esteem and control threat were not. In Study 3, drivers who perceived greater passenger invisibility reported stronger intentions to confront the passenger and weaker intentions to endure the situation, and control threat suppressed the association with confrontation while fully mediating the association with endurance. Perceived passenger invisibility was not associated with constructive communication.

Conclusions

Among ride-hailing drivers, greater perceived passenger invisibility was associated with greater psychological distress, and this association was partly explained by threats to fundamental psychological needs. The same need-threat process was further linked to how drivers intended to respond to passengers, with control threat shaping confrontation and endurance intentions. Perceived passenger invisibility therefore appears to be a subtle form of social exclusion that matters both for drivers' mental health and for the driver–passenger relationship, and longitudinal and experimental research is needed in the future to establish temporal and causal processes.

Background

Flexible and platform-mediated employment has become a major part of China's labor market. The latest number of flexibly employed workers in China is estimated to exceed 200 million [1]. Ride-hailing drivers are one of the most visible groups within this broad workforce: by 31 October 2024, 7.483 million ride-hailing driver licenses had been issued nationwide [2]. The scale of the workforce makes drivers' psychological health an important research concern. Yet ride-hailing work creates a visibility paradox. Drivers are continuously located, evaluated, and assigned orders by platforms, while working alone with little contact with supervisors or coworkers. Research with bicycle couriers and platform drivers suggests that such work arrangements can shape occupational identity, engagement, and psychological well-being [3, 4]. Online driver communities may partly compensate for occupational separation [5], but passengers remain the most immediate interpersonal presence in drivers' daily work.

Passengers are the people a driver actually meets during a working day, and the passenger encounter is therefore where the interpersonal life of the job takes place. How passengers treat drivers may accordingly carry substantial psychological weight. Previous studies show that difficult driver–passenger communication has been linked to psychological distress among public-transport drivers [6], and customer incivility can contribute to burnout and impaired well-being [7]. In addition, algorithmic management can also frustrate workers' psychological needs and increase occupational stress [8, 9]. These studies suggest that platform workers face significant occupational and interpersonal stressors. However, previous findings focus primarily on overt or readily identifiable stressors, such as complaints, aggression, incivility, and algorithmic control. Much less is known about a quieter experience: the driver's sense of not being acknowledged by the passenger at all. We refer to this experience as perceived passenger invisibility.

Perceived passenger invisibility

Interpersonal invisibility refers to receiving little cognitive, emotional, or behavioral investment from another person and consequently feeling that one's presence, perspective, or contribution is not acknowledged [10, 11]. In ride-hailing work, perceived passenger invisibility may arise when passengers fail to greet or respond to drivers, ignore their reminders, or behave as though the driver were merely part of the vehicle or platform. Although no previous study has examined this experience among ride-hailing drivers directly, evidence from other service occupations is instructive. Research with cleaners shows that workers may feel invisible when clients do not acknowledge either them or their work, even without an explicit insult [12]. Essential workers have likewise reported felt invisibility when public recognition bypasses their occupational group [13].

Notably, perceived passenger invisibility is related to, but distinct from, rejection, ostracism, incivility, and disrespect. Although social-exclusion research includes being ignored, many experimental paradigms create a clear episode of intentional exclusion, whereas incivility and disrespect involve an identifiable norm violation or negative evaluation [14]. Perceived passenger invisibility is often more ambiguous, because insufficient acknowledgment may occur without explicit rejection, deliberate hostility, or even a clearly identifiable offender. That ambiguity makes the experience easy for passengers, platforms, and

researchers to overlook, but it does not make the experience psychologically harmless. Two findings suggest that being ignored carries a psychological signature of its own. First, being ignored and being explicitly rejected motivate different responses in the person on the receiving end: those who are ignored tend to work at re-establishing the connection, whereas those who are openly rejected tend to protect themselves against further harm [15]. Second, even a minimal sign of acknowledgment from the excluding party reduces the harm of exclusion, which suggests that it is the absence of acknowledgment itself, rather than any hostile act, that does the damage [16].

Ride-hailing encounters therefore make perceived passenger invisibility especially plausible and potentially recurrent. The relationship is brief, asymmetrical, and organized around a transaction. Passengers may attend to the route, vehicle, or app while failing to acknowledge the driver as another social participant. A single instance may appear trivial, particularly when hostile intent is absent. Repeated across many rides, such encounters may communicate that the driver is functionally useful but socially peripheral. Examining perceived passenger invisibility therefore captures a subtle, low-intent form of social exclusion that conventional research on overt mistreatment may miss.

Perceived passenger invisibility and psychological distress

Psychological distress refers to nonspecific symptoms such as nervousness, hopelessness, restlessness, and low mood [17]. Social exclusion is one of its established risk factors. Previous studies show that even a brief episode of exclusion activates brain regions that also respond to physical pain [14, 18], and exclusion that persists over time depletes psychological resources and is associated with alienation, depression, helplessness, and a loss of self-worth [19].

Ride-hailing drivers are plausibly exposed to this risk in a form that is specific to their occupation. They spend long hours in close contact with a succession of strangers, and they do so without the stable colleague relationships or organizational support that buffer such encounters in conventional workplaces [5, 20]. Passenger disregard is therefore not an isolated incident for these drivers but a recurring feature of the working day, which makes it a plausible risk factor for their mental health.

Hypothesis 1

Perceived passenger invisibility is positively associated with ride-hailing drivers' psychological distress.

Fundamental psychological need threat as a mechanism

Why should a passenger's failure to acknowledge a driver affect that driver's mental health? The temporal need-threat model proposes that social exclusion threatens four fundamental needs: belonging, self-esteem, meaningful existence, and control [14]. As a covert form of social exclusion, perceived passenger invisibility conveys exclusionary meaning without any explicit act of rejection, and it may therefore threaten the same fundamental needs that overt exclusion threatens. When passengers fail to respond or acknowledge the driver's presence, drivers may feel excluded from the social exchange (belonging threat)

and treated as insignificant (meaningful-existence threat). Disrespectful or dismissive responses may undermine self-esteem, whereas ignored safety or service requests may reduce perceived control. Consistent with this account, meta-analytic evidence indicates that social exclusion reliably produces both need threat and negative affect [21, 22].

Self-determination theory extends the argument from the immediate episode to the longer term: persistent frustration of basic psychological needs is associated with negative affect and with maladaptive patterns of functioning [23]. Threatened needs are therefore a plausible route from repeated passenger disregard to the nonspecific symptoms captured by psychological distress.

One caveat concerns how this process has been studied. Most evidence comes from laboratory paradigms, in which exclusion is acute, brief, and highly arousing [14, 24]. Such paradigms have limited ecological validity for a covert and chronic form of exclusion that unfolds across hundreds of ordinary work encounters. We therefore measured the experience as drivers report it in their actual driver–passenger interactions.

Hypothesis 2

Fundamental psychological need threat mediates the positive association between perceived passenger invisibility and ride-hailing drivers' psychological distress.

Perceived passenger invisibility and interactional intentions

Psychological distress describes how perceived passenger invisibility registers at the level of the individual worker's mental health. A second, distinct question concerns the encounter itself, namely how drivers intend to respond to a passenger who has disregarded them. The two levels are related but not equivalent. Distress describes what the experience does to the worker, whereas interactional intentions describe what the worker is inclined to do next. Because those intentions are enacted in the driver–passenger relationship, they also bear on conflict, safety, and service quality.

No study has yet examined how ride-hailing drivers respond to being disregarded by a passenger, but the ostracism literature offers a starting point. The temporal need-threat model proposes that, after the immediate need threat caused by exclusion, people reflect on the event and respond in ways intended to restore threatened needs [14]. Prior research distinguishes three broad classes of response: attempts to reconnect with others [25], attempts to reassert the self or regain control, including aggressive or confrontational responses [26], and withdrawal from further social risk [27]. This tripartite structure corresponds to the motivational classes described in the multimotive model [28] and to recent frameworks of ostracism in everyday life [29].

In the ride-hailing context, these three responses (reconnection, self-assertion, and withdrawal) may appear as constructive communication, confrontation, and endurance. A driver may communicate constructively to restore a workable social exchange, confront the passenger to defend dignity or control,

or endure the situation to avoid economic and interpersonal costs. These intentions are not simple equivalents of prosocial, antisocial, and avoidant behavior, and endurance in particular may reflect restraint, resignation, or strategic conflict avoidance. The threat-and-defense model further suggests that the intensity of threat shapes which orientation prevails, such that mild threat tends to elicit approach-oriented responses, severe threat elicits avoidance, and very severe threat may override normative constraints on antisocial responding [29, 30]. The present work therefore examined whether perceived passenger invisibility and need threat were associated with these three interactional intentions.

Hypothesis 3

Perceived passenger invisibility is positively associated with confrontation intentions and negatively associated with endurance and constructive-communication intentions, and fundamental psychological need threat mediates these associations.

The present research

Existing research has not systematically examined whether perceived passenger invisibility, a subtle form of social exclusion that need not involve explicit hostility, is related to ride-hailing drivers' psychological distress, why such an association may occur, and how invisibility may relate to drivers' subsequent interactional intentions. To address these questions, we conducted three studies with ride-hailing drivers in China. Study 1 tested whether perceived passenger invisibility was associated with psychological distress. Study 2 used an interview-informed measure of perceived passenger invisibility to replicate this association and to test the mediating effect of fundamental psychological need threat. Study 3 used three difficult passenger vignettes to examine how perceived passenger invisibility and specific need threats were associated with drivers' intentions to confront, endure, or communicate constructively with passengers.

Methods

Overview and study setting

All three studies recruited adults currently working as ride-hailing drivers in China. Participants were recruited through Credamo (Chinese brand name: Jianshu), an online survey platform widely used for research in China. Study 1 additionally used offline snowball sampling, and Study 2 additionally used Yibiaoda, a Chinese online survey platform. Participants were told that the study concerned drivers' work experiences and gave informed consent before beginning. Each questionnaire ended with a demographic block, and participants received a small monetary reward on completion (3 Chinese yuan [CNY]). Every questionnaire contained attention-check items, and cases were excluded when the completion time was 1,000 s or longer or when one or more attention-check items were answered incorrectly. In Studies 2 and 3, responses not completed on a mobile device were also excluded as an additional procedural check intended to reduce potentially inauthentic responses. Exclusions are reported separately for each study

below. Studies 1 and 2 were cross-sectional surveys. In Study 3, all participants read the same three scenarios describing a passenger disregarding a driver. The scenarios were used to elicit the experience of being ignored by a passenger, and perceived passenger invisibility was then measured rather than manipulated, so the study is described as a vignette-based study rather than a randomized experiment. All measures were administered in Chinese. The K10 was administered using a previously published Chinese version [17, 31]. English translations of the administered measures and vignettes are provided in Additional file 1.

Study 1

Participants and procedure

A power analysis for multiple linear regression conducted in G*Power 3.1 ($\alpha = .05$, medium effect size, 95% power) indicated a minimum sample of 89 [32]. Data were collected in April 2024. Questionnaires were distributed to 334 drivers, of whom 4 were excluded because the completion time was 1,000 s or longer, and 58 because they answered at least one of the three attention-check items incorrectly, leaving 272 valid cases (81.44%). Participants came from 29 provincial-level regions of China. Most were men ($n = 203$, 74.6%; women: $n = 69$, 25.4%), and their mean age was 34.36 years ($SD = 8.52$). With regard to education, 9.2% had completed junior secondary school or below, 24.3% senior secondary or vocational school, 63.2% a college or bachelor's degree, and 3.3% a postgraduate degree. Monthly income was below CNY 3,000 for 9.6% of drivers, CNY 3,000–5,000 for 20.6%, CNY 5,000–8,000 for 41.9%, and above CNY 8,000 for 27.9%. Driving tenure was under six months for 13.6%, six months to two years for 41.2%, two to five years for 34.6%, and more than five years for 10.7%.

Measures

Perceived passenger invisibility. Perceived passenger invisibility was measured with three items adapted from Kim et al. [13], whose original items were based on the account of occupational invisibility given by Rabelo and Mahalingam [12]. A sample item is “Passengers often look right through me, as if I were invisible”. Responses ranged from 1 (strongly disagree) to 5 (strongly agree), and higher mean scores indicate greater perceived invisibility (Cronbach's $\alpha = .91$).

Psychological distress. Psychological distress was measured with the 10-item Kessler Psychological Distress Scale (K10) [17, 31]. Participants reported how often they had experienced each symptom during the past 30 days, from 1 (none of the time) to 5 (all of the time). Higher mean scores indicate greater distress ($\alpha = .90$).

Statistical analysis

Analyses were conducted in SPSS 27.0 and AMOS 26.0. Common method bias was examined with Harman's single-factor test, in which all 13 items were constrained to load on a single factor in a confirmatory factor analysis [33, 34]. The fit of this model was compared with that of the corresponding two-factor measurement model, in which the invisibility items and the K10 items loaded on separate but

correlated factors. We then computed descriptive statistics and Pearson correlations. Because gender and monthly income were associated with the study variables, they were entered as covariates in a multiple regression predicting psychological distress from perceived passenger invisibility.

Study 2

Participants and procedure

A Monte Carlo power analysis for an indirect effect, based on the Study 1 correlations and conservative planning values, indicated a minimum of 103 participants for 95% power [35]. Data were collected from October to November 2024 on two online platforms. On Credamo, 279 drivers responded, of whom 6 were excluded for answering at least one of the two attention-check items incorrectly, 4 for a completion time of 1,000 s or longer, and 13 for not completing the questionnaire on a mobile device, leaving 256 valid cases. A further 122 drivers responded on Yibiaoda, a Chinese online survey platform, which applied the same screening rules and returned 82 valid cases. Yibiaoda has since ceased operation and retained only the screened dataset, so the number of cases excluded under each rule cannot be recovered for this subsample. The two subsamples were combined, giving 338 valid cases out of 401 respondents (84.29%). Participants came from 28 provincial-level regions of China and had a mean age of 31.68 years ($SD = 7.40$). Most were men ($n = 212$, 62.7%; women: $n = 126$, 37.3%). At the time of the survey, 174 drivers (51.5%) drove full-time and 164 (48.5%) part-time, and 267 (79.0%) drove for the standard express service and 71 (21.0%) for the premier service. With regard to education, 2.1% had completed junior secondary school or below, 13.9% senior secondary or vocational school, 78.7% a college or bachelor's degree, and 5.3% a postgraduate degree. Monthly income was below CNY 3,000 for 31.7% of drivers, CNY 3,000–5,000 for 19.2%, CNY 5,000–8,000 for 29.6%, and above CNY 8,000 for 19.5%. Driving tenure was under six months for 10.1%, six months to two years for 44.1%, two to five years for 34.9%, and more than five years for 10.9%. Most drivers worked five to seven days per week (68.3%) and drove for seven hours or more per day (60.7%).

Measures

Perceived passenger invisibility. A context-specific questionnaire was developed for this study. Seventeen ride-hailing drivers took part in one-to-one interviews about occasions on which they had felt ignored or disregarded by passengers and about the attitudes, words, or behaviors involved. Eight recurring situations were converted into frequency items, and examples include passengers ignoring a safety reminder, showing indifference, failing to acknowledge help, or behaving as though the driver's requests and work environment did not matter. Items were rated from 1 (never) to 5 (always) and averaged ($\alpha = .82$).

A principal-components analysis with varimax rotation yielded one component with an eigenvalue greater than one, accounting for 45.11% of the variance (Kaiser–Meyer–Olkin statistic = .87; Bartlett's $\chi^2 = 740.91$, $p < .001$). A one-factor confirmatory model estimated in the same sample showed acceptable fit once the residuals of the first two items, both of which describe a passenger's general attitude during the ride, were allowed to covary on the basis of modification indices: $\chi^2/df = 3.05$, incremental fit index = .95, Tucker–

Lewis index = .92, comparative fit index = .95, and root mean square error of approximation = .08 [33]. Without this residual covariance the fit was poorer, $\chi^2/df = 3.75$, comparative fit index = .92, Tucker–Lewis index = .89, and root mean square error of approximation = .09, and the standardized loadings, composite reliability, and average variance extracted were essentially unchanged. Standardized loadings ranged from .55 to .65 (all $p < .001$). Composite reliability was .82. The average variance extracted was .37, and although this value is below the conventional .50 criterion, convergent validity can still be regarded as acceptable when composite reliability exceeds .60 [36, 37]. Taken together, these results support a unidimensional structure [38].

Fundamental psychological need threat. Fundamental psychological need threat was assessed with 12 items adapted from Ren et al. [27]. Three items represented each of belonging, self-esteem, meaningful existence, and control. Items were coded so that higher values indicated greater threat and then averaged (1 = strongly disagree, 5 = strongly agree; $\alpha = .85$).

Psychological distress. Psychological distress was measured with the K10 as in Study 1 ($\alpha = .89$).

Statistical analysis

Common method bias was examined with Harman's single-factor test using exploratory factor analysis [34]. After descriptive statistics and Pearson correlations, the indirect effect of perceived passenger invisibility on psychological distress through fundamental psychological need threat was estimated with PROCESS 4.1 (Model 4) using 5,000 bootstrap samples [39], with gender entered as a covariate because of its bivariate associations with the study variables. To identify which needs carried the association, the four need dimensions were entered simultaneously as parallel mediators in a single model.

Study 3

Participants and procedure

A Monte Carlo planning analysis for an indirect effect indicated a minimum of 148 participants for 95% power under the correlations and conservative values used in Study 2 [35]. Data were collected from December 2024 to January 2025. Of 407 drivers who responded, 14 were excluded for a completion time of 1,000 s or longer, 45 for answering at least one of the four attention-check items incorrectly, and 20 for not completing the questionnaire on a mobile device. Two further cases were excluded because the participants indicated in the final response-quality check that they had not completed the questionnaire attentively, leaving 328 valid cases (80.60%). Recruitment drew on the same online platform as Study 2, and drivers who had taken part in the earlier study were not excluded, so a small degree of participant overlap between the two studies cannot be ruled out. Participants came from 28 provincial-level regions of China and had a mean age of 31.68 years ($SD = 7.77$). Most were men ($n = 211$, 64.3%; women: $n = 117$, 35.7%). At the time of the survey, 198 drivers (60.4%) drove full-time and 130 (39.6%) part-time, and 257 (78.4%) drove for the standard express service and 71 (21.6%) for the premier service. With regard to education, 3.0% had completed junior secondary school or below, 16.2% senior secondary or vocational school, 75.3% a college or bachelor's degree, and 5.5% a postgraduate degree. Monthly income was below

CNY 3,000 for 28.4% of drivers, CNY 3,000–5,000 for 17.7%, CNY 5,000–8,000 for 31.4%, and above CNY 8,000 for 22.6%. Driving tenure was under six months for 5.8%, six months to two years for 38.4%, two to five years for 39.9%, and more than five years for 15.9%. Most drivers worked five to seven days per week (74.1%) and drove for seven hours or more per day (65.9%).

Vignettes and measures

Three vignettes were developed from the three most frequently endorsed items of the Study 2 questionnaire. They described a passenger damaging the in-car environment without meaningful acknowledgment, a passenger speaking contemptuously about ride-hailing work, and a passenger ignoring repeated safety reminders. Every participant considered all three scenarios. Because the participants were themselves ride-hailing drivers, they were asked to place themselves in the position of the driver described in the scenario. After each vignette, participants completed an attention check and rated whether the passenger had ignored the driver's feelings (1 = not at all, 7 = strongly).

Need threat. Need threat was assessed after each vignette with four items, one each for belonging, self-esteem, meaningful existence, and control [27]. Items were rated from 1 (strongly disagree) to 5 (strongly agree) and coded so that higher values indicated greater threat. Across the three scenarios, the 12 responses yielded $\alpha = .83$.

Interactional intentions. Following the three-category classification of behavioral responses to ostracism proposed by Büttner et al. [29], intended responses were measured with one scenario-specific item each for confrontation, endurance, and constructive communication (1 = strongly disagree, 5 = strongly agree). The exact materials appear in Additional file 1.

Statistical analysis

Common method bias was examined as in Study 2 [34]. For each participant, ratings were averaged across the three vignettes to create one person-level score for perceived passenger invisibility, each need-threat dimension, and each intended response, and the participant, rather than the individual vignette rating, was the unit of analysis. After Pearson correlations, indirect effects were estimated only for those need dimensions that correlated with both perceived passenger invisibility and the intended response concerned, in line with the correlational precondition for mediation analysis [40]. These were belonging threat and control threat for confrontation, and self-esteem threat and control threat for endurance. Models were estimated with PROCESS 4.1 (Model 4) and 5,000 bootstrap samples [39]. Covariates were selected from the observed bivariate associations, namely gender, age, and monthly income for confrontation, and gender and age for endurance.

Use of generative artificial intelligence

Claude (Anthropic) and Codex (OpenAI) were used to assist with English-language editing and with formatting the manuscript to the journal's requirements. They were not used to generate the research design, to collect data, to conduct the reported statistical analyses, to interpret the results, or to write the

initial manuscript. The authors reviewed and revised all text and take full responsibility for the content of the manuscript.

Results

Study 1

In Harman's single-factor test, the single-factor model fitted the data poorly, $\chi^2/df = 8.67$, incremental fit index = .73, Tucker–Lewis index = .67, comparative fit index = .73, and root mean square error of approximation = .17, whereas the corresponding two-factor measurement model fitted well, $\chi^2/df = 2.05$, incremental fit index = .96, Tucker–Lewis index = .96, comparative fit index = .96, and root mean square error of approximation = .06, indicating that common method bias was not a serious concern in this sample [33, 34]. Perceived passenger invisibility was positively correlated with psychological distress, $r = .46, p < .001$ (Table 1, Panel A). In the regression model controlling for gender and monthly income, perceived passenger invisibility remained a significant positive predictor of psychological distress, $B = .29, SE = .04, p < .001$. Hypothesis 1 was supported.

Table 1 Descriptive statistics and correlations across the three studies

Panel A. Study 1 (N = 272)

Variable	<i>M</i>	<i>SD</i>	1	2
1. Perceived passenger invisibility	2.42	1.00	—	
2. Psychological distress	1.99	0.67	.46***	—

Panel B. Study 2 (N = 338)

Variable	<i>M</i>	<i>SD</i>	1	2	3
1. Perceived passenger invisibility	2.56	0.71	—		
2. Need threat	2.26	0.62	.39***	—	
3. Psychological distress	2.12	0.66	.48***	.62***	—

Panel C. Study 3 (N = 328)

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8
1. Perceived passenger invisibility	5.94	0.82	—							
2. Belonging threat	3.85	0.92	.37***	—						
3. Self-esteem threat	3.47	0.82	.19***	.21***	—					
4. Meaningful-existence threat	3.61	0.89	.34***	.51***	.30***	—				
5. Control threat	3.78	0.82	.19***	.23***	.68***	.39***	—			
6. Confrontation	2.97	0.83	.22***	.13*	-.09	.07	-.14*	—		
7. Endurance	3.27	0.95	-.15**	.02	-.13*	-.03	-.16**	-.44***	—	
8. Constructive communication	4.16	0.78	.07	-.03	-.12*	-.05	-.08	.07	-.06	—

Note. Correlation coefficients are Pearson's *r*. Perceived passenger invisibility was rated on a 7-point scale in Study 3 and on 5-point scales in Studies 1 and 2, and all other focal variables were rated on 5-point scales. Full matrices including gender, age, and monthly income are in Additional file 1, Tables S1–S3. * $p < .05$. ** $p < .01$. *** $p < .001$.

Study 2

In Harman's single-factor test, six factors had eigenvalues greater than one, and the first factor accounted for 31.15% of the item variance, which is below the 40% criterion, so common method bias was not a serious concern [34]. Perceived passenger invisibility was positively correlated with need threat, $r = .39$, $p < .001$, and with psychological distress, $r = .48$, $p < .001$. Need threat was also positively correlated with distress, $r = .62$, $p < .001$ (Table 1, Panel B).

In mediation analyses, we found that fundamental psychological need threat mediated the association between perceived passenger invisibility and psychological distress. The indirect effect was .18 (Boot SE = .03, 95% CI [.12, .24]) and accounted for 40.0% of the total effect ($c = .45$, 95% CI [.36, .53]), and the direct effect remained significant, $c' = .27$, 95% CI [.19, .35] (Fig. 1; Additional file 1, Table S4). Hypothesis 2 was supported. In the dimension-specific models, the indirect effects through belonging threat, $ab = .09$, 95% CI [.02, .17], and meaningful-existence threat, $ab = .07$, 95% CI [.03, .12], were significant, whereas those through self-esteem threat, $ab = .01$, 95% CI [–.002, .03], and control threat, $ab = .02$, 95% CI [–.01, .04], were not.

Study 3

In Harman's single-factor test, seven factors had eigenvalues greater than one, and the first factor accounted for 19.51% of the item variance, so common method bias was not a serious concern [34].

Perceived passenger invisibility was associated with greater confrontation, $r = .22, p < .001$, and less endurance, $r = -.15, p = .006$, whereas its association with constructive communication was not significant, $r = .07, p = .216$. Perceived passenger invisibility was positively associated with overall need threat, $r = .37, p < .001$, and with each of its dimensions (belonging, $r = .37$; self-esteem, $r = .19$; meaningful existence, $r = .34$; control, $r = .19$; all $ps < .001$), whereas overall need threat was not significantly associated with confrontation, $r = -.004, p = .941$, or endurance, $r = -.10, p = .083$. At the dimension level, confrontation was positively associated with belonging threat, $r = .13, p = .022$, and negatively with control threat, $r = -.14, p = .013$, and endurance was negatively associated with self-esteem threat, $r = -.13, p = .018$, and with control threat, $r = -.16, p = .003$ (Table 1, Panel C; full matrices in Additional file 1, Table S3).

We then examined whether specific need threats accounted for the associations between perceived passenger invisibility and the two intentions that were related to it. For confrontation, the indirect effect through belonging threat was not significant, $ab = .02$, 95% CI $[-.03, .06]$. For control threat, the total effect, $c = .20$, 95% CI $[.09, .31]$, and the direct effect, $c' = .23$, 95% CI $[.12, .34]$, were both positive and significant, whereas the indirect effect was negative, $ab = -.04$, 95% CI $[-.07, -.01]$. Because the direct and indirect effects had opposite signs, control threat acted as a suppressor rather than as a mediator in this association ($|ab/c'| = 15.1\%$). For endurance, the indirect effect through self-esteem threat was not significant, $ab = -.03$, 95% CI $[-.06, .0002]$, an interval whose upper limit lies at the boundary of zero, so this path is better regarded as inconclusive than as a clear null result. Through control threat, the total effect, $c = -.15$, 95% CI $[-.28, -.02]$, and the indirect effect, $ab = -.03$, 95% CI $[-.07, -.01]$, were significant, whereas the direct effect was not, $c' = -.12$, 95% CI $[-.24, .01]$, a pattern consistent with full mediation (Additional file 1, Tables S5–S6 and Fig. S1).

Hypothesis 3

was partially supported. Perceived passenger invisibility was associated with confrontation and endurance intentions in the predicted directions, but it was unrelated to constructive communication, and need threat operated only through the control dimension.

Discussion

Principal findings

Across two surveys, ride-hailing drivers who reported greater perceived passenger invisibility also reported greater psychological distress. Study 2 further showed that this association was partly mediated by threats to fundamental psychological needs, in particular threats to belonging and meaningful existence. The vignette study extended the question to the encounter itself, in that drivers who felt more disregarded were more inclined to confront the passenger and less inclined to endure the situation, whereas constructive communication was unrelated to perceived invisibility. The convergence across

three different measures and tasks suggests that sparse social recognition during passenger encounters is psychologically consequential, although the designs do not establish causality.

A covert form of social exclusion in service encounters

The first contribution concerns the type of social exclusion under the present study. Research on workplace ostracism has largely examined exclusion inside bureaucratic organizations, where it is enacted by colleagues or supervisors and presupposes a stable employment relationship and clear organizational boundaries [41]. In platform work, the interpersonal core of the job is not the coworker relationship but a sequence of brief, instrumental encounters with customers. A passenger can receive the requested service while never acknowledging the provider as a participant in the encounter. Perceived passenger invisibility is therefore not simply poor service etiquette, but also the absence of recognition within an asymmetrical relationship, which identifies the customer as a source of exclusion in gig work.

This reading is broadly consistent with research on public-transport drivers, in which driver–passenger communicative stress is a central occupational risk factor for distress [6]. Perceived passenger invisibility is nonetheless not communicative stress transposed to a new occupational group. Communicative stress arises from demanding interaction, whereas invisibility arises from its absence, because the passenger is present but the driver is never addressed. The two also differ in what they place at risk. A difficult exchange taxes the driver's coping resources, whereas being unacknowledged calls into question whether the driver counts as a participant in the encounter at all. What the present studies add is therefore that exclusion can take a covert form, in which no rule is broken and no insult is delivered, and still be associated with poorer mental health.

Why belonging and meaningful existence

Study 2 points to belonging and meaningful existence as the needs through which perceived passenger invisibility was linked to distress. This pattern is consistent with the temporal need-threat model [14], although the cross-sectional data cannot test its temporal sequence. Belonging is a fundamental social need [42], and ride-hailing drivers have few stable occupational ties, because platforms provide little organizational support and colleagues are largely absent from the working day. Passenger disregard may therefore trigger a sense of isolation more readily than it would for workers embedded in a team. Meaningful existence is equally pertinent. The repetitiveness and low autonomy of platform-assigned work can lead drivers to question the meaning of what they do, as in the thought that they are only an order-taking tool, and threatened meaning has been linked to burnout and poorer well-being [43]. A passenger who responds to the vehicle or the app but not to the driver may communicate precisely that the person performing the work is interchangeable. By contrast, self-esteem threat and control threat did not carry the association. The anonymity and brevity of ride-hailing encounters may lower drivers' sensitivity to any single passenger's evaluation, which would weaken the self-esteem pathway, and drivers can partly restore control through adaptive strategies such as selectively accepting orders [44]. However, these interpretations may require longitudinal and within-person tests in future studies.

Interactional intentions and the role of control threat

Study 3 suggests that perceived passenger invisibility also matters for the encounter itself, and that confrontation and endurance are not two ends of a single dimension. Confrontation is an active expression of dissatisfaction, whereas endurance is passive suppression, and a driver may draw on either. Control threat played a different role in each. It suppressed the association with confrontation, in that being disregarded raised the impulse to confront, but drivers who felt they had lost control of their working environment, and who therefore weighed the risk that an argument might cost them a rating or a fare, were less likely to act on that impulse. It fully accounted for the association with endurance, in that drivers who felt unable to change the situation also lost the motivational basis for silent endurance. Taken together, these patterns describe a trade-off between reasserting control and avoiding risk. They also illustrate why behavioral interpretations should remain tentative, because the indirect effects through control threat were small and the study did not measure platform ratings, income risk, or perceived sanctions.

Constructive communication was unrelated to perceived passenger invisibility, although its mean level was the highest of the three intentions. Two explanations are plausible. First, platforms typically require standardized courteous service [45, 46], which may compress variance in this intention. In addition, self-reported prosocial responses are vulnerable to social desirability [47]. The present design cannot distinguish between these accounts. Future work could test whether platform dependence, passenger power, and procedural support determine when a driver challenges, tolerates, or constructively addresses conduct that leaves them feeling unseen.

Applied implications

Because drivers' psychological distress was associated with something as ordinary as whether a passenger acknowledged them, these findings shift attention from open conflict to the everyday cues that tell a service worker they have been noticed. Platforms could use brief passenger-facing prompts to set expectations for acknowledgment of safety reminders, respectful communication, and care for the vehicle as a workplace. A record of uncivil in-car conduct, together with a clearly bounded driver–passenger interaction charter, would make the behavioral boundaries of the encounter explicit to both parties. Driver interfaces could provide clear reporting and appeal routes for repeated disregard or disrespect. These procedures may matter psychologically because they signal that drivers' accounts are heard, not merely because they regulate passengers.

Because the association with psychological distress ran partly through belonging and meaningful existence rather than through the demands of the encounter alone, support should not be framed solely as training drivers to tolerate difficult passengers. Accessible peer networks, locally moderated driver groups, stress-management modules delivered through the driver application, and privacy-protected referral routes for psychological support may reduce isolation and help identify recurring problems that require platform-level action. Passenger-facing interventions should nevertheless be proportionate.

Inattention can be unintentional, and conversational norms vary. The present data support clearer interactional standards and supportive procedures, not punitive scoring based on ambiguous behavior.

Limitations and future research

First, the designs are cross-sectional or vignette-based, and none of them establishes temporal order or causality. Concurrent measurement can misrepresent longitudinal mediation [48], and in Study 3 every participant read the same three negative scenarios while perceived invisibility was measured rather than manipulated. Longitudinal designs are therefore the necessary next step. Diary and experience-sampling studies that record invisibility close to the encounter would separate within-driver fluctuations from stable response tendencies [49], and experiments with neutral comparison scenarios, randomized vignette order, and manipulation checks would allow the causal claims that the present data cannot support.

Second, perceived passenger invisibility was measured in three different ways, and the convergence of the results across them is a strength of the research. The interview-informed questionnaire developed in Study 2 also brings the construct closer to drivers' actual working conditions than general felt-invisibility items do. That instrument nonetheless remains preliminary. Several of its items describe disrespect, disregard for a request, or damage to the in-car environment, and although such behavior may communicate invisibility, it is not a pure indicator of it. The average variance extracted was also modest, and because the exploratory and confirmatory analyses were conducted in the same sample, the latter is descriptive rather than an independent cross-validation [38]. A properly validated measure of perceived passenger invisibility for ride-hailing drivers therefore remains to be developed. Such an instrument would need to separate low acknowledgment from incivility and rule violation, establish discriminant validity, and be cross-validated in an independent sample.

Third, all focal variables were self-reported, and Harman's test is a limited diagnostic of common method bias [34]. In Study 3, moreover, each interactional intention was measured with a single item per scenario. Passenger reports, audio-coded interactions, or privacy-protected platform records, together with multi-item behavioral measures, would provide complementary evidence.

Conclusions

Ride-hailing drivers perform socially necessary work in close physical proximity to passengers, but proximity does not guarantee recognition. Across three studies, we found that greater perceived passenger invisibility was associated with greater psychological distress, and this association was partly explained by threats to fundamental psychological needs, particularly belonging and meaningful existence. Perceived passenger invisibility was also associated with drivers' intentions to confront or to endure in their interactions with passengers, with control threat playing a differentiated role in the two intentions. Passenger invisibility therefore deserves attention from platforms and from passengers themselves, because platform work can make a worker operationally visible while leaving the person socially unseen.

Abbreviations

AVE, average variance extracted; CFA, confirmatory factor analysis; CFI, comparative fit index; CI, confidence interval; CR, composite reliability; CNY, Chinese yuan; IFI, incremental fit index; K10, Kessler Psychological Distress Scale; KMO, Kaiser–Meyer–Olkin; RMSEA, root mean square error of approximation; TLI, Tucker–Lewis index.

Declarations

Data availability

The anonymized item-level datasets and the scored analysis datasets for Studies 1 to 3, a codebook describing all variables and their derivation, the SPSS syntax, the AMOS model files, and the questionnaires as administered are available in the Open Science Framework repository at https://osf.io/4fwx5/overview?view_only=b39c346bf423457180c601dc7e2b1471. Responses that failed the screening criteria were rejected on the survey platforms, and the platforms do not retain rejected responses, so only the data of retained participants are available, and the numbers excluded under each rule are taken from the platforms' screening records.

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Authors' contributions

PS: conceptualization, writing – review and editing. XS: methodology, data curation, writing – original draft. YD: conceptualization, methodology. TJ: conceptualization, methodology, funding acquisition, supervision, writing – review and editing. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Ethical statements

All three studies were conducted within the framework of a broader research project approved by the Ethics Review Committee of Nanjing Normal University (approval number NNU202302015). All participants gave informed consent before taking part, and the studies were conducted in accordance with the Declaration of Helsinki.

References

1. State Council of the People's Republic of China. Report on safeguarding the rights and interests of workers in flexible employment and new forms of employment [Chinese] (2025)
https://www.npc.gov.cn/npc/c2/c30834/202512/t20251224_450484.html. Accessed 28 Jul 2026
2. China Urban Public Transport Association, Ride-Hailing B (2024) national ride-hailing market annual report [Chinese]. 2025. <https://www.citmt.cn/news/202505/114702.html>. Accessed 24 Jul 2026
3. Hjelle IØ, Nordrum H, Wentzeck JW, Teymoori A (2024) The powerless bosses: the working day experience of bicycle messengers and its impact on their identities and wellbeing. *BMC Psychol* 12:799. <https://doi.org/10.1186/s40359-024-02311-6>
4. Lang JJ, Yang LF, Cheng C, Cheng XY, Chen FY (2023) Are algorithmically controlled gig workers deeply burned out? An empirical study on employee work engagement. *BMC Psychol* 11:354. <https://doi.org/10.1186/s40359-023-01402-0>
5. Liang M, Zhou W, Yao J, Li Y (2023) Warming from afar and nomadic order-taking: how ride-hailing drivers in virtual communities cope with the atomization of platform labour. *Tsinghua Sociol Rev.* ; (2):142–165. [Chinese].
6. Tu Z, He J, Zhou N, Shen X (2021) Driver-passenger communicative stress and psychological distress among Chinese bus drivers: the mediating effect of job burnout. *BMC Public Health* 21:547. <https://doi.org/10.1186/s12889-021-10618-x>
7. Jeong J, Lee JH, Karahroodi HH, Jeong I (2025) Uncivil customers and work-family spillover: examining the buffering role of ethical leadership. *BMC Psychol* 13:723. <https://doi.org/10.1186/s40359-025-02944-1>
8. Duggan J, Gruda D, Ojo A (2026) I work hard for the algorithm: job demands, resources and strain in (and beyond) the gig economy. *J Manag Psychol*. <https://doi.org/10.1108/JMP-05-2025-0483>. ahead of print
9. Peng J, Wei M, Loi TI, Li J (2025) Every coin has two sides: a self-determination perspective on the relationship between algorithmic management and gig workers' job burnout. *J Manag Psychol* 40(3):243–258. <https://doi.org/10.1108/JMP-12-2023-0737>
10. He J, Yang J, Ji T, Ding Y (2024) The invisible disadvantaged: a review and theoretical explanation of interpersonal invisibility towards disadvantaged groups. *Adv Psychol Sci* 32(9):1539–1550. <https://doi.org/10.3724/SP.J.1042.2024.01539>. [Chinese]
11. Neel R, Lassetter B (2019) The stigma of perceived irrelevance: an affordance-management theory of interpersonal invisibility. *Psychol Rev* 126(5):634–659. <https://doi.org/10.1037/rev0000143>
12. Rabelo VC, Mahalingam R (2019) They really don't want to see us': how cleaners experience invisible 'dirty' work. *J Vocat Behav* 113:103–114. <https://doi.org/10.1016/j.jvb.2018.10.010>
13. Kim HY, Kim S, Howell TM, Doyle SP, Pettit NC, Bizzarro M (2023) Are we essential, or sacrificial? The effects of felt public gratitude on essential worker recovery activities during COVID-19. *Soc Psychol Personal Sci* 14(2):218–227. <https://doi.org/10.1177/19485506221077858>
14. Williams KD (2009) Ostracism: a temporal need-threat model. *Adv Exp Soc Psychol* 41:275–314. [https://doi.org/10.1016/S0065-2601\(08\)00406-1](https://doi.org/10.1016/S0065-2601(08)00406-1)

15. Molden DC, Lucas GM, Gardner WL, Dean K, Knowles ML (2009) Motivations for prevention or promotion following social exclusion: being rejected versus being ignored. *J Pers Soc Psychol* 96(2):415–431. <https://doi.org/10.1037/a0012958>
16. Rudert SC, Hales AH, Greifeneder R, Williams KD (2017) When silence is not golden: why acknowledgment matters even when being excluded. *Pers Soc Psychol Bull* 43(5):678–692. <https://doi.org/10.1177/0146167217695554>
17. Kessler RC, Andrews G, Colpe LJ et al (2002) Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med* 32(6):959–976. <https://doi.org/10.1017/S0033291702006074>
18. Eisenberger NI, Lieberman MD, Williams KD (2003) Does rejection hurt? An fMRI study of social exclusion. *Science* 302(5643):290–292. <https://doi.org/10.1126/science.1089134>
19. Williams KD, Nida SA (eds) (2017) *Ostracism, exclusion, and rejection*. Routledge, New York
20. Zhou M, Yin J, Tang Y, Yi H, Kong N, Campy KS (2024) What drives the drivers away? An empirical study on the factors influencing the turnover intention of full-time online ride-hailing drivers in China. *Transp Res Part Policy Pract* 186:104134. <https://doi.org/10.1016/j.tra.2024.104134>
21. Gerber J, Wheeler L (2009) On being rejected: a meta-analysis of experimental research on rejection. *Perspect Psychol Sci* 4(5):468–488. <https://doi.org/10.1111/j.1745-6924.2009.01158.x>
22. Hartgerink CHJ, van Beest I, Wicherts JM, Williams KD (2015) The ordinal effects of ostracism: a meta-analysis of 120 Cyberball studies. *PLoS ONE* 10(5):e0127002. <https://doi.org/10.1371/journal.pone.0127002>
23. Vansteenkiste M, Ryan RM (2013) On psychological growth and vulnerability: basic psychological need satisfaction and need frustration as a unifying principle. *J Psychother Integr* 23(3):263–280. <https://doi.org/10.1037/a0032359>
24. Büttner CM, Rudert SC, Greifeneder R (2021) Depressed and excluded: do depressive symptoms moderate recovery from ostracism? *J Affect Disord* 294:730–736. <https://doi.org/10.1016/j.jad.2021.07.075>
25. Balliet D, Ferris DL (2013) Ostracism and prosocial behavior: a social dilemma perspective. *Organ Behav Hum Decis Process* 120(2):298–308. <https://doi.org/10.1016/j.obhdp.2012.04.004>
26. Ren D, Wesselmann ED, Williams KD (2018) Hurt people hurt people: ostracism and aggression. *Curr Opin Psychol* 19:34–38. <https://doi.org/10.1016/j.copsyc.2017.03.026>
27. Ren D, Wesselmann ED, Williams KD (2016) Evidence for another response to ostracism: solitude seeking. *Soc Psychol Personal Sci* 7(3):204–212. <https://doi.org/10.1177/1948550615616169>
28. Smart Richman L, Leary MR (2009) Reactions to discrimination, stigmatization, ostracism, and other forms of interpersonal rejection: a multimotive model. *Psychol Rev* 116(2):365–383. <https://doi.org/10.1037/a0015250>
29. Büttner CM, Ren D, Stavrova O, Rudert SC, Williams KD, Greifeneder R (2025) Ostracism in everyday life: a framework of threat and behavioral responses in real life. *J Pers Soc Psychol* 129(5):870–887. <https://doi.org/10.1037/pspi0000471>

30. Jonas E, McGregor I, Klackl J, Agroskin D, Fritsche I, Holbrook C et al (2014) Threat and defense: from anxiety to approach. *Adv Exp Soc Psychol* 49:219–286. <https://doi.org/10.1016/B978-0-12-800052-6.00004-4>
31. Xu L, Zhou C, Wang J, Sun H, Wang X, Zhang X et al (2006) Mental health status and its influencing factors among residents of Weihai City. *Chin Ment Health J* 20(6):394–397. <https://doi.org/10.3321/j.issn:1000-6729.2006.06.016>. [Chinese]
32. Faul F, Erdfelder E, Buchner A, Lang AG (2009) Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behav Res Methods* 41(4):1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>
33. Wen Z, Hau KT, Marsh HW (2004) Structural equation model testing: cutoff criteria for goodness of fit indices and chi-square test. *Acta Psychol Sin* 36(2):186–194 [Chinese]
34. Tang DD, Wen Z (2020) Statistical approaches for testing common method bias: problems and suggestions. *J Psychol Sci* 43(1):215–223. <https://doi.org/10.16719/j.cnki.1671-6981.20200130>. [Chinese]
35. Schoemann AM, Boulton AJ, Short SD (2017) Determining power and sample size for simple and complex mediation models. *Soc Psychol Personal Sci* 8(4):379–386. <https://doi.org/10.1177/1948550617715068>
36. Fornell C, Larcker DF (1981) Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res* 18(1):39–50. <https://doi.org/10.1177/002224378101800104>
37. Hair JF, Black WC, Babin BJ, Anderson RE (2010) *Multivariate data analysis*, 7th edn. Pearson, Upper Saddle River
38. Kline RB (2023) *Principles and practice of structural equation modeling*, 5th edn. Guilford Press, New York
39. Hayes AF (2022) *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach*, 3rd edn. Guilford Press, New York
40. Wen Z, Ye B (2014) Analyses of mediating effects: the development of methods and models. *Adv Psychol Sci* 22(5):731–745. <https://doi.org/10.3724/SP.J.1042.2014.00731>. [Chinese]
41. Chen C, Yang F, Li Y (2017) Workplace ostracism: a review on mechanisms and localization development. *Adv Psychol Sci* 25(8):1387–1400. <https://doi.org/10.3724/SP.J.1042.2017.01387>. [Chinese]
42. Allen KA, Gray DL, Baumeister RF, Leary MR (2022) The need to belong: a deep dive into the origins, implications, and future of a foundational construct. *Educ Psychol Rev* 34(2):1133–1156. <https://doi.org/10.1007/s10648-021-09633-6>
43. Allan BA, Batz-Barbarich C, Sterling HM, Tay L (2019) Outcomes of meaningful work: a meta-analysis. *J Manag Stud* 56(3):500–528. <https://doi.org/10.1111/joms.12406>
44. Halbesleben JRB, Neveu JP, Paustian-Underdahl SC, Westman M (2014) Getting to the 'COR': understanding the role of resources in conservation of resources theory. *J Manag* 40(5):1334–1364. <https://doi.org/10.1177/0149206314527130>

45. Hu Z (2023) Strategies for improving ride-hailing service quality based on the service blueprint: the case of DiDi Chuxing. Shanghai Qual. ;(4):45–48. [Chinese].
46. Ma J, Hu X, Zhang L, Sun J (2021) Evaluation of ride-hailing service quality based on passenger demand characteristics: a case study of Suzhou. J Suzhou Univ Sci Technol (Soc Sci Ed) 38(5):35–43 [Chinese]
47. Grimm P (2010) Social desirability bias. Wiley international encyclopedia of marketing. Wiley, Chichester. <https://doi.org/10.1002/9781444316568.wiem02057>.
48. Maxwell SE, Cole DA (2007) Bias in cross-sectional analyses of longitudinal mediation. Psychol Methods 12(1):23–44. <https://doi.org/10.1037/1082-989X.12.1.23>
49. Bolger N, Laurenceau JP (2013) Intensive longitudinal methods: an introduction to diary and experience sampling research. Guilford Press, New York

Figures

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Figure 1

Indirect effect of passenger invisibility on psychological distress through need threat (Study 2). Values are unstandardized coefficients. Gender was controlled but is not shown. The indirect effect was estimated with 5,000 bootstrap samples.

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