The Study of the Relationship Between Youth Psychological Loneliness, Human-Computer Emotional Interaction, and Social Anxiety: Using Social Support as a Moderating Variable

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ABSTRACT

Psychological loneliness is closely linked to young people's social anxiety, perceived social support, and emotional engagement with AI chatbots. This study surveyed 165 users with prior experience using AI companion chatbots using a 72-item questionnaire adapted from the UCLA Loneliness Scale (Version 3), a Social Anxiety Scale, a Human–AI Emotional Interaction scale, and a Social Support scale. Data were analysed using independent-samples t tests, one-way ANOVA, Pearson correlation, and regression analyses. The results indicated a significant gender difference in human–AI emotional interaction, with male participants reporting higher levels than female participants, whereas no gender differences were found for loneliness, social anxiety, or perceived social support. Psychological loneliness positively predicted both social anxiety and human–AI emotional interaction; however, social anxiety did not significantly predict human–AI emotional interaction. Friend support moderated the association between loneliness and human–AI emotional interaction, such that the relationship was stronger among participants reporting higher friend support and weaker among those reporting lower friend support. In contrast, support from family and from teachers/supervisors did not show a significant moderating effect.

Keywords: Loneliness, Social anxiety, Human-computer emotional interaction, Social support

1. Introduction

Loneliness has become an increasingly salient public-health and social concern, and rising levels of social isolation may intensify its psychological consequences. A 2021 Statista survey reported that approximately 33% of adults worldwide felt lonely; Japan and the United Kingdom were among the

countries most affected and subsequently introduced governmental initiatives to address loneliness. In Taiwan, a 2020 Global Views Monthly survey found that more than 40% of respondents reported frequent loneliness, and over 60% of those under 30 were classified as high risk [1–3]. This trend is particularly concerning for adolescents and young adults, given that suicide is reported as the second leading cause of death among Taiwanese youth, following accidents [1–3].

In parallel, rapid advances in artificial intelligence (AI) have expanded the availability of AI-mediated companionship as a potential means of emotional support. Media Equation Theory (Reeves & Nass) posits that people often respond to computers and media as if they were social actors [4]. Consistent with this account, users may apply interpersonal norms during interactions with AI systems and develop affective bonds with them. As AI companion applications become more sophisticated and widely used, understanding their implications for the mental health of adolescents and young adults has become increasingly important.

Accordingly, this study examines the associations among psychological loneliness, social anxiety, and Human-Computer Emotional Interaction, and further tests whether social anxiety mediates and social support moderates these relationships. We conducted a web-based survey of users in Taiwan and China with prior experience using social AI chatbots and obtained 165 valid responses. The study addresses five research objectives: (1) describe levels of social anxiety, social support, and Human-Computer Emotional Interaction; (2) test demographic differences in key variables; (3) examine the relationships among loneliness, social anxiety, and Human-Computer Emotional Interaction; (4) evaluate the mediating role of social anxiety; and (5) evaluate the moderating role of social support. By doing so, we aim to clarify how AI companionship relates to young people's socio-emotional wellbeing, particularly among individuals experiencing loneliness and social anxiety.

2. Literature Review

2.1 Human–Machine (Human–AI) Emotional Interaction

Scholarly interest in human–computer emotional interaction can be traced to the 1970s. Short, Williams, and Christie [5] proposed Social Presence Theory, which highlights how communication technologies shape interpersonal relationships and socio-emotional experience. They argued that technologies that increase perceived social presence can facilitate relational closeness and emotional exchange. In the 1980s, Kiesler et al. [6] examined the psychological effects of computer-mediated communication (CMC) and showed that CMC may reduce social pressure and evaluation anxiety, thereby enabling users to express themselves more freely.

From the 1990s onward, research in human–machine communication (HMC) developed more systematic theoretical accounts. Nass, Steuer, and Tauber [7] proposed the Computers Are Social Actors (CASA) paradigm, suggesting that people often apply social rules and norms to computers automatically and implicitly. Experimental evidence under CASA indicates that users respond to computers in ways that resemble human–human social interaction. More recently, Guzman and Lewis [8] argued that advances in artificial intelligence (AI) have reframed machines as communicative agents, motivating an HMC perspective in which AI systems can simulate, interpret, and adapt to

human emotions and interactional cues.

2.2 Loneliness and Social Anxiety

Loneliness is commonly defined as a subjective experience arising from perceived deficits in social relationships, including feeling socially disconnected or lacking companionship [9]. Social anxiety refers to intense distress in social situations, typically driven by fear of negative evaluation [10]. Although conceptually distinct, loneliness and social anxiety are closely related insofar as both reflect negative socio-emotional experiences rooted in unmet interpersonal needs and heightened sensitivity to social threat.

Lin [11] noted that negative social evaluation in interpersonal contexts can elicit embarrassment, shame, and nervousness, which may undermine self-confidence and contribute to increased social anxiety. Over time, these processes may also intensify perceived loneliness. Against this background, AI companion applications raise a timely question: can emotional interaction with AI partially meet social needs and thereby relate to loneliness and social anxiety, and if so, for whom and under what conditions?

In contemporary digital environments, social media may both alleviate and exacerbate loneliness and social anxiety. For individuals with social anxiety, online communication can be experienced as relatively safer than face-to-face interaction, reducing immediate pressure and temporarily satisfying interpersonal needs [12]. However, excessive reliance on mobile devices and the internet has also been associated with higher levels of loneliness and social anxiety [13]. Empirical findings are mixed. For example, Deters and Mehl [14] reported that increasing Facebook status updates reduced loneliness, possibly by enhancing perceived social connection. In contrast, other studies suggest that heavy use, emotional dependence, or social comparison on social media platforms may increase anxiety and loneliness [15,16]. Given these inconsistent results, it is important to consider individual differences and usage patterns when examining the psychological implications of AI companion use.

2.3 Social Support

Social support refers to resources provided through social relationships that help individuals cope with stress and maintain psychological wellbeing. In this study, social support is conceptualized by source (friends, family, teachers/supervisors) and by function, including emotional, informational, and instrumental support.

Emotional support involves expressions of care, empathy, respect, and encouragement that foster belonging and positive affect. Informational support refers to advice, guidance, and suggestions that help individuals understand situations and identify coping strategies. Instrumental support involves tangible assistance (e.g., financial or material aid) that addresses practical needs [17]. Together, these forms of support can promote psychological flexibility and resilience by reducing stress reactivity, strengthening coping efficacy, and providing concrete resources.

Importantly, both the type and the source of support may influence its protective effects. Support from close ties (e.g., family members and intimate friends) is often especially salient in buffering loneliness because it directly reinforces perceived acceptance and connectedness. Overall, social

support is widely regarded as a key protective factor against loneliness and related distress, particularly through emotional and informational pathways.

3. Research Design

3.1 Research Procedure

3.1.1 Development of the research questions and framework

After identifying the research topic, we conducted a comprehensive review of the relevant literature to refine the research questions and develop the study's theoretical framework.

3.1.2 Instrument selection and adaptation

This study employed a quantitative, questionnaire-based design. Four established instruments were selected and adapted: the UCLA Loneliness Scale (Version 3; Russell) to measure loneliness [18]; a Human-Computer Emotional Interaction scale adapted from Shao's interview protocol and reformulated as a structured questionnaire [19]; a Social Anxiety scale adopted from Wu [20]; and a Social Support scale based on Hsieh [21]. All instruments were reviewed and revised in consultation with the thesis advisor prior to pilot testing.

3.1.3 Pilot testing

A preliminary version of the questionnaire was administered to a small pilot sample. Responses deemed invalid were removed, and the remaining data were analysed to evaluate item clarity and internal consistency. Based on the pilot results, the questionnaire was refined to produce the final instrument.

3.1.4 Main survey administration

The final questionnaire was distributed online to the target population to collect data for the main study.

3.1.5 Data management and statistical analysis

Survey data were screened, coded, and organised for analysis. Descriptive and inferential analyses were then conducted, and the results were synthesised to inform the interpretation and discussion.

3.1.6 Participants and sampling

An online survey was conducted among users with prior experience using AI companion applications. Convenience sampling was used. In the pilot study, 31 valid responses were obtained. For the main survey, 243 questionnaires were distributed; 78 were excluded due to missing data, patterned or random responding, or incomplete submissions. The final analytic sample therefore comprised 165 valid responses.

3.2 Research Framework

The proposed model treats psychological loneliness as the independent variable, social anxiety as a mediating variable, social support as a moderating variable, and Human-Computer Emotional

Interaction as the dependent variable (see Figure 1).

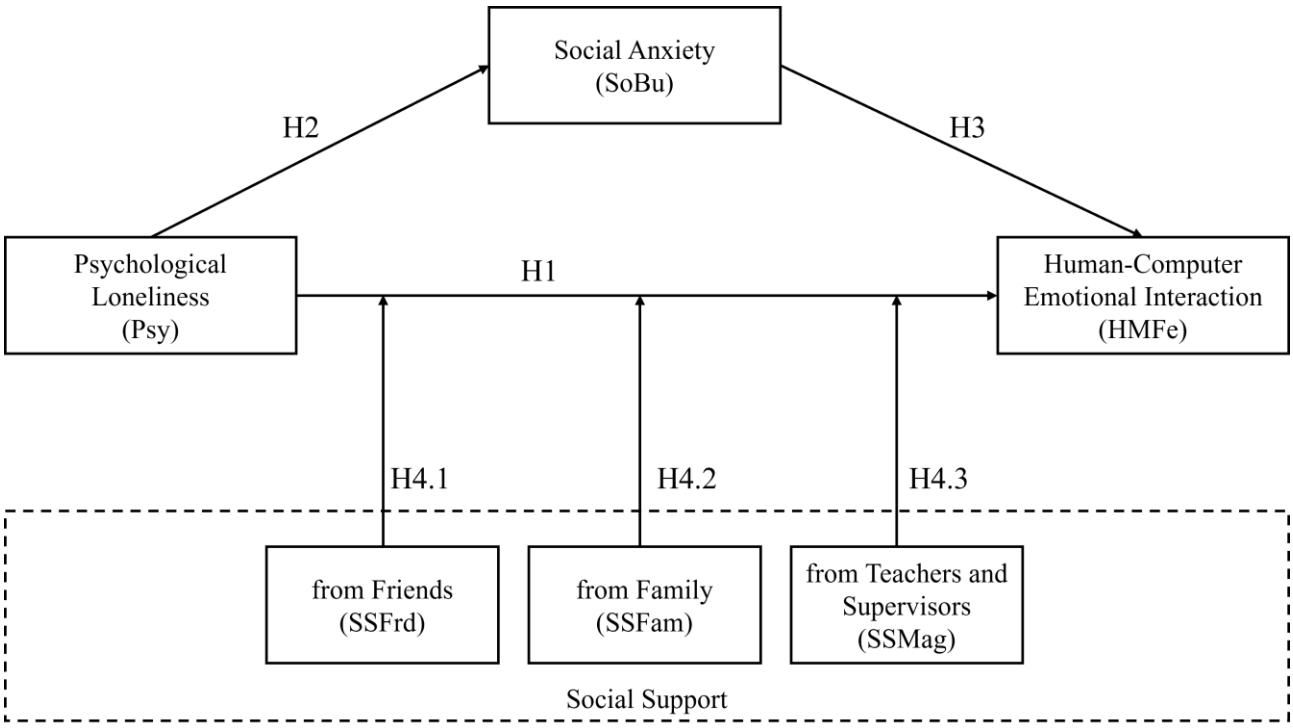

Figure 1. Research framework diagram

Source: By authors.

4. Results and Discussion

4.1 Descriptive Statisticals

A total of 165 valid responses were included in the analysis. The sample was predominantly female (n = 119, 72.5%), with male participants accounting for 27.4% (n = 45). Table 1 summarises the demographic characteristics of the respondents.

Table 1. Summary of respondents' demographic information (n = 165)

Variable	Category	Frequency (n)	Valid Percentage (%)	Missing
Gender	Female	119	72.5	1
	Male	45	27.4	
Age	25 years or younger	83	49.4	-
	26–30 years	47	27.9	-
	31–40 years	18	10.7	-
	Over 41 years	17	10.1	-
Education	High school or below	21	12.5	-
	College (current or grad)	101	60.1	-
	Graduate school (M.A./Ph.D.)	43	25.5	-

4.2 Reliability

Internal consistency reliability was assessed using Cronbach's alpha. All scales demonstrated excellent reliability, with alphas exceeding .90: Psychological Loneliness (α = .939), Social Anxiety (α = .956), Human-Computer Emotional Interaction (α = .946), Social Support from Teachers/Supervisors (α = .942), Social Support from Friends (α = .930), and Social Support from Family (α = .942). The overall questionnaire also showed strong internal consistency (α = .946), indicating that the instrument was reliable for subsequent analyses (Table 2).

Table 2. Reliability analysis coefficients of the research questionnaire (n = 165)

Research Factor	Number of Items	Cronbach's α
Psychological Loneliness (Psy)	10	.939
Social Anxiety (SoBu)	17	.956
Human-Computer Emotional Interaction (HCEI)	11	.946
Social Support from Teachers and Supervisors (SSMag)	12	.942
Social Support from Friends (SSFrd)	11	.930
Social Support from Family (SSFam)	11	.942
Overall:	72	.946

4.3 Validity Analysis

Exploratory factor analysis (EFA) was conducted to examine construct validity. The analysis yielded six factors that were consistent with the study's conceptual structure: Social Anxiety, Social Support from Teachers/Supervisors, Human-Computer Emotional Interaction, Social Support from Family, Psychological Loneliness, and Social Support from Friends. Together, these factors explained 64.395% of the total variance, suggesting an acceptable level of explanatory power for a multi-construct instrument.

Item loadings were generally substantial and concentrated on their intended factors, supporting the proposed measurement structure. Social Anxiety accounted for the largest share of explained variance (15.409%) and showed stable factor loadings and communalities. The three social-support sources (teachers/supervisors, family, and friends) emerged as distinguishable dimensions. Notably, the Friends-support factor showed comparatively lower loadings than the other support factors, indicating that items in this domain may warrant further refinement in future work (Table 3).

Table 3. Factor analysis of the research questionnaire (n = 165)

Dimension	Item	Explained Variance (%)	Cumulative Explained Variance (%)	Extracted Factors						Communalit
				Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	
Social Anxiety	SoBu02	15.409	15.409	**.858**						.814
	SoBu03			**.825**						.803
	SoBu11			**.813**						.827
	SoBu01			**.806**						.741
	SoBu10			**.791**						.789
	SoBu14			**.785**						.754
	SoBu04			**.782**						.752

Dimension	Item	Explained Variance (%)	Cumulative Explained Variance (%)	Extracted Factors						Communalit
				Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	
	SoBu09			**.774**						.733
	SoBu07			**.768**						.761
	SoBu16			**.750**						.689
	SoBu12			**.716**						.730
	SoBu08			**.702**						.652
	SoBu06			**.665**						.711
	SoBu15			**.651**						.666
	SoBu17			**.605**						.677
	SoBu13			**.593**						.729
	SoBu05			**.592**						.742
Social Support from Teachers and Supervisors	SSMag10	12.675	28.083		**.795**					.781
	SSMag03				**.786**					.711
	SSMag04				**.778**					.753
	SSMag07				**.769**					.710
	SSMag12				**.766**					.667
	SSMag11				**.736**					.628
	SSMag02				**.735**					.641
	SSMag09				**.697**					.597
	SSMag08				**.693**					.640
	SSMag06				**.686**					.648
	SSMag01				**.684**					.606
	SSMag05				**.593**					.730
Social Support from Family	SSFam08	11.299	39.383			**.819**				.790
	SSFam05					**.783**				.709
	SSFam03					**.781**				.780
	SSFam02					**.762**				.765
	SSFam06					**.752**				.653
	SSFam04					**.751**				.699
	SSFam10					**.721**				.756
	SSFam07					**.719**				.643
	SSFam09					**.675**				.721
	SSFam01					**.633**				.683
	SSFam11					**.580**				.594
Psychological Loneliness	Psy02	9.633	49.016				**.817**			.763
	Psy01						**.797**			.723
	Psy05						**.790**			.699
	Psy08						**.776**			.772
	Psy03						**.758**			.686
	Psy07						**.736**			.765
	Psy06						**.712**			.755
	Psy04						**.689**			.678
	Psy09						**.600**			.616
	Psy10						**.526**			.599
Human-Computer Emotional Interaction	HCEI06	8.497	57.513					**.907**		.851
	HCEI05							**.883**		.830
	HCEI07							**.868**		.807
	HCEI04							**.865**		.802
	HCEI08							**.844**		.743
	HCEI10							**.755**		.669
	HCEI09							.599		.698
	HCEI11							**.549**		.768
Social Support from Friends	SSFrd07	6.882	64.395						**.711**	.678
	SSFrd08								**.677**	.726
	SSFrd06								**.675**	.744
	SSFrd05								**.613**	.696
	SSFrd11								**.605**	.666
	SSFrd10								**.604**	.682
	SSFrd09								**.589**	.722

Dimension	Item	Explained Variance (%)	Cumulative Explained Variance (%)	Extracted Factors						Communalit
				Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	
	SSFrd02								**.554**	.723
	SSFrd01								**.466**	.626
	SSFrd03								**.463**	.650

4.4 Correlation Analysis

Pearson correlation analyses were conducted to examine bivariate associations among the main variables (Table 4). Psychological loneliness was positively correlated with Social Anxiety ($r = .609$, $p < .01$) and with Human-Computer Emotional Interaction ($r = .264$, $p < .01$). Psychological loneliness was negatively correlated with Social Support from Friends ($r = –.297$, $p < .01$) and Social Support from Family ($r = –.190$, $p < .05$), indicating that higher perceived support from close relationships was associated with lower loneliness.

Human-Computer Emotional Interaction was positively correlated with Social Support from Friends ($r = .197$, $p < .05$), Social Support from Family ($r = .211$, $p < .01$), and Social Support from Teachers/Supervisors ($r = .333$, $p < .01$). The three social-support sources were also moderately to strongly intercorrelated ($rs = .614–.703$, $ps < .01$), suggesting that individuals who perceived support from one source tended to report support from others as well.

Table 4. Correlation coefficient analysis of research variables (n = 165)

Variable	Psychological Loneliness	Social Anxiety	Human-Computer Emotional Interaction	Social Support from Friends	Social Support from Family	Social Support from Teachers and Supervisors
PL	---					
SA	.609**	---				
HCEI	.264**	0.106 ns.	---			
SSFr	-.297**	-0.054 ns.	.197*	---		
SSFa	-.190*	-0.041 ns.	.211**	.703**	---	
SSTS	-0.078 ns.	0.023 ns.	.333**	.664**	.614**	---

ns. $p>.05$; * $p<.05$; ** $p<.01$; *** $p<.001$

4.5 Simple-Regression Analysis

4.5.1. Psychological loneliness predicting social anxiety

To test whether psychological loneliness predicted social anxiety (H1), a regression model was estimated with loneliness as the predictor and social anxiety as the outcome. Psychological loneliness significantly predicted social anxiety ($\beta = .609$, $p < .001$). The model explained 37.0% of the variance in social anxiety ($R^2 = .370$), indicating a substantial association between greater loneliness and higher social anxiety (Table 5).

Table 5. Stepwise multiple regression analysis summary for predicting social anxiety from psychological loneliness (n = 165)

Predictor Variable (X)	Multiple Correlation Coefficient (R)	Coefficient of Determination (R^2)	R^2 Change ($+R^2$)	F-value	Unstandardized Coefficient (b)	Standardized Coefficient (β)	t-value
Constant	.609	.370	.367	95.9	1.385		7.254
Psychological Loneliness					.614	.609***	9.793

*** p<.001

4.5.2. Psychological loneliness and social anxiety predicting human-computer emotional interaction

To test whether psychological loneliness and social anxiety predicted Human-Computer Emotional Interaction (H2–H4), both variables were entered simultaneously as predictors. Psychological loneliness emerged as a significant positive predictor of Human-Computer Emotional Interaction ($\beta = .318$, $p < .01$). In contrast, social anxiety was not a significant predictor ($\beta = –.088$, $p > .05$). The model explained 7.5% of the variance in Human-Computer Emotional Interaction ($R^2 = .075$), suggesting that loneliness—rather than social anxiety—was more directly associated with emotional engagement with AI companions in this sample (Table 6).

Table 6. Multiple regression analysis of psychological loneliness and social anxiety predicting human-computer emotional interaction (n = 165)

Predictor Variable (X)	Multiple Correlation Coefficient (R)	Coefficient of Determination (R^2)	R^2 Change ($+R^2$)	F-value	Unstandardized Coefficient (b)	Standardized Coefficient (β)	t-value
Constant	.273	.075	.063	.358	2.126		7.277
Psychological Loneliness					.351	.318**	3.337
Social Anxiety					-.096	-.088ns.	0.922

ns. p>.05; *** p<.001

4.5.3. Social support as a moderator

To examine whether social support moderated the association between loneliness and Human-Computer Emotional Interaction (H5a–H5c), separate regression models were estimated for support from friends, family, and teachers/supervisors. Friend support showed a significant positive association with Human-Computer Emotional Interaction ($\beta = .242$, $p < .01$), and the overall model explained 12.7% of the variance ($R^2 = .127$) (Table 7).

Table 7. Multiple regression analysis of psychological loneliness and friend support predicting human-computer emotional interaction (n = 165)

Predictor Variable (X)	Multiple Correlation Coefficient (R)	Coefficient of Determination (R^2)	R^2 Change ($+R^2$)	F-value	Unstandardized Coefficient (b)	Standardized Coefficient (β)	t-value

Constant	.357	.127	.117	11.78	.043		0.579
Psychological Loneliness					.303	.298**	4.020
Friend Support					.205	.242**	3.269

** $p<.01$

In contrast, neither family support (β = .125, p > .05; Table 8) nor teachers/supervisors support (β = .071, p > .05; Table 9) significantly predicted Human-Computer Emotional Interaction when included alongside psychological loneliness.

Table 8. Multiple regression analysis of psychological loneliness and family support predicting human-computer emotional interaction (n = 165)

Predictor Variable (X)	Multiple Correlation Coefficient (R)	Coefficient of Determination (R^2)	R^2 Change ($+R^2$)	F-value	Unstandardized Coefficient (b)	Standardized Coefficient (β)	t-value
Constant	.292	.086	.074	.001	.005		.067
Psychological Loneliness					.275	.270**	3.591
Family Support					.114	.125ns.	1.662

ns. $p>.05$; ** $p<.01$

Table 9. Multiple regression analysis of psychological loneliness and support from supervisors or mentors predicting human-computer emotional interaction (n = 165)

Predictor Variable (X)	Multiple Correlation Coefficient (R)	Coefficient of Determination (R^2)	R^2 Change ($+R^2$)	F-value	Unstandardized Coefficient (b)	Standardized Coefficient (β)	t-value
Constant	.274	.075	.064	.002	-.012		.015
Psychological Loneliness					.267	.262**	3.468
Support from Supervisors or Mentors					.057	.071ns.	0.939

ns. $p>.05$; ** $p<.01$

As illustrated in Figure 2, the loneliness–Human-Computer Emotional Interaction association was stronger at higher levels of friend support and weaker at lower levels of friend support. This pattern indicates that perceived friend support amplifies the positive relationship between loneliness and emotional engagement with AI companions.

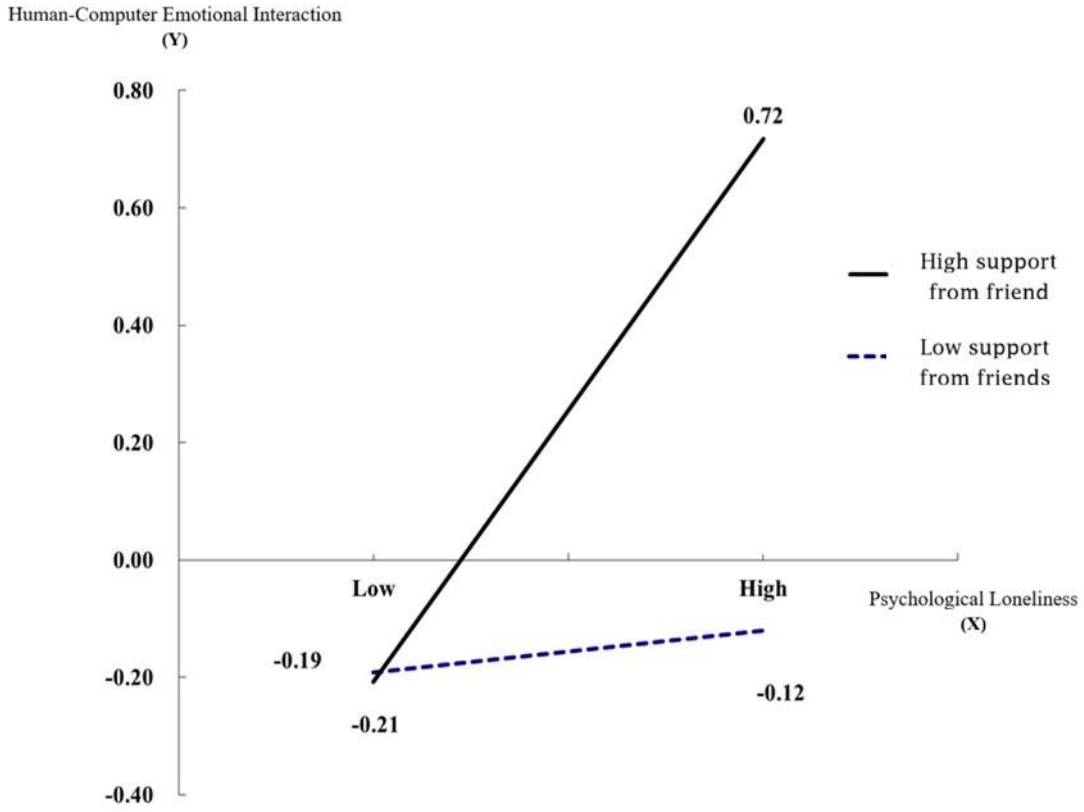

Figure 2. Interaction effect of psychological loneliness and friend support on human–machine emotional interaction

Source: By authors.

5. Conclusions

This study found a significant gender difference in Human-Computer Emotional Interaction, with male participants reporting higher levels of engagement than female participants. By contrast, gender differences were not observed for psychological loneliness, social anxiety, or perceived social support from friends, family, and teachers/supervisors. Taken together, these results suggest that gender may be more closely related to patterns of engagement with AI-mediated emotional interaction than to underlying socio-emotional needs or perceived support.

Psychological loneliness was positively associated with Human-Computer Emotional Interaction. Engagement with AI companions also varied by selected background characteristics (e.g., relationship status and frequency of use). Among the sources of social support examined, support from friends uniquely moderated the association between loneliness and Human-Computer Emotional Interaction, whereas support from family and from teachers/supervisors did not show a comparable moderating effect.

Notably, higher friend support strengthened (rather than attenuated) the positive association between loneliness and Human-Computer Emotional Interaction. This pattern is not fully consistent with a simple social compensation account, which would predict greater reliance on virtual interaction

primarily among individuals with limited offline support. Instead, the finding is more compatible with a social enhancement perspective (i.e., a "rich-get-richer" pattern), whereby socially connected individuals may also be more inclined to adopt additional communication channels. One possible interpretation is that youths with stronger friend support—who are generally more accustomed to frequent socio-emotional exchange—may use AI companions as an accessible and supplementary outlet during brief periods of loneliness, rather than as a substitute for human relationships.

In contrast, among youths reporting lower friend support, the association between loneliness and Human-Computer Emotional Interaction was weaker. This may reflect reduced motivation to seek interaction when social resources are chronically limited, although this interpretation remains speculative given the cross-sectional design.

Overall, the findings indicate that Human-Computer Emotional Interaction may partially align with youths' emotional needs, but it should not be viewed as a standalone solution for social isolation. Practical efforts should therefore prioritise strengthening offline support networks while considering how AI companionship tools might be integrated responsibly. Future research should employ longitudinal and/or experimental designs and examine additional demographic and psychosocial factors (including cross-cultural contexts) to clarify the directionality and boundary conditions of these relationships.

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Conflicts of Interest

The authors confirm that there are no conflicts of interest.

References

[1] Gv Magazine Editorial Team. Gv magazine survey: under-30 age groups are high-risk groups. Gv Magazine, 2020.

[2] Ministry of Health and Welfare. Mental health report 106-109. Ministry of Health and Welfare National Health Bureau, 2020.

[3] Ministry of Health and Welfare. National health bureau fiscal year 110 adolescent health behavior survey report. Ministry of Health and Welfare National Health Bureau, 2021.

[4] Reeves, B. and Nass, C.I. The media equation: how people treat computers, television, and new media like real people and places. Stanford, CA, USA: Center for the Study of Language and Information; Cambridge: Cambridge University Press, 1996.

[5] Short, J., Williams, E. and Christie, B. The social psychology of telecommunications. London, UK: John Wiley & Sons, 1976.

[6] Kiesler, S., Siegel, J. and McGuire, T.W. Social psychological aspects of computer-mediated communication. American Psychologist, 1984, 39(10), 1123–1134.

[7] Nass, C., Steuer, J. and Tauber, E.R. Computers are social actors. In: Proceedings of the SIGCHI conference on human factors in computing systems, 1994, 72–78.

[8] Guzman, A.L. What is human-machine communication, anyway? In: Guzman, A.L. (Ed.), Human machine communication: rethinking communication, technology, and ourselves, 2018, 1–28.

[9] Bekhet, A.K., Zauszniewski, J.A. and Nakhla, W.E. Loneliness: a concept analysis. Nursing Forum, 2008, 43(4), 207–213. DOI: 10.1111/j.1744-6198.2008.00114.x.

[10] Carleton, R.N., Collimore, K.C. and Asmundson, G.J. Social anxiety and fear of negative evaluation: construct validity of the BFNE-II. Journal of Anxiety Disorders, 2007, 21(1), 131–141. DOI: 10.1016/j.janxdis.2006.03.010.

[11] Lin, M.H. Study on the relationship among adolescent body image, social anxiety, and loneliness [Master's thesis]. Da Yeh University, 2020.

[12] Erwin, B.A., Turk, C.L., Heimberg, R.G., Fresco, D.M. and Hantula, D.A. The internet: home to a severe population of individuals with social anxiety disorder? Journal of Anxiety Disorders, 2004, 18, 629–646. DOI: 10.1016/j.janxdis.2003.08.002.

[13] Zhao, Y. and Lin, Q.W. Study on the relationship among university students' smartphone dependency, social anxiety, and perfectionism. Guidance and Counseling Journal, 2018, 40(2), 1–24.

[14] Deters, F.G. and Mehl, M.R. Does posting Facebook status updates increase or decrease loneliness? An online social networking experiment. Social Psychological and Personality Science, 2013, 4(5), 579–586.

[15] Mackson, S.B., Brochu, P.M. and Schneider, B.A. Instagram: friend or foe? The application's association with psychological well-being. New Media & Society, 2019, 21(10), 2160–2182.

[16] Petrocchi, N., Asnaani, A., Martinez, A.P., Nadkarni, A. and Hofmann, S.G. Differences between people who use only Facebook and those who use Facebook plus Twitter. International Journal of Human-Computer Interaction, 2015, 31(3), 157–165.

[17] Ye, Z.T. The relationship among adolescent emotional adjustment, anxiety, social support, life events, and suicidal ideation. Chinese Guidance Journal, 2001, 10, 151–178.

[18] Russell, D.W. UCLA loneliness scale (version 3): reliability, validity, and factor structure. Journal of Personality Assessment, 1996, 66(1), 20–40. DOI: 10.1207/s15327752jpa6601_2.

[19] Shao, R. An empathetic AI for mental health intervention: conceptualizing and examining artificial empathy. In: Proceedings of the 2nd Empathy-Centric Design Workshop, 2023, 1–6.

[20] Wu, J.Y. Study on the relationship among university students' basic needs, social anxiety, and loneliness [Master's thesis]. National Kaohsiung Normal University, 2023.

[21] Hsieh, M.C. Study on the relationship among university students' loneliness, social support, and well-being [Master's thesis]. National Taiwan Normal University, 2015.

[22] Fang, Z.W. Study on first-year university students' social support from different sources online, internet addiction, and loneliness. Chinese Mental Health Journal, 2008, 21(2), 139–168.