Facebook, Social Comparison and Happiness: Evidence from a Quasi-Natural Experiment

Abstract

The ubiquity of Facebook usage compels us to study its effects on well-being. We identified a unique sample of Facebook users and non-users who are employed at a security-related organization, where Facebook usage was differentially restricted (even at home) creating a quasi-natural experiment. Performing between-subject analysis, we found significant differences between Facebook users and non-users with regard to social comparison orientation and happiness. Given the exogenous nature of the assignment into groups (i.e., users and non-users), we attribute these differences to the accumulated effect of Facebook usage. Specifically, we infer that Facebook usage increases engagement in social comparison which is liable to reduce user happiness. Social comparison fully mediates the effect of Facebook on happiness, but only among young employees and only among those who believe that others have many more positive experiences than they do. Overall, our findings suggest that even if Facebook users understand that their friend's posts are positively biased, the increased engagement in social comparison may adversely affect those who believe that their friends' lives are better than their own.

The authors do not have any conflicts of interest to report.

Introduction

Social media has become an integral part of daily life with 84% of 18–29-year-olds in the US using it (*Social Media Fact Sheet*, 2021). Facebook has over 2 billion users worldwide, with an average daily usage of 37 minutes per user (Gesenhues, 2019). The analysis presented in this paper is intended to shed light on the effect of social network sites (SNS), and in particular Facebook usage, on users' subjective well-being (SWB).

SNS, like their offline counterparts, have been found to fortify one's self-esteem, reinforce group identity and increase trust and cooperation (e.g., Fox & Warber, 2015; Gonzales & Hancock, 2011; Zhao et al., 2008). Since these benefits and the SWB of users are strongly associated (e.g., Bjørnskov, 2003; Helliwell, 2001; Leung et al., 2013), it is reasonable to assume that participating in SNS has a positive effect on well-being.

However, there is increasing evidence to the contrary, suggesting that SNS may have a negative impact on SWB (Kraut et al., 1998; Kross et al., 2021; Verduyn et al., 2020). The design of online platforms can influence user behavior (Dellarocas, 2005; Overby et al., 2010; Tiwana et al., 2010). In the case of Facebook, the design of the news feed creates an overwhelming emphasis on the positive experiences of others (Chou & Edge, 2012; Kross et al., 2013), which may give rise to envy, rumination, jealousy and low self-esteem (Feinstein et al., 2013; Fox & Moreland, 2015; Tandoc et al., 2015; Triệu et al. 2021), as well as depression, anxiety and stress (Braghieri et al., 2022; Farahani et al., 2011; Labrague, 2014).

The broad spectrum of positive and negative effects on well-being that are attributed to Facebook and other SNS needs to be understood (Appel et al., 2016; Kross et al., 2021; Verduyn et al., 2017, 2020).

Facebook architecture is likely to trigger comparison of one's own experiences to others' experiences. Thus, social comparison may have an important role in determining

the effect of using Facebook on SWB. Previous research has identified correlation between heavy or passive Facebook usage and social comparison (e.g., Burke et al., 2020; Rozgonjuk et al., 2019). Offline upward social comparison has been found to induce negative feelings (Gerber et al., 2018) and reduce happiness (Argyle, 2013). Furthermore, several studies have investigated the effects of online social comparison on SWB and found both positive and negative effects, as summarized by Verduyn et al. (2020) and Meier & Johnson (2022). Meta-analyses by Yang et al. (2019) and Yoon et al. (2019) revealed that social comparison on SNS generally leads to a decrease in SWB and to depression. However, social comparison may also have favorable effects (Meier et al., 2020; Park & Baek 2018).

The current study uses a quasi-natural experiment to measure the cumulative effect of prolonged Facebook usage on users' SWB in a real-world setting. In 2015, employees from a large security organization were sampled, including Facebook users and non-users, with quasi-exogenous allocation to these two groups due to organization-imposed restrictions on Facebook usage. The setting makes it possible to compare users and non-users to examine the causal effect of Facebook usage on social comparison and happiness. The study also measures individuals' perceptions of their friends' lives (compared to own) and investigates the interplay between these three factors.

We present two hypotheses on the impact of Facebook usage on social comparison and happiness. The first hypothesis suggests that using Facebook increases one's tendency to engage in social comparison (SCO), with younger users being more susceptible than older ones. The second hypothesis posits that the negative effect of Facebook on happiness is mediated by SCO, and that this effect is stronger for users who perceive their friends' experiences as much more positive than their own.

Our new measure of the perception of friends' experiences allows to shed light on the mechanism behind Facebook's effect on SWB, by disentangling two potential paths: (1) Facebook biases one's perception of others' positive experiences. This perception bias may affect happiness even if one's SCO (the tendency to compare) has not increased, because the biased perception makes any comparison incidence more harmful. (2) Facebook's architecture induces users to observe the positive experiences of others more vividly and frequently than non-users, which triggers a higher frequency of upward social comparisons. Increased engagement in (upward) social comparison due to Facebook use may affect happiness even if one's perceptions of others' lives haven't been altered by Facebook use, because more comparisons are made.

The results of our analysis suggest that Facebook usage increases SCO, which in turn decreases happiness, particularly for users who perceive their friends' experiences as much more positive than their own. It was found that only young participants (aged 18-25) were susceptible to the negative effects of Facebook usage on social comparison and happiness, which could be due to their more passive use of the platform and greater focus on others compared to older users. We did not find any indication that Facebook affects the perception of others' experiences (compared to one's own experiences). Thus, the findings provide empirical support for our proposed mechanism, in which increased tendency to compare to others may affect happiness even if one's perceptions of others' lives haven't changed due to Facebook use.

This study is innovative in its experimental setting, which facilitates a quasi-natural experiment in a workplace. Notably, the partially exogenous nature of the assignment into users and non-users reduces the inherent selection bias which has been evident in previous studies, allowing for causal interpretation to some extent. Individuals who choose not to use Facebook are likely to differ in character from Facebook users
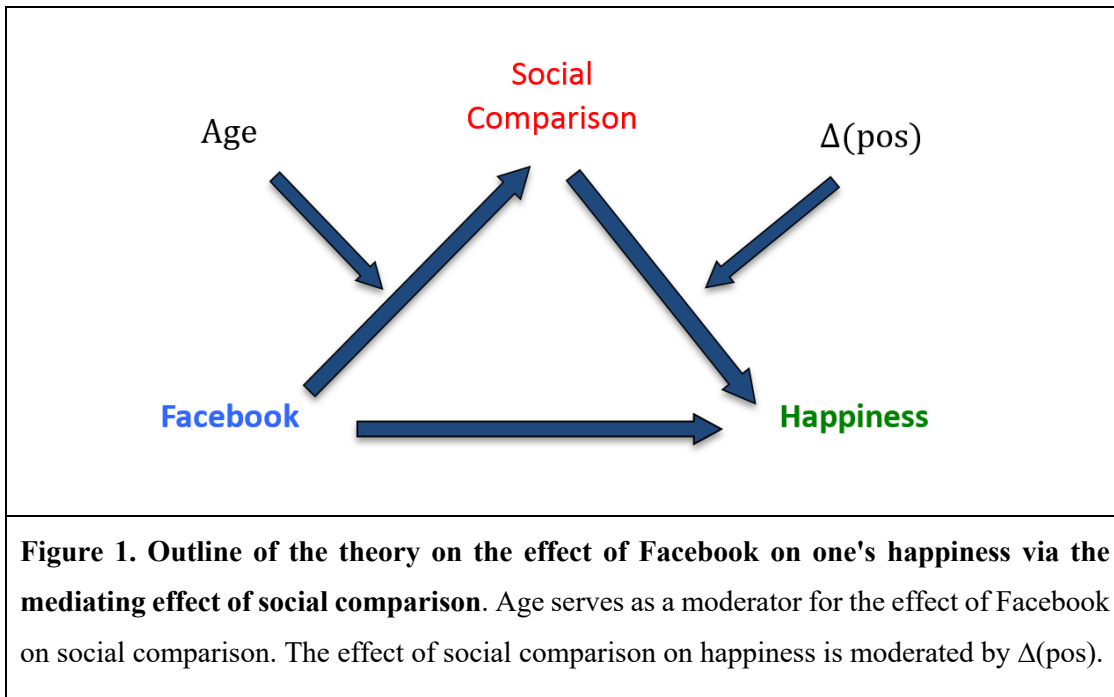
(Ljepava et al., 2013; Nadkarni & Hofmann, 2011) which makes it difficult to devise a proper control group of Facebook non-users. A similar selection problem exists in studies that compare the SWB of users who are characterized by different types or intensities of usage (Chou & Edge, 2012; Tandoc et al., 2015). A person's general disposition may affect how they use Facebook (e.g., passive use vs. active use, etc.), making it difficult to identify the impact of the type or intensity of Facebook usage on happiness. Even longitudinal within-subject studies that compare SWB across time and types of usage (e.g., Kross et al., 2013; Verduyn et al., 2015) may be subject to bias since in periods when the participants are happier, they might also choose to use Facebook more or less intensively. Lastly, using path analysis (Baron & Kenny, 1986) does not eliminate the possibility of underlying endogeneity (see Appel et al., 2016).

An additional contribution of our study is that it examines how the effect of Facebook usage on SWB varies with age. While previous studies used more homogenous subject groups, usually consisting of students (Wenninger et al., 2014), we analyze a sample of employees of varying ages and find that the older members of the sample were less vulnerable to Facebook's influence on their SCO and in turn on their happiness.

Finally, the study's unique setting allowed for the examination of passive Facebook usage, where even employees who were permitted to use Facebook were asked to be cautious about the information they shared online, including refraining from uploading photos and disclosing work-related information. This type of usage is in fact common (Ginsberg & Burke, 2019; Levin, 2018; Verduyn et al., 2015) and our findings add to the growing body of literature that highlights the negative implications of passive social media usage (Burnell et al., 2019; Liu et al., 2019; Verduyn et al., 2015, 2017; Wenninger et al., 2014).

Theory

We seek to investigate Facebook's effect on social comparison and happiness, while considering users' perceptions of the positive/negative experiences of their friends, and to study the interplay between these factors. Specifically, the proposed theoretical framework distinguishes between two constructs: (a) the degree to which one considers one's own actions in light of what others do, i.e., SCO; and (b) the perceived difference between one's own positive experiences and those of one's friends, denoted as Δ(pos). The theory is outlined in Figure 1.

Figure 1. Outline of the theory on the effect of Facebook on one's happiness via the mediating effect of social comparison. Age serves as a moderator for the effect of Facebook on social comparison. The effect of social comparison on happiness is moderated by Δ(pos).

People have an innate drive to evaluate their own opinions and abilities (Festinger, 1954), with the goal of reducing uncertainty (Gibbons & Buunk, 1999) and establishing their standing relative to others (Brown et al., 2007). Since humans are social creatures, self-evaluation often depends upon comparing oneself with other people, a process called "social comparison" (Festinger, 1954). Formally, social comparisons are defined as "comparative judgments of social stimuli on particular content dimensions" (Kruglanski

& Mayseless, 1990). People vary considerably from one another in the extent to which they engage in social comparison, which can be measured by a widely used index called "social comparison orientation" (Gibbons & Buunk, 1999).

Many online user interactions on Facebook correspond to offline social interactions and have social effects, such as enforcing group identity (Fox & Warber, 2015; Zhao et al., 2008), and increasing social capital, social support and relationship maintenance (Ellison et al., 2007; McEwan, 2013; Nabi et al., 2013). Facebook's design, and in particular the news feed, intensifies the social experience. The news feed stacks the experiences of multiple people, making the comparison to one's own experiences unavoidable. Furthermore, the ubiquity of Facebook may make the increased social comparison a habit that manifests outside of Facebook. Facebook friends are often also real-world friends, and thus it is reasonable to expect a social comparison spillover.

We hypothesize that the effect of using Facebook on social comparison is moderated by age.[1] Social comparison is a part of human development that supports self-evaluation and changes with age (Ruble et al., 1980). Consistent with Suls and Mullen's (1982) life-span model of comparison processes, it was found that older adults report less of a tendency to socially compare than younger adults (Callan et al., 2015). Hence, it is important to control for age when estimating the effect of Facebook usage on social comparison. Furthermore, since Facebook provides an additional channel for social comparison, it may intensify already existing differences in social comparison between

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[1] Interestingly, in the context of Facebook usage it was found that comparison orientation is the mediating variable between age and the intensity of Facebook activity, suggesting that younger adults are more inclined to compare themselves with others and therefore use Facebook more than older adults (Ozimek & Bierhoff, 2016). Due to the exogenous assignment of non-users in our setting, we can examine the reversed direction of this link.

age groups.[2] Recent evidence suggests that the type and intensity of Facebook usage varies according to age (Pettijohn et al., 2012) and that passive Facebook usage (e.g., examining others' profiles rather than sharing experiences and engaging with other users) is very common among young users (Pempek et al., 2009; Verduyn et al., 2015). The passive form of usage intensifies social comparison using Facebook and it becomes the core experience (Rousseau et al., 2017; Verduyn et al., 2017). Combined with evidence that young adults are more easily influenced by external factors and their character is more malleable than that of older adults (Finn, 1986; Gardner & Steinberg, 2005; Helson & Moane, 1987; Siegler et al., 1990), it is likely that the effect of Facebook on SCO is larger for young adults than for older ones.

Thus, we propose the following hypothesis:

H1 (social comparison): Facebook usage increases one's SCO, an effect that is moderated by age (such that older users are less affected than younger users).

Social comparison can be in two directions – upward or downward (Gibbons & Buunk, 1999; Wills, 1981). In an upward comparison, one perceives another to be superior along some dimension while in a downward comparison, the opposite is the case. Research suggests that in offline contexts, upward comparison is much more common among individuals (Gerber et al., 2018). Smith (2000) distinguishes between several negative emotions that are likely to arise due to upward social comparison, such as depressive feelings, shame, and envy.

A number of previous studies have focused on the mediating role of envy in reducing subjective well-being (Cohen-Charash, 2009; Smith et al., 1999; Vecchio,

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[2] It is also likely that younger users rely on Facebook as a source of social information to a greater extent than older users, who are "used to" collecting social information from offline sources.

2000), also on Facebook (Krasnova et al., 2013; Krasnova et al., 2015).[3] Envy is one possible outcome of upward social comparison. However, the theory proposed here is somewhat subtler in that it distinguishes between Facebook's effect on the *intensity* of social comparison and the *direction* of the comparison (upward or downward). Each of these two effects may lead to increased envy. In particular, it may be that Facebook usage increases one's SCO (in line with H1), online and/or offline, but does not affect one's perception of others' experiences relative to one's own, which may cause either upward or downward social comparison, depending to the user's *unbiased* perception of others vs. that of himself. This mechanism is somewhat similar to the one suggested in Reer et al. (2019), in which SCO mediates the link between social media use and depression, where self-esteem moderates the relationship between social comparison and depression.

Based on the existing literature off-platform, we expect that Facebook usage will decrease user happiness in the case of upward social comparison (Argyle, 2013; Wood et al., 1985). This is also consistent with studies on SNS which found that upward social comparison decreases other measures of SWB (Lim & Yang 2019; Schmuck et al., 2019; Wang et al., 2017).

Therefore, we also propose the following hypothesis:

H2 (social comparison as mediator for happiness): The (negative) effect of Facebook usage on happiness is mediated by SCO and moderated by the relative frequency of friends' positive experiences as perceived by the user (such that the effect is stronger for users with high levels of Δ(pos)).

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[3] Distinguishing between different types of envy on social networking sites and users' response to it have been the focus of many recent studies, such as Lim and Yung (2019), Meier et al. (2018, 2022), Noon et al. (2019), Wenninger et al. (2019) and Wenninger et al. (2021).

Method

The sample consists of employees from a large, well-known security organization. They must go through a rigorous security clearance process before being hired. The employees consist of knowledge workers, IT experts, administrators, scientists and managers. The ages in the sample vary from 18 to 58 (mean=26); 40% are females; 26% are married; and 56% have at least a college degree while the rest have at least a high school education. The average income in the sample is above the average in Israel and their socioeconomic background is comparable to that of university students in Israel.

In January 2015, 144 randomly selected employees filled out a pencil-and-paper questionnaire we had formulated. All of those who were asked to take part in the study agreed to, thus mitigating the risk of happiness-associated volunteer bias (Heffetz and Rabin, 2013). Informed consent was obtained from all participants. Employees who did not have an active Facebook account at the time of the study (in 2015) were classified as *non-users* and those with an active account as *users*. The sample consisted of 95 users and 49 non-users.[4]

The assignment to the groups of users and non-users is described below, followed by a description of the questionnaire, descriptive statistics and the data analysis method.

Quasi-Exogenous Assignment of Employees

For security reasons, the organization's employees were not allowed to use social networks during the period from 2008 to 2012 (neither at work nor at home). Employees with an existing Facebook account, including employees joining the organization during

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[4]   Most of the non-users have never opened a Facebook account. Ten out of them had an account in the past but closed it well before the study (2.34 years before, on average), where the most recent non-users are three employees who closed their account 6 months before the study.

this period, were asked to delete their account. In 2012, the restrictions were relaxed and the policy became dependent on the projects an employee is involved in (rather than his job in the organization). For example, an administrator and a scientist may have identical restrictions placed on them while two engineers might have different ones.

The changes in policy serve to create a quasi-natural experiment by assigning employees to one of two groups: users or non-users. Our main claim is that the restrictions imposed on the employees serve as an external barrier to using Facebook, which encourages employees to avoid using Facebook entirely (thus "assigning" them to the non-users group). This "encouragement" operates by means of two channels:

1. Present Prohibition. This includes employees who were not allowed to use Facebook at the time of the study (2015). Considering the nature of the organization, the importance of an employee maintaining his credibility within the organization, the possibility that Facebook usage is monitored, and the periodic polygraph testing, it is safe to assume that employees who were instructed not to use Facebook complied with the restriction.

2. Previous Blanket Ban. This includes employees who worked in the organization prior to 2012. They were forbidden to use Facebook during the period 2008-2012; even subsequent to that period, many of the employees who were allowed to have a Facebook account were still forbidden to use their full name or to upload photos, restrictions that compromised their Facebook experience. Post-study interviews indicate that these employees were also used to not having Facebook and therefore decided not to use Facebook even though they were allowed to.

In our random sample of 144 employees, 49 (34%) did not have an active Facebook account, compared to only 4% of non-users in a comparable student group.[5] A

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[5] Out of the employees who are 29 years old and younger (whose average age is similar to that of the students), 26% did not have an active account.

difference of this order of magnitude suggests that the extent of Facebook abstinence in the sample is related to the organization's restrictions on usage (whether current or previous).

Since the above assignment to the groups (users and non-users) was not random, as in an experiment, we employ a matching method in order to balance the two groups and analyze the matched sample.

The Questionnaire

The questionnaire (which appears in the online appendix) included six sections, which were presented to the subjects in the following order:

A. **Demographics**: age, gender, family status, a choice between three levels of education and five levels of income.

B. **Friends' Experiences:** There were ten questions regarding the positive experiences in their friends' lives (such as how often during the week they go out, read a book, watch a movie, etc.) and five questions regarding the negative experiences (such as how often during the week they are upset, sick, etc.).

C. **Social Comparison:** This section was based on the *Scale for Social Comparison Orientation* (Gibbons & Buunk, 1999). A high score indicates a high tendency to engage in social comparison. The reliability of the scale was evaluated using Cronbach's alpha measure (α=.80).

D. **Happiness:** This section is based on *The Oxford Happiness Questionnaire* (Hills & Argyle, 2002). A high score reflects a high level of satisfaction with one's own life. The reliability of the scale was evaluated using Cronbach's alpha measure (α=.71).

E. **Personal Experiences:** Participants were asked about the frequency of ten positive experiences and five negative experiences in their own lives, which correspond to the

experiences they were asked about in Section B. Based on the answers to sections B and E, we measured the difference between the frequency of others' positive and negative experiences and one's own and created the variables Δ(pos) and Δ(neg). A high value of Δ(pos) (Δ(neg)) reflects an individual's tendency to believe that others have more positive (negative) experiences than he or she does.

F. **Facebook Usage:** This section is based on Ellison et al. (2007). The questions concerned the frequency of Facebook usage and the type of activities that users engage in. For example, participants were asked how often they check their Facebook account, how often they upload photos, how often they tag, etc.

Descriptive Statistics

Since the original assignment to the groups (users and non-users) was not random, we employ the propensity score matching method (Dehejia & Wahba, 1999; Rosenbaum & Rubin, 1983), using Matchit (Ho et al., 2007) in order to balance the two groups based on their demographic features and then perform the analysis on the balanced groups. The matching procedure uses the *nearest neighbour* method and *probit* as the distance function and discards observations with low quality matches that lie outside the common support of the distance measure (without replacement). The process resulted in two balanced groups: 41 non-users (out of the original 49 non-users) and 41 users.[6] The demographics and main characteristics of users and non-users in the matched sample are shown in Table 1. The users spend an average of 48 minutes on Facebook each day (the median is about 30 minutes) and 78% of them check their account at least once a day (34% check it more frequently).

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[6] In a previous version of the paper we analyzed the original sample of 144 employees, as well as a matched sample obtained through a different approach - propensity score matching with replacement. The qualitative results are the same in all of these approaches.

	p	Non-users (N=41)				Users (N=41)			
		Min	Max	Mean	Std. dev	Min	Max	Mean	Std. dev
Age	.654	18.00	42.00	27.07	6.65	18.00	44.00	26.41	6.61
Gender	.640	1.00	2.00	1.29	0.46	1.00	2.00	1.34	0.48
Education	.453	3.00	5.00	4.51	0.84	3.00	5.00	4.37	0.92
Income	.662	1.00	5.00	2.90	1.76	1.00	5.00	2.73	1.76
Family Status	.646	1.00	2.00	1.63	0.49	1.00	2.00	1.68	0.47
Social comparison	.097	1.00	5.38	3.35	0.84	2.00	5.50	3.69	0.98
Happiness	.113	2.88	6.00	4.60	0.66	3.25	5.75	4.37	0.62
Δ(pos)	.852	0.20	0.66	0.42	0.11	0.15	0.71	0.42	0.13
Δ(neg)	.802	0.06	0.73	0.40	0.17	0.11	0.76	0.41	0.18
Own(pos)	.407	0.08	0.61	0.36	0.13	0.19	0.70	0.38	0.12
Own(neg)	.842	0.00	0.90	0.39	0.23	0.00	0.85	0.40	0.21

Table 1. Descriptive statistics of our matched sample. Gender: 1 is male, 2 is female. Education: 3 is high-school education, 5 is more than 15 years of education and 4 is in between. Income: 3 is the average income in the country, 1 is much lower and 5 is much higher than the average income. Family status: 1 is married, 2 is single. Social comparison and happiness are both between 1 and 6. Δ(pos) is the extent (potentially between 0 and 1) to which one finds others' lives richer in positive experiences compared to one's own; Δ(neg) is the analogous extent for negative experiences. The column titled p presents the p-value of a t-test comparing the two groups' means. The are no significant differences between Facebook users and non-users in the below variables' means, with the exception of the social comparison's means, which are significantly different at the 10% level.

Empirical Model

We carried out a linear regression analysis using the matched sample. In the basic analysis, we measure the differences between users and non-users but do not take into consideration the manner and scope of Facebook usage, which may be *endogenously*

determined by the users. In the online appendix, we extend the basic analysis to include usage patterns and how these patterns relate to social comparison and happiness.

We estimate a moderated mediation model (using PROCESS, Model 21; Hayes, 2013), which examines our hypotheses. According to the model (Figure 1), the effect of Facebook usage on happiness is mediated by social comparison. Age serves as a moderator for the effect of Facebook on social comparison and therefore it influences the indirect effect of Facebook usage on happiness. Furthermore, the effect of social comparison on happiness is moderated by the perceptions of others' positive experiences relative to the perceptions of one's own (Δ(pos)). Thus, we investigate the variable effect of Facebook usage according to age and according to the level of Δ(pos). The indirect effects are estimated using nonparametric bootstrapping procedure (i.e., 5,000 resamples; Preacher & Hayes, 2004).

The moderated mediation model is given by the following equations:

$$Social\ comparison = \alpha_1\ Facebook + \alpha_2\ Age + \alpha_3\ Facebook * Age + \varepsilon_1 \tag{1}$$

$$Happiness = \beta_1 Facebook + \ \beta_2\Delta(neg) + \beta_3 Social\ comparison + \beta_4\Delta(pos)$$
$$+ \ \beta_5 Social\ comparison * \Delta(pos) + \varepsilon_2 \tag{2}$$

We control for Δ(neg) for the sake of symmetry (the main effect of Δ(pos) is included in the model). As a test of robustness, we ran a number of variations of the model and found that not controlling for Δ(neg) or using additional demographic covariates does not alter the qualitative results.

We also estimate the model in Figure 1 using binary moderators, for both age and Δ(pos), instead of using the original continuous measures. For this purpose, we split the sample into two groups according to age – employees who are younger than the median age (age < 25) and the rest (age $\geq$ 25). Similarly, we split the sample into Δ(pos)$_H$ (higher

than the median) and $\Delta(pos)_L$ (lower than the median). We then re-estimate equations (1) and (2) where Age is replaced by the dummy variable "Age < 25" and $\Delta(pos)$ is replaced by the dummy variable "$\Delta(pos)_H$". Although we lose some information when transforming continuous variables into binary ones, this exercise allows to estimate the effect of Facebook usage for younger vs. older employees and the effect of social comparison on happiness for $\Delta(pos)_H$ vs. $\Delta(pos)_L$, while maintaining a reasonable group size in these comparisons.

Results

The findings indicate that Facebook usage increases social comparison, an effect that is moderated by age (thus supporting H1), which in turn reduces happiness conditional on the perception of friends' positive experiences relative to the perception of one's own (thus supporting H2).

We start with the estimation of the moderated mediation model outlined in Figure 1 and Equations (1) and (2), using the continuous moderators age and $\Delta(pos)$. The full regression results appear in Table 2. A Bootstrap estimation of confidence intervals for the regression's coefficients and of the indirect effect of Facebook on happiness appear in the online appendix.

We found a significant effect of Facebook on social comparison (B=2.46, SE=0.81, t=3.03, p=.003). We did not find a main effect of age on social comparison (B=0.02, SE=0.02, t=1.04, p=.300). However, age's interaction with Facebook usage was negative and significant (B=-0.08, SE=0.03, t=-2.70, p=.009), suggesting that the effect of Facebook usage decreases with age, thus supporting H1. According to the Johnson-Neyman procedure, the estimated effect of Facebook usage on social comparison is positive and significant only for employees who are up to the age of 25, who account for 52% of the sample.
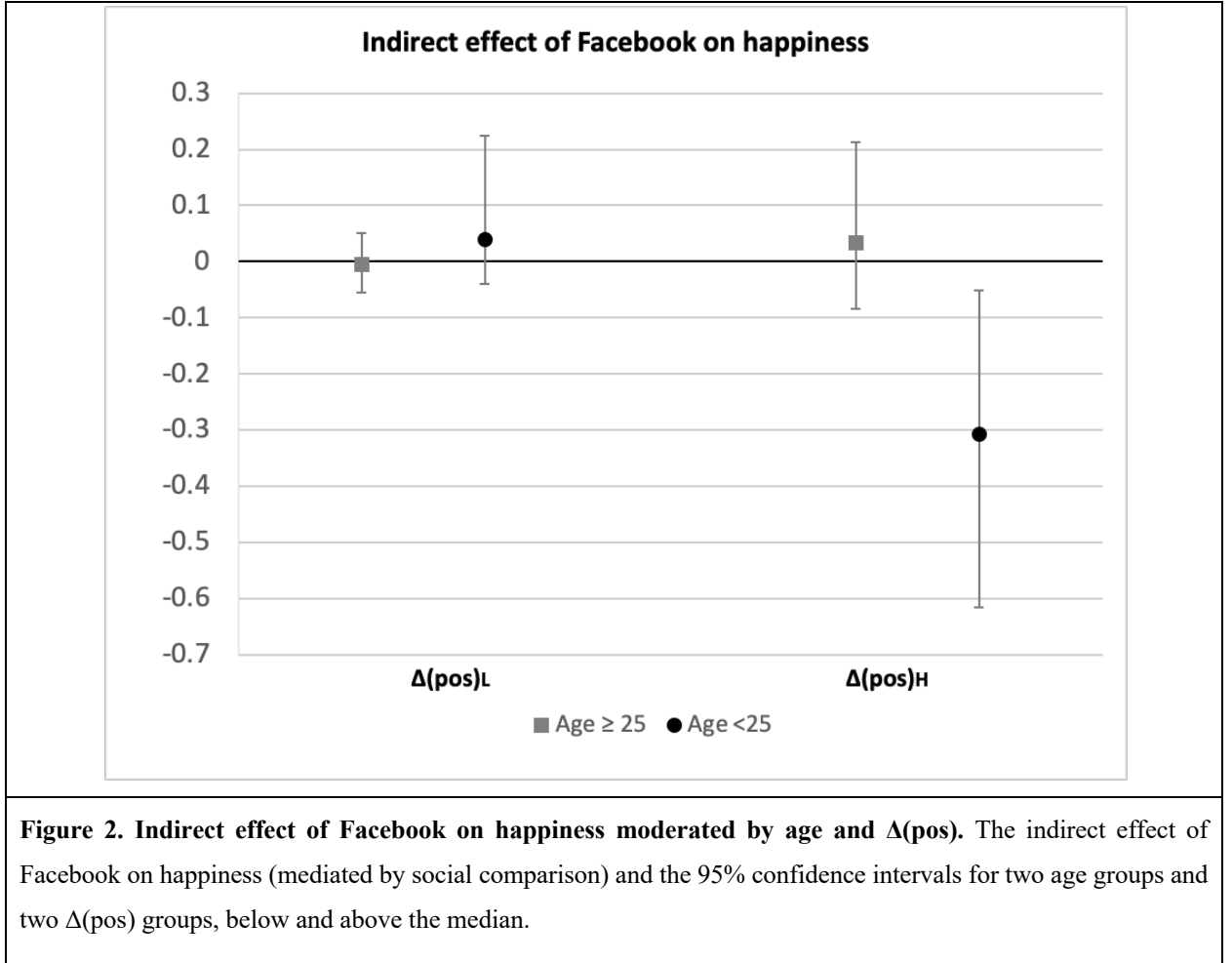
	Social comparison	Happiness
Facebook	2.46*** (0.81)	-0.14 (0.13)
Age	0.02 (0.02)	
Facebook X age	-0.08** (0.03)	
Δ(neg)		1.21*** (0.38)
Social comparison		0.44* (0.23)
Δ(pos)		3.69** (1.79)
Social comparison X Δ(pos)		-1.38*** (0.50)
R^2	.13	.27
N	82	82

Table 2. The results of the mediated moderation model outlined in Figure 1. The predictors in Equations 1 (Social comparison) and 2 (Happiness) appear in the left column. Standard errors in parentheses. *p<.1, **p<.05, *** p<.01.

Social comparison, in turn, decreases happiness (B=0.44, SE=0.23, t=1.93, p=.057) and the interaction Social comparison X Δ(pos) is both negative and significant (B=-1.38, SE=0.50, t=-2.76, p=.007), which confirms H2. According to the Johnson-Neyman procedure, the estimated negative effect of social comparison on happiness is significant only among the upper 44 percentiles of Δ(pos), averaging across age. Thus, employee's level of Δ(pos) determines whether and to what extent social comparison decreases happiness.[7]

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[7] We estimated a variation of the model which does not include the interaction of social comparison and Δ(pos). Although social comparison significantly reduces happiness, we feel

Finally, Facebook usage has no significant *direct* effect on happiness (B=-0.14 (0.13), t=-1.07, p=.286). In other words, social comparison fully mediates the effect of Facebook on happiness.

Figure 2. Indirect effect of Facebook on happiness moderated by age and Δ(pos). The indirect effect of Facebook on happiness (mediated by social comparison) and the 95% confidence intervals for two age groups and two Δ(pos) groups, below and above the median.

We now report the re-estimation of the model in Figure 1 using binary moderators, instead of the original continuous measures of age and Δ(pos). The estimated effect of Facebook usage on social comparison for the younger employees (age < 25) is 0.85 (SE=0.30, t=2.84, p=.006), whereas the effect for the older employees (age ≥ 25) is

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that this variation of the model misses an important element and, accordingly, the estimation's adjusted R^2 is lower than that of the original model's estimation (see the online appendix for more details).

insignificant (-0.10, SE=0.25, t=-0.38, p=.704), consistent with H1. The estimated effect of social comparison on happiness for $\Delta(pos)_H$ is -0.36 (SE=0.09, t=-3.85, p<.001), whereas the effect for $\Delta(pos)_L$ is insignificant (0.05, SE=0.09, t=0.51 p=.614), consistent with H2. Overall, there is a significant negative indirect effect on happiness for the younger group, conditional on $\Delta(pos)_H$ (-0.31, SE=0.15, 95% CI [-0.62,-0.05]), and an insignificant effect for the older group (0.03, SE=0.09, 95% CI [-0.15,0.21]), consistent with H2. See the online appendix for the full regression results. Figure 2 summarizes the indirect effect of Facebook usage on happiness given the different values of the binary moderators.

Discussion

Our findings indicate that using Facebook increases engagement in social comparison (H1). The questionnaire was not restricted to on-platform comparison, but rather measured overall comparison orientation. We suggest that the Facebook user experience promotes social comparison (particularly via the news feed) and may establish a tendency to compare oneself to others both on- and off-platform. We did not find any indication that Facebook usage affects the belief that others' lives are richer in positive experiences than one's own (i.e., $\Delta(pos)$; see the online appendix). However, we did find indications that increased engagement in social comparison combined with a belief that others' lives are richer in positive experiences than one's own causes users to be less happy than non-users (H2).

These findings suggest that a user's decline in happiness is due to an *increase* in social comparison, even if neither $\Delta(pos)$ nor $\Delta(neg)$ are affected by Facebook usage. This has the important implication that designers of the Facebook platform should invest more effort in reducing Facebook's encouragement to compare, while the need to de-bias users' perceptions of others may be overemphasized.

Another contribution of the study relates to the moderating effect of age. Most of the studies on the effect of Facebook usage have been conducted among relatively young participants, most of them students (Wenninger et al., 2014). Our setting made it possible to examine a wide range of ages (18-44 years old) and to isolate the effect of its interaction with Facebook use on social comparison and happiness. We found that only young participants (aged 18-25) were susceptible to the Facebook effect on social comparison and consequently on happiness.

A possible explanation for the age-related differences is that younger participants are more susceptible to Facebook's influence because they rely on Facebook as a source of social information to a greater extent than older adults, who are "used to" collecting social information from offline sources. This may be reflected in differences between younger and older adults in the use of Facebook's various features. We explore the age-related usage patterns among the employees in the organization (see the online appendix) and find that younger users tend to use Facebook more passively (i.e., they concentrate on obtaining information) and focus more on others than on themselves (i.e., they tag and comment more than uploading photos or posting statuses), which may trigger social comparison. Note that we found no age-related differences in the overall intensity of usage, although the frequency of checking the account was significantly larger for younger employees.

One caveat to consider is the possibility that young employees have a greater tendency to use other social media (e.g., Twitter) as well and that their levels of social comparison and happiness are not affected solely by Facebook usage. However, other social media platforms were not widely in use in Israel at the time of the study and we believe that communication channels (such as Facetime) that augment off-platform social relationships are less likely to reduce users' well-being.

This study is the first, to the best of our knowledge, to use a quasi-natural experiment to measure the cumulative effect of prolonged Facebook usage in a real-world setting. It demonstrates a potential negative effect of using social network platforms such as Facebook on users' subjective well-being. Our setting has some advantages over lab experiments, in which there may be a need to simulate Facebook usage; participants may be influenced by an awareness of the research questions; and the effects measured in a lab may only be momentary. Another advantage of the unique setting is that it allows to account for the cumulative effect of Facebook usage "in the wild", in contrast to lab experiments and brief-duration field studies (Allcott et al., 2020; Kross et al., 2013; Lin & Utz, 2015; Verduyn et al., 2015; Vogel et al., 2015). However, our natural setting also carries some limitations. First the assignment to groups (users and non-users) as a result of the organization's Facebook policy is not random as it would be in a lab experiment and does not completely eliminate selection bias. Second, we were limited to a relatively small sample which means that our statistical power is low. Third, our population was characterized by a particularly passive usage of Facebook which may drive our main results.

The interpretation of our results is based on the argument that the restrictions imposed on the employees in our sample serve as an external barrier to using Facebook, which "assigns" them into the groups of users and non-users. Nonetheless, there is a concern that non-users and users have different characteristics, which are associated with the projects they work on. For example, it may be that the projects in which Facebook use is forbidden are top secret, and working on such projects may be systematically associated with high job satisfaction, which, in turn, is correlated with the dependent variables, i.e. social comparison and happiness. Furthermore, it may be that employees in

these projects were assigned to them because they have some specific trait desirable in those projects, which again may bias the estimates.

Although this is a valid concern, we believe that it does not create a systematic bias in the estimates, given the nature of the organization and the administration of the questionnaires. Specifically, the questionnaires were administered over a three-week period on the organization's campus. The participants, both users and non-users, were physically dispersed in different buildings and in different offices and were employed in nine different departments (in various divisions) and 18 different teams. Furthermore, both groups included employees in a variety of positions (administrators, scientists, engineers, managers, etc.). Thus, the diversity in the sample mitigates the risk of systematic in-group bias. In addition, we found that the frequencies of the various everyday experiences of users and non-users in the sample were not significantly different.

There is also a concern regarding non-compliance, as in any field experiment. In our context, this involves employees who were allowed to use Facebook without restriction, but refrained from doing so nevertheless. Thus, the 2015 snapshot distinguishes between treated subjects (non-users) and non-treated subjects (users), although this is not necessarily in perfect alignment with the restrictions imposed on the subjects. This potential non-compliance is a manifestation of self-selection and may bias the estimated effect. We assessed the magnitude of this selection bias by means of post-study interviews and found it to be of a small magnitude (the interviews are described in the online appendix). We also reduced the effect of potential selection bias on the estimation by using a matching procedure, which creates two balanced groups based on their demographic features, and estimating our model on the matched sample.

Future studies should investigate the effect of Facebook on users' well-being using a larger and more diverse sample, yet attempting to identify unique natural settings in which not using Facebook is not an outcome of one's choice.

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