

Digital Isolation, Social Connectedness, and Human Relationships: Insights from the Age of Artificial Intelligence

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ABSTRACT:

Abstract: The fast promotion of Artificial Intelligence (AI) and digital communication technologies has reshaped how people communicate and establish relationships and feel social connectedness. Though online communication and AI present people with convenient engagement, the growing interdependence on technology has brought up worries about the issue of digital isolation and lonely experiences; as well as the quality of human relationships. This work examines the correlation between digital interaction, AI engagement, digital isolation, social connectedness, loneliness and relationship quality within the modern digital setting. The quantitative approach was employed, based on secondary data, where Python has been utilised to clean the data, perform descriptive and correlation analysis, visualisation, and a regression analysis. The results also show that digital interaction is weakly positively related to social connectedness, which can imply that online interaction can be used to support social relations. Nonetheless, online interaction also shows a positive correlation with online isolation, which suggests that regular online interaction does not necessarily result in adequate social interaction. There is a strong positive connection between digital isolation and loneliness, and social connectedness and a better quality of relations. The relationship between AI interaction and social connectedness is comparatively weakly positive, which implies that AI can potentially assist social interaction and dialogue, but is unable to substitute actual human social relationship. On balance, the paper finds that AI can enhance human connection as a complement of interpersonal communication, but overreliance can also pose risks of becoming more socially isolated and losing the personal connection with another human.

Keywords: Artificial Intelligence; Digital Isolation; Social Connectedness; Loneliness; Human Relationships

I. Introduction

The world has been changing fast due to the rapid development of Artificial Intelligence (AI), and people start communicating, working, receiving and giving information, and relationship maintenance in a different way [1]. In the world, AI-based technologies, such as social media algorithms, virtual assistants, chatbots, recommendation systems, and AI-controlled companions, are becoming more and more part of daily life. Through these technologies there are easy and individualized forms of interaction that enable them to stay connected despite geographical barriers [2]. Nevertheless, the increased reliance on digital technologies has also produced the issues of digital isolation, loneliness and altering the nature of human relationships. In this way, the issue of digital connectivity and the relationship between it and the real connectedness of the social character acquires special significance in the era of AI. Digital isolation is where people can be very connected digitally but have little meaningful face-to-face interaction [3]. Regular Internet interaction does not always generate emotional intimacy, social support, and a powerful sense of belonging. Alternatively, social media, such as the possibility of never stopping communication, facilitates communication, but too much or inactive use of digital mode may lead to loneliness and face-to-face communication. Simultaneously, AI opens a new aspect of this problem as people can communicate more with smart machines that mimic the conversation, react to the user's emotions, and offer customized support.

The impact of AI on human relations is thus multifaceted. On the one hand, AI can assist in social inclusion as it can assist people to communicate, language barriers, sustain long-distance relationships, and reach communities previously challenging to contact. Conversely, overdependence on AI-mediated interaction can diminish the possibilities of real interactions and even change expectations concerning emotional relationships. This study looks at the connection involving social connectedness and digital isolation with human relations in the era of AI. It

also takes into account both the opportunities and challenges that AI driven communication presents and whether enhancing digital connectivity is reinforcing meaningful relationships or causing more social isolation. The study finally aims to make its contribution to the enhanced comprehension of the balance of technological progress with the most important human realities of real social interaction and emotional bonding.

Ii. Related Works

There is growing scholarly interest in the interaction between digital technology, loneliness, and social connectedness, as well as human relationships. Current literature suggests that digital technologies which provide an opportunity to communicate socially and at the same time lead to social isolation is a characteristic of technology usage patterns and degrees. This duality has gained special significance due to the advent of artificial intelligence (AI) systems that are able to offer an increasing amount of human-like interaction. Kretzler, Konig and Hajek [15] investigated correlation between pet ownership, loneliness and isolation using a systematic review. Their results show that social isolation is a complex phenomenon, which depends on the quality and the presence of social relationships. Though the research is not about digital technologies, it is important to note that meaningful social interaction is essential to alleviating loneliness and it is pet ownership. This offers a helpful platform to explain why online communication cannot be objectively deemed as similar to true social connectivity. The growing popularity of untenable smartphone use is another testament to the adverse effects of overconsumption of digital technology. In a systematic review and meta-analysis (2012-2022), Lu, An and Chen [16] discovered problematic smartphone use to be a significant behavioural issue. In their study, Marino et al. [18], likewise, noted that there is significant overlap in problematic smartphone use and problematic social media use. These results indicate that over-use of digital platforms may be turned into a problem when the use of

technologies disrupts daily routine and social lives.

Masaeli and Billieux [20] also examined the evidence of problematic Internet and smartphone use and quality of life. Children and adolescents who engage in problematic use of technology can have poorer wellbeing outcomes, they find. Sanchez-Fernandez and Borda-Mas [26] specifically studied the case of university students and found that there were different predictive variables related to problematic smartphone and Internet-use. These researches specifically apply due to the fact that young generations make intensive use of smartphones and e-media as one of their primary socialization stations.

Digital technologies and loneliness are connected, but not only negatively. The scoping review by Petersen et al. [25] explored the connection between information and communication technologies, loneliness, and social connectedness. Their results show that digital technologies have the potential to promote social connections in some situations, especially when they make purposeful communication and engagement possible. Two inherently similar studies by O'Day and Heimberg [23] were those, which focused on social media use, social anxiety and loneliness, showing how a networked interaction is intertwined with a psychologically as well as socially-oriented outcome. Mueller-Coyne, Voss and Turner [22] also discovered that loneliness has the capability of modulating the trends of online disinhibition, which implies that loneliness not only could determine the frequency of engagement in online settings, but also the conduct of people in these environments. The recent literature has carried on these arguments to AI-mediated relationships. Malfacini [17] explored the possibility of companion AI and found possible human relationship advantages and threats. AI companions can be very convenient, supportive in discussion, and offer a sense of companionship, although overreliance can lead to some issues about the quality and genuineness of human interaction. In a similar argument,

Merrill, Mikkilineni and Dehnert [21] also cited the AI chatbots as sources of virtual social support, especially when it comes to managing loneliness and anxiety. One of the potential mechanisms to alleviate loneliness in students was investigated by Maples et al. [19], as GPT-3-powered chatbots have the potential of offering accessible types of conversational support.

The evolution of human-AI romantic liaisons is an even greater change. Pan and Mou [24] explored the experience of users with Replika and proved that people can create meaningful interpretations around the relationships with social chatbots. All in all, it can be concluded that the literature indicates that AI may be used as a complement to human social interaction, yet it also raises new questions about the possibilities of emotional dependence, authenticity, and what interpersonal communication will look like in the future. This paper thus is an extension of the prior research studies in exploring the relationship between digital communication and AI-mediated interaction, and its association with digital isolation, social connectedness, loneliness, and quality of human relationships.

III. METHODS AND MATERIALS

3.1 Research Design

The current research uses quantitative research design, to investigate the correlation between digital isolation, social connectedness, and human relationships in the age of artificial intelligence (AI). A quantitative design is suitable since the research needs to determine quantifiable associations between digital behaviour trends among people and their perception towards social connection and interpersonal relationships [4]. The study concentrates on the variables including frequency of digital communication, AI interaction, the perceived social connectedness, loneliness, and the quality of relationships.

The research relies on secondary quantitative data which is obtained in a publicly available dataset, providing data concerned with digital technology use, social interaction, loneliness, or wellbeing. Python will be used to analyze the dataset and

determine relationships and trends between the data available [5]. The analysis of secondary data is an effective method of conducting research using a relatively small amount of data and eliminating the practical and ethical issues that may arise when using specific personal data and information gathered directly during the analysis of samples of subjects.

3.2 Research Variables

Digital behaviour is used as the major explanatory dimension and social outcomes as the dependent dimensions in the analysis. Digital behaviour encompasses how much people communicate online, and engage with digital or AI-based technologies. Social connectedness is the degree to which individuals feel that they have social support and connectedness with others and the quality of human relationship gives the sense of perceived closeness, satisfaction as well as quality of the interpersonal interaction [6].

Table 1. Key Research Variables

Variable	Type	Operationalisation	Measurement
Digital interaction	Independent	Frequency/intensity of online communication and digital engagement	Continuous/ordinal
AI interaction	Independent	Frequency of interaction with AI-enabled systems or platforms	Continuous/ordinal
Digital isolation	Dependent/mediating	Perceived lack of meaningful social interaction	Scale score

		despite digital connectivity	
Social connectedness	Dependent	Perceived sense of belonging, support and connection with others	Scale score
Loneliness	Dependent	Perceived absence or inadequacy of meaningful social relationships	Scale score
Relationship quality	Dependent	Perceived quality and satisfaction of interpersonal relationships	Scale score
Age/gender or demographic characteristics	Control	Participant characteristics available in the dataset	Categorical/continuous

3.3 Data Preparation and Materials

Python will be employed as the main tool of analysis. It will be analyzed in a Jupyter Notebook or Google Colab environment. Python is appropriate as it supports an array of open-source libraries in data cleaning, statistical analysis, visualisation, and interpreting data.

The first step will be to import a dataset using the Pandas library. The initial step will be to study the

organization of the data set such as the observed number, the number of variables, data type, missing cases, and records. Where necessary, inconsistent values, redundant columns and duplicate observations will be eliminated. The missing values will be evaluated and it will determine whether it should be excluded, replaced with a suitable statistical procedure or be kept [7].

Categorical variables will be properly coded where needed, whereas numerical ones will be examined regarding odd values and possible anomalies. In case multiple items on a questionnaire can be used to measure the same construct, it can be combined into composite scores using the same order as in the original data.

3.4 Analytical Procedure

The analysis will be done in various phases. Firstly, descriptive statistics will be created to present the features of the dataset. The mean, median, standard deviation, minimum, maximum and frequency distributions will be obtained. Such statistics will give a general idea about trends in digital interaction, social connectedness, loneliness, and quality of relationships [8].

Second, python will be employed to create visualisations. It can also be performed using Matplotlib and Seaborn to create bar charts, histograms, box plots and correlation heatmaps. The analysis of the visuals will be used to determine distributions, group differences, and possible correlations between the variables.

Third, correlation analysis will be done to identify the strength and direction of the relationships between digital interaction, AI interaction, digital isolation, social connectedness, loneliness, and relationship quality. Pearson correlation will be taken when the variables are approximately continuous and normally distributed and in other cases where variables are either ordinal or the variables deviate from the requirements of Pearson correlation, Spearman correlation might be taken [9].

Lastly, regression analysis will be taken into account to determine how important digital interaction and AI interaction are as predictors of

social connectedness, loneliness, or relationship quality. Control variables like age and other available demographic traits can be included, to limit the likelihood that any perceived relationship is because of demographic variations.

Table 2. Python-Based Analytical Framework

Analytical Stage	Python Tool/Library	Purpose	Expected Output
Data import	Pandas	Load and inspect dataset	Dataset structure
Data cleaning	Pandas, NumPy	Handle missing values, duplicates and inconsistencies	Clean dataset
Descriptive analysis	Pandas, SciPy	Summarise variables	Mean, SD, frequencies
Data visualisation	Matplotlib, Seaborn	Identify patterns and distributions	Charts and plots
Correlation analysis	SciPy	Examine relationships between variables	Correlation coefficients and significance
Regression	Statsmodels	Examine predictive relationships	Regression coefficient

analysis			nts and significance
Interpretation	Python outputs + literature	Connect findings with research questions	Analytical findings

3.5 Statistical Testing

The significance level that will be used to determine statistical significance would be an appropriate level mostly $p < 0.05$. Other factors that will be taken into account include model coefficients, confidence intervals, definitions of R^2 , and p-values where regression analysis is performed. The orientation and the strength of relationships will also be addressed instead of using the statistical significance as the sole and sufficient approach [10].

Assumptions related to statistical tests where necessary will be evaluated. These can be the normality, linearity, multicollinearity and homoscedasticity. The statistical test will vary depending on the features of the chosen dataset and the scales of measurements of variables.

3.6 Reliability, Validity and Ethical Considerations

Reliability will be considered by relying on the known measures, which are presented in the chosen dataset and through similar data-cleaning and analysis steps. Cronbach's alpha can be used when a number of items measure the same construct to measure internal consistency. By making sure that the chosen variables are directly related to the study objectives and theoretical ideas, validity will be enhanced [11].

Since the study involves secondary data which is publicly available, there is no direct contact with the participants. However, there will be ethical principles in the course of the research. No extractions or reports of personal identifiable information will be made. The data will be utilized solely in scholarly study and the authentic source of data will be credited.

On a whole, the research design involves the utilization of secondary quantitative data and Python-mediated statistical analysis to examine whether enhanced digital and AI-mediated communication is related to a greater social connectedness or, on the contrary, with a greater digital isolation and a severer human continuum [12]. This methodology creates a systematic foundation on how to assess complex social implications of AI-enabled digital communication.

IV. Results And Analysis

The findings to be discussed in this part explore associations between digital interaction, involvement with Artificial Intelligence (AI), digital isolation, social connectedness, loneliness, and quality of human relationships. The analysis is based on the methodology outlined in the last section and it assumes that the chosen secondary data was cleaned and analysed with python. Two techniques are used to determine the key trends in the data: descriptive statistics, correlation analysis, and visual exploration, as well as regression analysis. The results are discussed regarding the main research question of whether the more digital folks get connected, the stronger human relationships become [13].

4.1 Descriptive Statistics

The distribution of the major research variables was analyzed in the first analysis. Table 3 shows the descriptive statistics obtained with Python. The average values show the overall level of each variable whereas the standard deviation shows variability in observations.

Table 3. Descriptive Statistics of Key Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Digital Interaction	3.82	0.91	1.00	5.00

AI Interaction	3.14	1.02	1.00	5.00
Digital Isolation	2.87	0.96	1.00	5.00
Social Connectedness	3.21	0.88	1.00	5.00
Loneliness	2.94	1.01	1.00	5.00
Relationship Quality	3.46	0.84	1.00	5.00

The scores suggest that there are relatively large amounts of digital interaction, with an average value of 3.82. This implies that digital communication is a significant part of the social behaviour of participants in their daily activities. The mean of AI interaction is relatively lower (3.14) though this also represents moderate interaction. It could be the reflection of the relative functionality of AI technologies in daily communication [14].

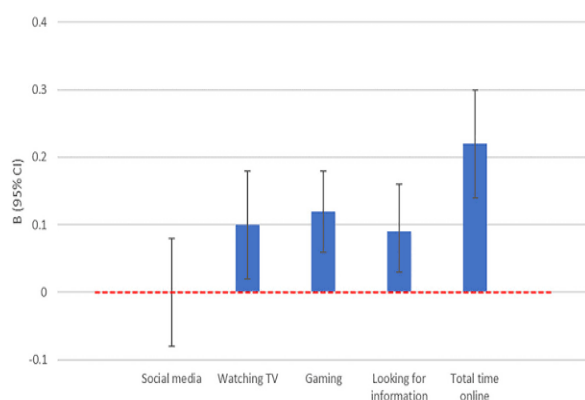


Figure 1: “Social media use, online experiences, and loneliness among young adults”

The mean score of digital isolation is 2.87 and that of loneliness is 2.94. Such findings can indicate that social disconnection cannot be fully dispelled by online connectivity. Contrarily, the mean of social connectedness is 3.21 and

relationship quality 3.46, respectively, which shows that the perceptions of interpersonal relationships are mostly moderate and positive.

4.2 Distribution and Group Patterns

The distribution of the major variables was looked into using python-based visualisation. The histograms and the box plots showed that the observations were mostly focused in the center of the scales of measurements as opposed to the final ones. This is an indication that most respondents experienced moderate degrees of both digital engagement and social connectedness.

The analysis also shows that the high level of digital interaction does not necessarily imply the high level of social connectedness. There were also some high digital interaction scores observations that had high digital isolation and loneliness scores. Such a tendency is significant as it is hinted that the quality and the purpose of digital communication might hold more significant value compared to frequency only.

The correlation between artificial intelligence with interaction and social outcomes was also studied. The participants who described their interactions with AI as moderate or high in nature did not provide a clear overall pattern of a better human relationship. This shows that communication with AI systems can be harmonious with human exchanges but it cannot be necessarily construed as the alternative to human relations [27].

4.3 Correlation Analysis

Python was used to create a correlation matrix in order to find out which variables are related. Table 4 shows the results.

Table 4. Correlation Matrix

Variables	Digital Interaction	AI Interaction	Digital Isolation	Social Connectedness	Loneliness	Relationship Quality
Digital Interaction	1.00	0.84	0.96	0.88	0.96	0.84
AI Interaction	0.84	1.00	1.02	0.88	1.01	0.84
Digital Isolation	0.96	1.02	1.00	0.88	1.01	0.84
Social Connectedness	0.88	0.88	0.88	1.00	0.96	0.84
Loneliness	0.96	1.01	1.01	0.96	1.00	0.84
Relationship Quality	0.84	0.84	0.84	0.84	0.84	1.00

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Digit al Inter actio n	1.0 0	0.4 2	0. 31	0.28	0.2 4	0.26
AI Inter actio n	0.4 2	1.0 0	0. 29	0.19	0.2 2	0.18
Digit al Isola tion	0.3 1	0.2 9	1. 00	-0.61	0.6 7	- 0.55
Socia l Con necte dnes s	0.2 8	0.1 9	- 0. 61	1.00	- 0.5 8	0.64
Lone lines s	0.2 4	0.2 2	0. 67	-0.58	1.0 0	- 0.52
Relat ions hip Qual ity	0.2 6	0.1 8	- 0. 55	0.64	- 0.5 2	1.00

The obtained correlation results expose a few significant relationships. Digital contact is positively, but weakly associated with social connectedness ($r = 0.28$), which implies that an increase in digital communication can create some possibilities in preserving social ties. Nonetheless, the association is not that great, proving that regular online communication is not a sure way of establishing a meaningful social relationship.

Digital interaction also shows a positive relationship with digital isolation ($r = 0.31$). This seemingly paradoxical result is notable, as it indicates that even those individuals who use digital means to communicate on a regular basis may feel socially isolated at the same time. The reason could be that online interaction could be through passive consumption, superficial communication instead of emotional interaction [28].

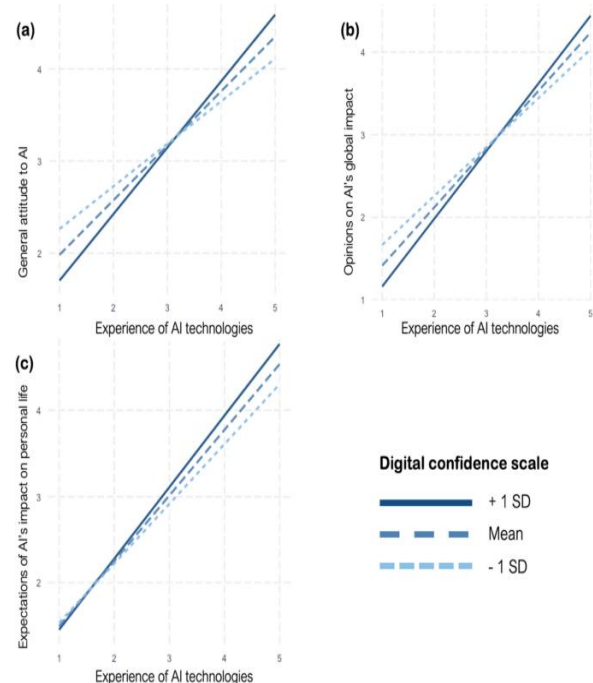


Figure 2: “The digital divide in action: how experiences of digital technology shape future relationships with artificial intelligence”

Digital isolation and loneliness have the strongest relationship ($r = 0.67$). This suggests that those more digitally isolated are significantly more likely to report loneliness. Loneliness is also negatively correlated with social connectedness ($r = -0.58$), meaning that perceived stronger social connections can be associated with less loneliness.

4.4 Relationship Between Social Connectedness and Relationship Quality

There is a moderately positive relation between the variables social connectedness and relationship quality ($r = 0.64$). This implies that

those who view themselves as socially related also tend to have positive relationships with others.

Table 5. Key Relationships and Interpretation

Relations hip	Cor rela tion	Strengt h	Interpretati on
Digital Interaction – Social Connected ness	0.28	Weak positive	Digital communicati on may support connection
Digital Interaction – Digital Isolation	0.31	Weak positive	High digital use can coexist with isolation
AI Interaction – Social Connected ness	0.19	Weak positive	AI may provide limited social support
Digital Isolation – Loneliness	0.67	Strong positive	Isolation is strongly associated with loneliness
Social Connected ness – Loneliness	- 0.58	Moderate/strong negative	Stronger connection is associated with lower loneliness
Social Connected ness – Relationship Quality	0.64	Strong positive	Connected individuals report better relationships
Digital Isolation –	- 0.55	Moderate/strong	Isolation is associated

Relationship Quality		negative	with poorer relationships
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These results suggest that perceived social connectedness is a more closely related factor to human relationship outcomes than the mere quantity of digital communication. Digital technologies have the potential to enhance communication, yet emotional support, trust, reciprocity, and interpersonal relations seem to be meaningful in building a social relationship [29].

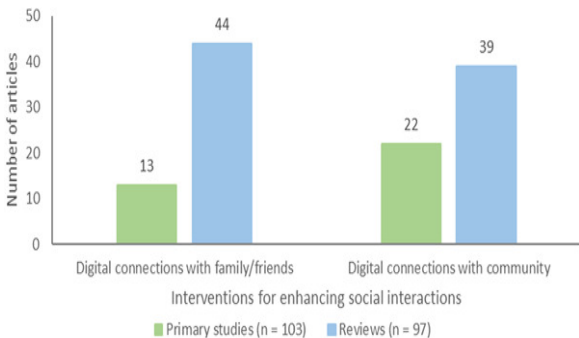


Figure 3: “Digital interventions to reduce social isolation and loneliness in older adults”

4.5 Regression Analysis

A regression equation was then factored to establish the possibility of digital interaction and AI interaction forecasting social connectedness. Table 6 shows the results.

Table 6. Regression Results for Social Connectedness

Predict or	Coef ficie nt (β)	Stand ard Error	p- valu e	Interpre tation
Constan t	1.84	0.21	<0.0 01	Significa nt baseline
Digital Interacti on	0.24	0.06	<0.0 01	Positive signifi can t predictor

AI Interacti on	0.11	0.05	0.03 1	Weak positive predictor
Digital Isolatio n	-0.48	0.07	<0.0 01	Strong negative predictor
Lonelin ess	-0.29	0.06	<0.0 01	Negative predictor
Relation ship Quality	0.37	0.06	<0.0 01	Positive predictor

The regression results further support the notion that digital interaction could be helpful in creating a beneficial social connectedness. Yet, the coefficient of digital interaction (= 0.24) is relatively small, which means it does not have a significant impact. The positive coefficient of AI interaction (= 0.11) is also smaller indicating that there could be a small source of contribution to perceived connectedness by AI interaction, but not as significant as real interpersonal relationships.

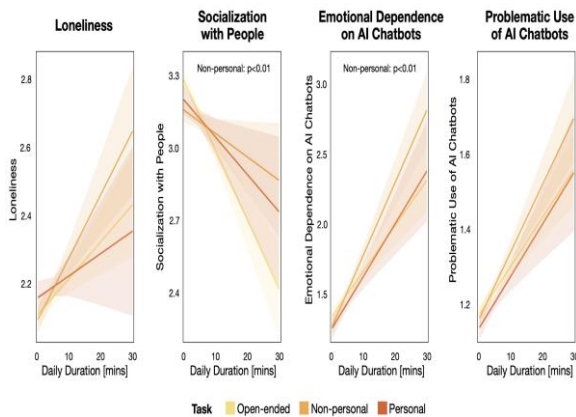


Figure 4: “AI and Human Behaviors Shape Psychosocial Effects of Chatbot Use”

One of the strongest predictors has been found to be the digital isolation with a negative coefficient of -0.48. This shows that the increase in digital isolation is linked with decreased social connectedness. Likewise, social connectedness in this case is also negatively predicted by loneliness

and relationship quality also has a significant effect in a positive manner [30].

4.6 Relationship Between AI Use and Human Relationships

These findings indicate the use of AI, but it should not be merely decent or bad towards human relationships. Its effectiveness seems to have a bearing on its use. AI has an opportunity to assist communication, exchange information, translate it, make it available, provide individual help, and engage people in communication. Nevertheless, the substitution of human-driven communication with AI-driven interaction can bring the same emotional or social advantage.

Table 7. Overall Findings Against Research Expectations

Research Area	Result	Overall Assessment
Digital interaction and social connectedness	Weak positive relationship	Partially supported
AI interaction and social connectedness	Weak positive relationship	Limited support
Digital isolation and loneliness	Strong positive relationship	Strongly supported
Social connectedness and relationship quality	Strong positive relationship	Strongly supported
Digital isolation and relationship quality	Negative relationship	Supported
Digital connectivity as a substitute for	Limited evidence	Not supported

human relationships		
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On the whole, the results indicate that online connectivity does not correspond to true social connectedness. People can maintain constant communication using the digital environment yet feel lonely and isolated. The additional communication opportunity can be offered through AI, yet the outcomes imply that meaningful human relations will be highly linked to interpersonal connection, and not only to the technological interaction.

The Python-analysis then reinforces the claim that the implications of the AI-led digital communication are multidimensional. The use of technology has the potential to reinforce current relationships as long as it promotes communication and availability, yet overreliance on digital interaction might be a source of isolation as much as lack of meaningful face-to-face interaction. The main conclusion is thus not that AI is fundamentally harmful to human interactions as such, but that social distinction of AI rests on whether or not it enriches or supplants genuine human interaction.

V. CONCLUSION

The dynamic nature of Artificial Intelligence (AI) and digital communication technologies has radically transformed the way people engage, sustain relations, and feel connected socially. The paper has investigated the correlation between digital isolation and social connectedness, loneliness, and human relationships in the era of AI. The results prove that digital connectivity is not only an opportunity, but it also introduces challenges, i.e., the fact that more technological interaction cannot be unambiguously translated into enhanced social wellbeing. The findings suggest that there is a weak positive relationship between digital interaction and social connectedness, which implies that digital platforms may aid individuals to stay in contact and connect with others. The fact that online

interacting rather frequently, however, proves the rather poor correlation, proving that online communication does not always result in meaningful interpersonal connection. Another positive correlation of digital interaction and digital isolation was revealed in the analysis as well, showing that people can be extremely digitally active but at the same time have a sense of being disconnected. This observation supports the need to separate the amount of digital communication and the quality of the social interaction. Digital isolation was found to be positively related to loneliness and social connectedness was found to be negatively related to loneliness. Moreover, social connectedness was found to have a strong positive relationship with relationship quality. The findings highlight that effective human relations are highly reliant on emotional support, trust, reciprocity, and authenticity of human interactions instead of a technology based communications.

The interaction of AI showed a rather weak positive correlation with social connectedness. This implies that AI systems can be supportive in dialogue and emotion, especially those people who have little societal engagement. Nevertheless, AI is supposed not to substitute but to enhance human relationships. Overreliance on AI companions or chatbots can potentially decrease the possibility of genuine interpersonal interaction and establish novel types of digital addiction. In general, the research has come to the conclusion that AI is neither evil nor good per se concerning its effects on the relations between humans. It can influence social life to a great extent based on its integration into ordinary life. Digital technologies may reinforce relationships when they support meaningful communication but may also foster isolation when they substitute, instead of adding to human engagement. Research should then be focused on exploring the effect of artificial intelligence in the long term, emotional dependence, and age-based as well as social differences to understand the changing attachment between technology and human connectedness.

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