

The Digital Footprints of Adolescent Depression, Social Rejection and Victimization of Bullying
on Facebook

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Abstract

Online Social Networking Sites (SNSs) are immensely popular, especially among adolescents. Activity on these sites leaves digital footprints, which may be used to study online behavioral correlates of adolescent psychological distress and to, ultimately, improve detection and intervention efforts. In the present work, we explore the digital footprints of adolescent depression, social rejection, and victimization of bullying on Facebook. Two consecutive studies were conducted among Israeli adolescents ($N = 86$ and $N = 162$). We collected a range of Facebook activity features, as well as self-report measurements of depression, social rejection, and victimization of bullying. Findings from Study 1 demonstrate that explicit distress references in Facebook postings (e.g., "Life sucks, I want to die") predict depression among adolescents, but that such explicit distress references are rare. In Study 2, we applied a bottom-up research methodology along with the previous top-down, theory driven approach. Study 2 demonstrates that less explicit features of Facebook behavior predict social rejection and victimization of bullying. These features include 'posts by others', 'check-ins', 'gothic and dark content', 'other people in pictures', and 'positive attitudes towards others'. The potential, promises and limitations of using digital Facebook footprints for the detection of adolescent psychological distress are discussed.

Keywords: adolescents, digital footprints, depression, social rejection, bullying, social networking sites

Online social networking technology have become a central arena for adolescent social life today (Lenhart, Purcell, Smith, & Zickur, 2010; Statista, 2017). Adolescents around the world use social network sites (SNSs)¹ not only for establishing and maintaining friendships, but also for self-presentation purposes, for frustration venting and for emotional self-disclosure (Ophir, 2017; Hew & Cheung, 2012; Manago, Taylor, & Greenfield, 2012). While interacting with and on these sites, users leave digital footprints, a set of traceable digital activities (Lambiotte & Kosinski, 2014). Recognizing these trends, social workers in youth-at-risk centers, as well as school teachers and counselors have leveraged these tools and established online connections with adolescents under their care (Asterhan & Rosenberg, 2015; Rosenberg, Ophir & Asterhan, 2018). It allows them to monitor adolescents' emotional states and to detect signs of psychological distress from their online SNS behavior.

In spite of these spontaneous practitioner initiatives, however, little is known about the extent and the ways in which psychological distress is expressed in, and can therefore be deduced from, adolescents' logged SNS activities. How valid and informative are explicit online expressions of emotional distress in SNSs? What types of distress are expected to be found online? Finally, is it possible to detect adolescents' distress from patterns of online behavior when users choose *not* to explicitly express their emotional state in postings?

Recent research on adult users has shown that the digital footprints from their SNS activities can be used to infer personal information, such as their age, gender, certain personality traits (e.g., Kosinski, Stillwell, & Graepel, 2013; Lambiotte & Kosinski, 2014; Schwartz et al., 2013), and even certain mental health conditions, such as depression and anxiety (Csepeli & Nagyfi,

¹ Online social networking sites are computer-based platforms such as Facebook, Twitter, or Instagram, which allow users to present themselves, upload and share content, and establish or maintain connections with others (Obar & Wildman, 2015).

2017; Park et al., 2014; Reece et al., 2016). In the current work, we extend existing research in this emerging field by focusing on adolescents. The highest rates of peer bullying (Wang, Iannotti, & Nansel, 2009) and suicide attempts are documented among adolescents and young adults (Varnik, 2012). Moreover, parents or other caregivers are often not aware of their children's suffering (Rey & Bird, 1991; Velting et al., 1998). Knowledge about the digital footprints of adolescent distress will inform theory and may be used to support mental health professionals, teachers and youth counselors in ongoing detection and prevention efforts. We focus our search on two types of digital footprints: direct, explicit distress references in SNS postings and additional features of SNS activity that do not include explicit references to distress experiences. We review existing research on these two types of digital footprints separately next.

Explicit distress references

In explicit references to distress, SNS users directly and explicitly write about their personal experiences of distress or the symptoms of their mental health condition (e.g., "Life sucks, I want to die ☹"). Several studies have shown that subsets of SNS postings indeed include explicit, direct references to distress experiences, in particular to depression (e.g., Cavazos-Rehg et al., 2017; Moreno et al., 2011; Saleem et al., 2012). For example, Moreno et al. (2011) developed a coding method to identify explicit references to depression based on the list of symptoms specified in the Diagnostic and Statistical Manual of Mental Disorders (DSM). These symptoms include, among others, depressed mood, diminished interest or pleasure, and suicide thoughts (American Psychiatric, 2013). In addition to these classical, DSM-defined symptoms depressed individuals have also been found to endorse maladaptive beliefs about themselves (Beck, 1974) and ruminate about their negative experiences (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Ophir, Asterhan and Schwarz (2017) found explicit depression references

among adolescents Facebook postings: Depressive posts included more references to DSM-based depressive symptoms, included more cognitive distortions, and revealed more negative attitudes towards the social "other" (Ophir et al., 2017).

Several explanations have been suggested for why individuals explicitly express their personal distress on SNSs. Compared to face-to-face settings, users may feel more comfortable to share their personal depressive feelings on online sites (Christofides, Muise, & Desmarais, 2009). SNS-based communication provides a sense of control (with privacy options to limit access to one's profile), alongside a sense of belonging to specific networks of friends (Holleran, 2010; Pickett, Gardner, & Knowles, 2004). With the act of public, online emotional sharing, adolescents reach broad audiences and increase the frequency of supportive feedback from their online friends and contacts (Bazarova, Choi, Schwanda Sosik, Cosley, & Whitlock, 2015). Their friends' replies (i.e., verbal comments, likes, or emojis) can signal attention, co-presence, and partaking in their emotional experiences (Sosik & Bazarova, 2014), which may contribute to their overall well-being (Burke & Kraut, 2016).

Despite these recent advances in research on online distress sharing, however, the *validity* of online SNS references to psychological distress is rarely addressed. Most existing studies only consider distress references without further cross-validating these with external criteria (i.e., validated diagnostic tools), whereas in others validated mental health screening tools as associated with self-report questionnaires on SNS activities (instead of examining actual online postings).

To date, only few studies have empirically explored the validity of (adults') explicit SNS-based distress references using external diagnostic tools: Moreno and colleagues (2012) found a trend approaching significance, whereby explicit, Facebook-based references to depressive

symptoms were associated with self-reported symptoms of depression, using validated screening tools. Holleran (2010) also reported that depression can be assessed with a moderate degree of accuracy from a person's online postings on Facebook and Myspace. These first findings on depression in adult populations support the notion that a person's explicit references in social media postings can provide valuable information about his/her mental health condition.

The overall goal of the current research is to determine whether and how features of adolescents' online social network activities can be used as a basis for detecting their personal distress. In Study 1, we extend the line of research on the predictive validity of explicit distress references in two ways: First, we focus on adolescents, rather than on adults. Second, in addition to depression, we include two additional types of distress, which are of a more *psychosocial* nature (i.e., distress that relates to, or results from social relationships). With the transition from childhood to adolescence, teenagers begin to spend more time with their peers, without adults' supervision. Their social relationships grow more complex and their social status and prestige become exceptionally dominant in their life experiences (Brown & Larson, 2009). Unfortunately, a subset will experience social rejection or become victims of bullying. More than half of all adolescents report that they have been bullied verbally or socially (Wang et al., 2009). Early detection of psychosocial distress is crucial because low socio-metric status has been consistently linked to adjustment difficulties (Brown & Larson, 2009). Adolescents who suffer from social rejection or peer bullying are at risk to develop severe psychological distress, experience low self-esteem and depression (McDougall, Hymel, Vaillancourt, & Mercer, 2001) and, in extreme cases, may even attempt suicide (Kim & Leventhal, 2008). For these reasons, we not only focus on depression, but also include measures of two types of adolescent *psychosocial* distress: social rejection and victimization of bullying.

Non-explicit footprints of psychological distress on SNS activity

Whereas experiences of personal distress may be explicitly and intentionally communicated in SNS postings, it may also leave non-explicit footprints on a person's online social network activities (Lambiotte & Kosinski, 2014). In other words, emotional distress may "leak through" unintentionally, in seemingly unrelated online behavioral features. These features may include social interaction markers (e.g., number of friends, number of 'likes' received to posts, number of posts received on one's timeline), personal interests and self-representational choices (e.g., types of pages and groups that appear on one's personal profile), and level of engagement in social networks (e.g., number and types of postings).

Interestingly, early studies from the pre-SNS era have already shown how bottom-up, data mining techniques may be useful for such explorations. For example, essays of students, which were subjected to computerized text analysis program revealed that depression is associated with non-clinical written expressions, such as excessive usage of first person pronouns in essay writing (Rude, Gortner, & Pennebaker, 2004). Similarly, neuroticism was found to be predicted by a higher rate of first person pronouns usage in daily diary writing (Pennebaker & King, 1999). More recent research has shown that personality traits can be predicted by social network activity features (Lambiotte & Kosinski, 2014). For example, Schwartz et al. (2013) found that introversion and extroversion leave different and distinctive digital footprints on Facebook. Finally, a recent examination of 12 million SNS profiles has showed that SNS behaviors that indicate offline social interactions (e.g., posting photos from offline social events), as well as accepting online friendships requests are associated with reduced mortality rates (Hobbs, Burke, Christakis, & Fowler, 2016).

Using a designated Facebook application to record ongoing depressive symptoms of 55 adult

Facebook users, it was found that depressive symptoms are correlated with number of friends and location tags (Park, Lee, Kwak, Cha, & Jeong, 2013). Other digital footprints such as first person pronouns, negative affect, and increased nighttime activity were found to be predictive of the onset of depression disorder among adult Twitter users (De Choudhury, Gamon, Counts, & Horvitz, 2013). Taken together, these findings about non-explicit footprints of depression and personality traits form the basis for Study 2. In Study 2, we examine whether psychological distress may be detected, not only by explicit distress references, but also by additional, non-explicit features of adolescents' SNS activity.

Whereas Study 1 applies a top-down, theory-driven research approach, Study 2 combines both top-down and bottom-up, exploratory research methods. Top-down and bottom-up are different, yet complementary research approaches in the social sciences. In top-down approaches, researchers apply deductive reasoning from the general theory on a given topic (e.g., depression) to its more specific sub-components. This method is a primary research method in confirmatory data analyses aimed to prove or refute a given theory. Based on this method, the search for online signs of depression should be limited to the theoretical, clinical picture of the disorder (e.g., explicit manifestations of depressive symptoms). In the bottom-up approach, researchers apply inductive reasoning, from specific observations to larger patterns. This method, which is not confined to an a priori theory, is a common approach in exploratory research. In Study 2, we therefore search for SNS-based non-explicit footprints of adolescent distress, that *a priori* do not seem directly related to the clinical picture and symptoms of the various types of psychological distress.

In addition to its focus on adolescent users and the inclusion of two types of psychosocial distress (i.e., social rejection and victimization), Study 2 extends the existing line of research on

non-explicit digital footprints as follows: We examine Facebook activity rather than public Twitter posts, which is the focus of most existing work in this field (e.g., Coppersmith, Dredze, Harman, Hollingshead, & Mitchell, 2015; Reece et al., 2016; Tsugawa et al., 2015). Non-explicit, digital footprints of psychosocial distress may be more dominant on Facebook than on Twitter. Twitter usage is usually driven by interests in real-time news and by the need to be updated on "hot" topics, people, and conversations (Hargittai & Litt, 2011), whereas Facebook usage is focused on social interaction and relationships (Hew, 2011). Facebook users tend to form online connections with people they know from their offline environments and thereby increase their "bonding social capital", strong relationships that provide emotional kinship and social support (Phua, Jin, & Kim, 2017). Twitter usage, in contrast, has been linked to increased "bridging social capital", more weak and distant relationships (Phua et al., 2017). Since social relationships are intertwined in individuals' mental health, we expect that Facebook activities would serve as a natural source for digital footprints of psychological distress.

The current work and hypotheses

Relying on both theory-driven and exploratory research methods, we present two consecutive studies that examine the relation between adolescents' online SNS behaviors on Facebook and external, traditional validators of emotional distress. The first study focuses on direct, explicit distress references in adolescent SNS postings (i.e., "I feel depressed"). Based on previous research that has examined the validity of explicit references to depression among young adults (Holleran, 2010; Moreno et al., 2012), we hypothesize that explicit references to distress in Facebook postings, and specifically to depressive symptoms, will predict self-reported depression among adolescents (hypothesis #1). In study 2, we adopt an open, exploratory search for non-explicit Facebook behavior features that distinguish between adolescents that do and do

not suffer from emotional distress. Based on findings from research on adult users of social media, it is expected that emotional distress leaves discernable digital footprints in adolescents' Facebook activities (hypothesis #2). Finally, in light of the fact that Facebook serves as a platform for social interactions for many adolescents, we hypothesize that two types of *psychosocial* distress, namely social rejection and victimization of bullying, will be correlated with, and expressed in, features of teenagers' Facebook activity (hypothesis #3).

Study 1

The main goal of Study 1 is to examine the predictive validity of *explicit* references to personal distress in adolescents' Facebook postings. In order to increase the frequency of encountering self-reported, actual distress, we did not limit recruitment of participants from the general adolescent population only, but also specifically recruited participants from youth-at-risk associations. In this study, the occurrence of explicit references to personal distress on Facebook was compared with external, well-established, self-report measures of psychological distress (i.e., depression, social rejection, and victimization of bullying).

Method

Participants and procedure. The procedure was approved by the Chief Scientist's office at the [BLINDED] Ministry of Education (protocol number #8335) and by the Ethical Committee for the Use of Human Subjects in Research of the School of Education at the [BLINDED] University. Participation criteria included age (between 13 and 18), language (Hebrew speakers), and having a Facebook profile. Recruitment was conducted in informal education settings, such as in local, popular youth movements, and other after-school activities. Youth leaders, counsellors and educators were contacted to recruit participants and conduct the data collection on their facilities.

Adolescents received information about the general goal and importance of the study and were informed in detail about the study's procedure, including the request to download data from their personal Facebook activity log. The adolescents were provided with parental consent forms, which were attached to written descriptions of the study, and were informed of the reward for participation (i.e., a pizza raffle). A total of 101 adolescents achieved their parents' consent and agreed to participate in the study. Eight participants dropped out without completing the self-report questionnaires and seven participants were omitted from the final sample because they did not meet the language criterion. Altogether, the ultimate sample used for analyses in Study 1 consisted of 86 (51.2% girls) Hebrew speaking adolescents, aged 13 to 18 yrs ($M = 15.98$, $SD = 1.3$). Close to forty percent of the sample ($N = 34$) were recruited from after-school programs organized by youth-at-risk organization.

Participants were instructed to find a quiet and private spot where they could read the instructions, sign the consent form and take their time to honestly complete three self-report measures of distress: social rejection, victimization of bullying, and depression. Subsequently, participants downloaded the last three months of their personal Facebook account's "activity log". The activity log is a feature of Facebook that allows users to review their own postings and actions, as well as the posting that others have posted on the participant's Facebook "wall". Specifically, participants were asked to download three sections from this activity log: (1) 'Your posts', which include Facebook posts that were created ('Owner-Created') or shared ('Owner-Shared') by the user, (2) 'Posts by others', which include posts that were created by other people but had a reference to the participant ('Other-Tagged') or that were attached to the participant's own timeline ('Other-Created'), and (3) a screen shot of the 'About' page (i.e., a Facebook page that allows users to share basic personal details about themselves, including hobbies, movies, and

music preferences). The About section also shows the total number of Facebook friends of the user. Technical assistance was provided when needed. The data was transferred with a flash drive to a secured computer that was authorized for use by the authors and a research assistant only.

Instruments and content analysis. Three self-report measures of distress were used in both studies: Depression was measured using the well-established Beck depression inventory-II (Beck, Steer, Ball, & Ranieri, 1996). Social rejection was measured with four items from the social problems sub-scale of the widely used Youth Self Report protocol (YSR; Achenbach 1991). Finally, victimization of bullying was measured using six items drawn from the Peer Relations Questionnaire (PRQ), a well-validated 33 items scale (Rigby, 1998). All self-report scales demonstrated good internal consistency across both studies (*Cronbach's α* of depression, social rejection, and victimization ranged from .90-.91, .77-.85, and .85-.86, respectively). A detailed description for each scale is offered in the supplementary material.

Content analysis. Each Facebook profile was evaluated whether it contained (one or more) explicit references to distress. The content of all the posts published by fifteen (out of 86) different Facebook users was rated by two trained, independent judges, the first author and a research assistant ($N = 142$ posts in total), who were blind to the participants' self-report measure outcomes. Interrater reliability was satisfactory ($\kappa = .73$, *Fisher's Exact Test* = 14.74, $p = .01$). Specifically, only one profile was coded differently between the judges, with two versus three explicit references to personal distress. After the rating of all 86 profiles, all posts that were marked as containing explicit references to personal distress (26 posts altogether), were subjected to further classification by *both* judges. The two judges classified the type of distress in each post upon three nominal variables: (1) posts with references to depressive symptoms, (2)

posts with references to *psychosocial* distress, and (3) posts with undefined or other type of distress. Inter-rater reliability was high for the primary type of distress ($\kappa = .86$) as well as for the secondary type of distress ($\kappa = .91$). Three disagreements (two primary, and one secondary, type of distress) were discussed among the judges until a final score was decided (Further description of the content analysis is offered in a supplementary material).

Results

Self-report measures of distress. Descriptive statistics and zero order correlations of the self-reported measures are presented in Table 1. Consistent with the literature on adolescents' distress, positive correlations were found between social rejection, victimization of bullying, and depression. The average *sum* score² of the BDI was 10.23 ($SD = 8.9$).

Explicit references to personal distress. Altogether, the 86 participants published a total of 1,168 posts on their timeline in the three months prior to the date of data collection. Of these, 26 posts contained explicit references to personal distress. The 26 distress posts were published by 10 different individuals (12% from the total sample), three individuals from the mainstream sample (5.7%) and seven individuals from the youth-at-risk sample (20.6%). In 15 cases (58% of the explicit postings) the primary distress reference related to depression, nine (35%) to psychosocial distress, and two (8%) referred to undefined distresses. Seven posts (26.9%) included a secondary type of distress: four (15%) references to depressive symptoms and three (12%) references to psychosocial distress.

Explicit references to personal distress and depressive symptoms. An independent-samples t-test was conducted to compare depression scores for adolescents with ($N = 10$) and without explicit references to any type of distress ($N = 76$). Levene's test for equality did not allow us to

² The average *sum* score of the BDI appears in addition to the mean score from Table 1 in light of the conventional standardized norms and cut-off points of depression scores that are usually considered in their sum scores.

assume equality of variances between the two groups ($F = 12.31, p = .001$). The results of the t -test comparison (equal variances not assumed) demonstrated a significant difference in BDI scores between users that published posts with explicit references to personal distress ($M = 19.60, SD = 14.69, N = 10$) and users that did not ($M = 9.00, SD = 7.19, N = 76$), $t = 2.25, p = .050$. A calculation of the standardized differences between the two means indicated a large effect size (Cohen's $d = .92$). These results lend support to our *first* hypothesis that explicit references to distress imply higher levels of depression among adolescents.

In light of our general dichotomous goal to use Facebook as a detection tool that determines whether or not the adolescent suffer from depression (i.e., a 'yes or no' question), we continued and examined the predictive value of posts with explicit references, specifically to depressive symptoms, using a non-parametric, Chi-square test. A dichotomous variable was created to differentiate between depressed and non-depressed participants. The standard cut-off score for mild depression is 14. However, we used a cut-off score of 13 because two items from the original BDI scale (sexual and suicidal behaviors) were omitted in the current study and the adjusted cut-off score was re-calculated to 12.667. Based on this cut-off score, 25 participants (29.1%) were found to experience at least mild depression. A Chi square test of independence demonstrated a significant difference, $\chi^2(1, 86) = 9.19, p = .002$. Remarkably, seven out of ten (70%) participants who published posts with explicit references to depressive symptoms experienced at least mild depression, whereas 18 out of 76 (24%) participants who did not publish depressive posts fell in that same category. This finding is specifically informative because it suggests that explicit references to depression significantly increase the chances that the adolescent is indeed suffering from depression (hypothesis #1).

Explicit references to distress and social rejection. A t-test was conducted to compare social rejection scores for adolescents with and without explicit references to any type of distress. Levene's test for equality was significant ($F = 9.80, p = .002$). The difference in social rejection scores for students who expressed distress ($M = 2.15, SD = 1.21, N = 10$) and those who did not ($M = 1.70, SD = .69, N = 76$) was not significant, $t = -1.14, p = .280$ (equal variances not assumed). A Chi square test of independence, using a dichotomous variable for social rejection based on the upper quartile of the scale (2.25), did not demonstrate significant differences in social rejection, with and without explicit posts of psychosocial distress, $\chi^2(1, 86) = .14, p = .705$.

Explicit references to distress and victimization of bullying. A t-test was conducted to compare victimization scores for adolescents with and without explicit references to distress. Levene's test for equality was significant ($F = 24.51, p < .001$). The test did not demonstrate a significant difference in victimization scores for adolescent with explicit references to distress ($M = 1.95, SD = 1.06, N = 10$) and without references to distress ($M = 1.45, SD = .40, N = 76$), $t = -1.48, p = .171$ (equal variances not assumed). The following Chi square test, which used a dichotomous variable of victimization based on the upper quartile of the scale (1.67), did not demonstrate significant differences in victimization of bullying with and without references to psychosocial distress, $\chi^2(1, 86) = .92, p = .336$. Thus, it cannot be concluded that explicit manifestations of any type of distress or psychosocial distress are significantly linked to experiences of social rejection or victimization of bullying.

Discussion

The main goal of Study 1 was to examine the predictive validity of explicit online references to personal distress. The results of Study 1 confirmed our first hypothesis that explicit references

to distress predict higher levels of depression among adolescents. Most of the documented explicit references to distress were to depressive symptoms (58% of the distressed posts) and, remarkably, seven out of the ten (70%) participants who published posts with explicit references to depressive symptoms experienced at least mild depression. These findings extend previous research that examined the validity of explicit references to depression (Holleran, 2010; Moreno et al., 2012) to include younger SNS users (i.e., adolescents rather than adult).

Nevertheless, even though the findings in Study 1 showed that explicit references to personal distress in Facebook postings are predictive of self-reported symptoms of depression, distress references could not predict *psychosocial* distress (i.e., social rejection and victimization of bullying). Moreover, even the most frequent explicit distress references (to depression) are rare: Only 2% of adolescent postings collected contained explicit references to personal distress. In addition, only 12% of the number of adolescents posted Facebook status updates that included explicit depression references. Vice versa, most of the Facebook timelines of the adolescents who, according to the self-report measures, were suffering from depressive symptoms (18 out of 25), did not include explicit reference to any type of personal distress. This false negative identification error, whereby the test (explicit distress references in Facebook postings) failed to detect a depressive individual, requires further research that examines whether additional, less explicit Facebook activity features, may serve as online indicators for distress.

Study 2

The first goal of Study 2 is to replicate the Study 1 findings in a new and larger sample of Israeli adolescents. The second goal is to broaden the scope of Facebook activity features that could potentially add to the prediction of psychological distress. As documented in recent research, both general measures of psychological well-being (Burke & Kraut, 2016) as well as

specific ones, such as depression (De Choudhury et al., 2013) have been found to leave digital footprints on a person's social network activity. We therefore complement the top-down search for explicit distress references with a bottom-up search for Facebook activity features that are not rooted in traditional clinical assessment tools and definitions.

Method

Participants and procedure. A few modifications were made to the data collection procedure, which both facilitated the data collection itself and expanded the scope of data collected (e.g., by including 'Likes', 'Groups', and other people's reactions to the user postings). All changes are provided in the supplementary material. A total of 162 adolescents (51.3% girls) participated in Study 2. The collected Facebook data included the 'About' section (i.e., basic personal details and hobbies as well as number of Facebook friends) and the users' 'Timeline' activity. Timelines included Facebook posts, created ('Owner-Created'), or shared ('Owner-Shared') by the user, as well as posts that included a reference to the user ('Others-Tagged') or that were attached to the user 'Timeline' ('Others-Created'). The Facebook data included both quantitative data and qualitative verbal content. A quantification process of the verbal content (Chi, 1997) was applied: First, all the collected data was carefully read several times to identify recurrent themes. Following, a coding scheme was developed, while taking into consideration previous work that yielded non-trivial categories that may serve as non-explicit digital footprints of distress (Ophir, Asterhan, & Schwarz, 2017).

The About section. The content analysis process yielded six distinct content categories: (a) Fun & news, (b) Commercials, (c) Belonging, (d) Values & involvement, (e) Gothic & dark, and (f) Extreme & offensive. The research coders were then instructed to judge which category is best suited to a given item from this section. We calculated the frequencies of each content

category in order to construct the idiosyncratic compound of each one of the collected About sections. For example, the About section of a particular teenager may consist of 70% 'Fun and news' and 30% 'Commercial content'.

Timeline section. The *quantitative* data from the 'Timeline' section included the overall number of posts on a participant's timeline during three months of activity, as well as the proportions of each type of post: 'Owner-Created', 'Owner-Shared', 'Other-Tagged', and 'Other-Created'. Each participant was also given a total score for the number of posts that appear on his/her timeline because of actions undertaken by other people ("Others-Total"), that is: the sum of "Other-Tagged" and "Other-Created". The relative frequency of "Others-Total" out of the overall number of posts on one's timeline reflects the pivot point between the user own postings and the postings published by others. We have also calculated the total number of Likes and Comments a teenager received for his/her own Timeline postings (i.e., 'Owner-Created' or 'Owner-Shared') in the last three months.

In addition to these numerical data, *qualitative* features were also extracted from the Timeline section, by focusing on the content of posts, which were published or shared by the users (Owner-Created and Owner-Shared). Similar to Study 1, posts were first examined for explicit references to personal distress. Nevertheless, even though, self-reported depression rates were approximately the same as in Study 1 (see Results), only four participants in this sample showed explicit references of distress in their Facebook postings (three of whom also received high self-reported depression scores). Based on previous findings on Facebook postings of distress (Ophir et al., 2017), we coded the content along six categories: (a) number of first person *single* pronouns, (b) number of first person *plural* pronouns, (c) number of other people in pictures, (d) valence of content, (e) attitudes towards others, and (f) poetic-concrete content.

Good interrater reliability was achieved in all categories, except for *poetic-concrete content*, which was found more subjective and amorphous. The poetic-dramatic ratings were excluded from further analyses. The complete content analysis procedure is provided in the supplementary material along with detailed descriptions of the scales of measurements and inter-rater reliability statistics for each coding category.

Results

Self-report measures of distress. Corresponding with the findings in Study 1 and the literature on psychological distress, significant correlations were documented between the three self-report measures of distress (Table 1). Similar to Study 1, the average sum score of the BDI was 9.81 ($SD = 8.64$). Thirty-one percent of the participants reported at least mild depression.

Self-reported distress and features of the Facebook About section. Table 2 presents zero order correlations between the different quantitative measures from the Facebook About section and the three measures of distress. The total number of Check-Ins (adolescents sharing their geographic location at a particular moment with Facebook contacts) was found to be negatively correlated with social rejection ($r = -.17, p = .028$) as well as with depression ($r = -.16, p = .047$). The number of Apps a person is subscribed to was negatively correlated with Depression ($r = -.16, p = .047$). However, the overall pattern that emerges from the data shows that most of the quantitative "About" categories and self-reported distress measures are not associated (Table 2).

Table 3 presents the zero-order correlations between self-report distress measures and the six content categories, which were based on classifications of the types of Likes and Groups in the Facebook About section. The data in Table 3 shows that the frequency of 'Gothic and dark' content was positively correlated with social rejection ($r = .29, p < .001$) and with victimization

of bullying ($r = .24, p = .002$). The frequency of 'fun and news' was positively correlated with victimization of bullying ($r = .16, p = .039$).

Self-reported distress and features of the Facebook Timeline. Zero order correlations between self-reported distress and the different types of timeline posts are presented in Table 4. Social rejection was found to be negatively correlated with the pivot point score of Others-Total, $r = -.21, p = .009$, specifically with the proportions of Other-Tagged, $r = -.24, p = .002$.

Table 5 presents correlations between self-reported distress and the sum scores of Likes, Comments and the six content categories. The total number of comments or likes a teenager received for their own posts was not found to be associated with any of the three self-reported levels of distress. Social rejection was negatively associated with Other people in pictures, the number of other individuals that appear in the pictures posted by the teenager him/herself, $r = -.21, p = .012$. Interestingly, social rejection was positively correlated with the combined score of attitudes towards others, $r = .18, p = .019$.

Similar trends were observed in victimization of bullying: Victimization was also negatively associated with Other people in pictures, $r = -.18, p = .033$ and the correlation between victimization and attitudes towards others approached significance, $r = .14, p = .068$.

Victimization of bullying was also positively correlated with the number of first person single pronouns adolescents used in their Facebook postings, $r = .24, p = .008$.

Although the size of the reported significant correlations was small ($.17 \leq r < .29$), taken together, the results suggest that even though explicit teenage references to distress in online Facebook postings is rare, less explicit features of behavior on the adolescent's personal Facebook space can predict social rejection and victimization of bullying (hypotheses #2 and #3). In contrast, self-reported depression demonstrated only two (negative) correlations, namely

with the number of Check in's and Apps. In the next section, we apply discriminant analyses to examine which of the abovementioned Facebook features may distinguish between adolescents who suffer from psychosocial distress from those who do not. In this way we could consolidate, and make sense of, the online clinical picture of psychosocial distress.

Discriminant analysis. A discriminant analysis was performed to examine whether and to what extent Facebook variables can be used to discriminate between adolescents with high levels of social rejection (upper quartile, $SR \geq 8$) and adolescents with low levels of social rejection (lower quartile, $SR \leq 4$). Five Facebook variables, which were significantly correlated with social rejection served as predictors of membership in the one of the two groups of social rejection: (1) Check-ins, (2) posts by others on Timeline (Others-Total), (3) Gothic and dark content themes from the About section, (4) Other people in pictures from the user Timeline postings, and (5) Attitudes towards others in Timeline postings.

The discriminant analysis transformed the original Facebook variables into one new variable (i.e., a canonical variable) that combines the five separate variables, appropriately weighted, into a single index which maximally discriminates between low and high social rejection. The overall test of function was significant, Wilks $\lambda = .79$, $\chi^2 = 19.31$, $df = 5$, Canonical correlation = .46, $p = .002$, with 68.2% correct re-classification of originally grouped cases. These results suggest that the composite of the five Facebook activity features of Posts by others, Check-Ins, Gothic and dark content, Other people in pictures, and Attitudes towards others can significantly discriminate between adolescents with high levels of social rejection and low levels of social rejection.

A second discriminant analysis was performed to examine whether and to what extent Facebook variables can be used to discriminate between adolescents with high levels of

victimization of bullying (upper quartile, Victimization ≥ 10) and adolescents with low levels of social rejection (lower quartile, Victimization ≤ 7). Four Facebook variables significantly correlated with victimization of bullying and served as predictors of membership in one of the two groups of victimization: (1) Fun and news themes from the About section, (2) Gothic and dark content from the About section, (3) First person single usage in Timeline postings, and (4) Other people in pictures from the Timeline section.

The overall test of function was significant, Wilks $\lambda = .84$, $\chi^2 = 10.44$, $df = 4$, Canonical correlation = .40, $p = .034$, with 61.5% correct re-classification of originally grouped cases. These results suggest that the above four Facebook categories may significantly discriminate between adolescents who suffer from victimization of bullying and those who do not.

Discussion

The main goal of Study 2 were to explore the predictive value of both explicit distress references as well as non-explicit, additional Facebook activity features. The results of Study 2 suggest that even though explicit distress references are rare in teenage online Facebook postings, some forms of distress (i.e., social rejection and victimization) leave less explicit, yet discernable digital footprints on adolescents' Facebook activities (hypotheses #2 and #3).

Discriminant analyses suggested composites of Facebook features that can serve as indicators for the existence of social rejection and victimization of bullying: On the one hand, the online clinical picture of social rejection seems to reflect 'real' social difficulties (i.e., low frequency of Others-Total, low number of Other people in pictures, and low number of Check-ins). On the other hand, adolescent that are socially rejected publish more postings of their own (i.e., more Owner-created and Owner-shared posts, the complementary side of 'Others-Total') and their communication behavior expresses positive attitudes towards others. Finally, socially rejected

adolescents endorse distinct online preferences and participate in marginal Facebook groups and pages with Gothic and dark content.

Similar to social rejection, the online picture of adolescents who are victims of bullying may reflect the 'offline' social status of the user (i.e., low number of Other people in pictures) and may be detected through their interest in Gothic and dark content. Moreover, adolescent who experience acts of bullying were found to be more active on Facebook (i.e., high number of 'Your posts' and high frequency of the primary content category 'Fun and news'). Finally, they tend to publish posts in which they refer to themselves (First person single pronouns) more often. Further theoretical implications and limitations are discussed in the general discussion section.

General discussion

The current research investigated whether and how data logged and stored on online social network sites can be used as a tool to detect adolescents' psychological distress. We conducted two consecutive studies to address three research hypotheses according to which: (1) online explicit references to distress is predictive of adolescents' depression; (2) personal distress might appear indirectly, in other, non-explicit, online behaviors; and (3) psychosocial distress can be detected from Facebook activities. Whereas Study 1 focused on explicit references to distress, in Study 2 we searched for less explicit signs of distress as well. In both studies, features of adolescents' Facebook activity was compared with their self-reported answers to well-established measures of depression and of psychosocial distress (i.e., social rejection and victimization of bullying). An integration and discussion of the main findings from both studies is presented below, separately for depression and for psychosocial distress.

Depression. A small number of postings in Study 1 contained explicit references to personal distress and mainly to depressive symptoms. These explicit postings were published by 12% of

the sample. The results of Study 1 confirmed hypothesis #1 and indicated that explicit references to distress do *predict* higher levels of depression among adolescents. Specifically, seven out of the ten (70%) participants who published posts with explicit references to depressive symptoms experienced at least mild depression. Study 2 documented only four participants who published explicit references to distress, three of whom indeed received high depression scores. Based on these combined findings, we conclude that explicit postings of referring to depression are rare, but when they do appear on adolescents' Facebook accounts, they are very informative and substantively increase the chances that the adolescent is indeed experiencing depression. This finding extends previous research that examined the validity of explicit references to depression in adult samples (Holleran, 2010; Moreno et al., 2012) to the adolescent population .

However, our results also qualify previous research by warning against over-reliance on explicit references to depression. Over-reliance on explicit references may result in false negative errors in identification (type II error), whereby the test (i.e., online explicit references to depression) fails to detect an existing effect (i.e., depressive symptoms). In both studies, the majority of depressed adolescents did not publish explicit references to any type of personal distress. In the absence of explicit references to depression, adolescent depression may be not so easy to detect via online activities. The analyses presented in Study 2 failed to find any additional differences in Facebook activity behaviors that could distinguish between depressive and non-depressive adolescents. It is possible that our failure to detect Facebook features that associate with depression is a result of the relatively small sample of adolescents who were depressed at the time of the study. Moreover, it appears that adolescents publish significantly less (verbal) content than adults' users of SNS. The overall number of postings of adolescents in three months documented in Study 2 was 11, of which only four posts approximately (39%) contained

truly personal content ('Owner created'). In comparison, previous research on adult Twitter users documented close to 1,133 Twitter posts in a three months period on average (De Choudhury et al., 2013). More research is needed, preferably with larger samples, data sets that include more SNS activity features and computerized language processing techniques to extract significant online (non-direct) signs for depression from a larger set of potential Facebook features. Longitudinal research is also recommended to trace changes in online Facebook activity, which can be considered a leisure activity, to detect decrease in pleasure or interest over time.

Psychosocial distress. In contrast to depression, social rejection and victimization of bullying were not significantly associated with explicit references to any type of distress. Interestingly however, the findings presented in Study 2 revealed a number of less explicit Facebook activity features that predicted social rejection and victimization of bullying. Study 2, which included a larger sample and a richer data set, lend initial support to hypothesis #2 and #3 by demonstrating how experiences of social rejection and victimization of bullying may be expressed in subtler and indirect Facebook behaviors of adolescents. Discriminant analyses suggested several Facebook features that can serve as indicators for the existence of social rejection or victimization of bullying.

Our findings contribute to the growing body of research that aims to predict mental health states from social media. Existing research in this now field, has predominantly focused on more defined DSM-based constructs of mental disorders, such as depression (De Choudhury et al., 2013) or post-traumatic stress disorder (e.g., Reece et al., 2016). To the best of our knowledge, the current research is the first to show that sub-clinical negative psychosocial distress (i.e., social rejection and victimization of bullying) can be detected through (non-explicit) features of SNS behaviors. These digital footprints of psychosocial distress are especially valuable

considering the low frequency of explicit references to any type of distress, which was documented in both studies and the importance of social relationships in adolescence.

From a more theoretical point of view, the findings from Study 2 may also advance the dialogue between two competing theories on the link between internet usage and social status and skills (Kraut et al., 2002): The *rich-get-richer* model posits that extroverted, socially adept individuals are more likely to benefit from online communication, than introverts. They form valuable online relationships and their "real-life" social skills are replicated online (Kraut et al., 2002). The *social compensation* model argues to the contrary that introverted people with less social skills benefit more from Internet communication because they are now granted with an exceptional opportunity to engage in social interactions in less threatening environments (Sivashanker, 2013). The emergence of the internet also allowed introverts to reveal hidden facets of their "true self" (Amichai-Hamburger, Wainapel, & Fox, 2002; Bargh, McKenna, & Fitzsimons, 2002; McKenna, Green, & Gleason, 2002), their inner feelings, hidden fantasies, and "real" identity (Winnicott, 1960). This theoretical dispute continues to this day and the available empirical research does not provide conclusive evidence to either hypothesis (Baker & Oswald, 2010; Lee, 2009).

Our findings contribute to this theoretical discussion and suggest that the relationships between social status and Internet usage are more complex than can be explained simply by either hypothesis. We did not find a simple relationship between social status and *overall* number of Facebook postings (as would be predicted by both theoretical hypotheses). The relationships that were found addressed different types of online postings (i.e., 'Your posts' versus 'Others-Total'), thus corroborating with both theoretical hypotheses and perhaps offering a theoretical solution for this dispute. Even if adolescents who experience social rejection are more likely to

actively use social media as a less threatening social substitute (*social compensation hypothesis*), as documented in their tendency to publish more postings of their own, and even if they are using internet communication as an opportunity to reveal hidden facets of their "true self" (Amichai-Hamburger et al., 2002) by joining marginal online groups with gothic and dark content, their efforts of communication do not always bear fruits. Despite their wishes to use social media as a means to develop social relations (as documented in the higher scores of Positive attitudes towards others), their social difficulties continue and extend into their online relationships, as predicted by the *rich-get-richer hypothesis*, and they do not manage to attract the social support they may have hoped for. They receive fewer tags and fewer postings by others, their pictures include fewer friends, and they hesitate to announce their physical presence using the Check-in option.

This integrative perception of these two allegedly competing hypotheses is repeated in victimization of bullying. Victimization showed a similar pattern to social rejection with fewer friends in pictures and more 'likes' of gothic and dark content. Additionally, victims of bullying may prefer the SNS sphere, which only includes those individuals that they have allowed in. This is reflected in their excessive usage of Facebook activities (high number of 'Owner-created' and 'Owner-shared' postings as well as their high frequency of Likes and Group in the primary content category of 'Fun and news'). It is also possible that they feel more comfortable to discuss their own affairs online as is manifested in their increased usage of First person single pronouns. In this way, the current research suggests that the two theoretical hypotheses do not necessarily exclude each other. Adolescents who struggle with social situations may indeed try to compensate for their underdeveloped social skills with increased usage of SNS, yet at the same time their efforts may not yield the social benefits they expected.

Limitations and future research

In addition to the above-mentioned contributions of the present work, we would also like to point out several limitations that have to be taken into account and should direct future research efforts. First, the reliance on self-report surveys rather than on clinical interviews to assess psychological and psychosocial distress, though validated and well-established, limits our ability to establish the participants' full mental health status. We made significant efforts to identify uncompleted questionnaires or negligent respondents, but it is possible that some adolescents were not devoted to the research and chose to be less straightforward.

Second, even though the present methodology allows for the establishment of predictions and associations between variables, it does not allow us to determine the direction of the relationships between them. It is commonly assumed that personal distress is manifested or implicitly reflected in social media usages, but the present results cannot rule out the opposite, namely that social media usages create or contribute to personal feelings of distress (e.g., that posting excessively or engaging in Dark and Gothic online content leads to social rejection or victimization in the real world). Third, some of the coding categories of the verbal content relied on high-inference, human coding. Though good inter-rater reliabilities were documented in most categories included in the final analyses, the coding process is very time-consuming and can address small samples only. Future studies may leverage automated, unsupervised data mining and natural language processing methods to examine larger data sets and to include a larger set of Facebook features as potential predictors of psychological distress.

In conclusion

The take-home message of the research presented here can be concluded as follows: (a) adolescent postings of explicit distress in Facebook are rare; (b) when they do appear, they

usually include references to depressive symptoms and they are indeed predictive of depression among adolescents; and (c) psychosocial distress (i.e., negative interpersonal experiences of social rejection and victimization of bullying) leaves less explicit, digital footprints that can be discerned and detected. We contend that these results should be seen as first illustrations for the new opportunities generated with the rise of social media. Further research is required, preferably in larger samples and with automated language processing tools to prove the proposed direction of the research and reveal a more comprehensive picture of how distress is expressed in online behavior. Scholars that have already used such computerized tools to predict personal features such as age, gender, or introversion (Schwartz et al., 2013) are predicting that early screening of mental health conditions from social media activity logs is right around the corner (Csepeli & Nagyfi, 2017; Park et al., 2014). The findings presented here show this seems a viable and realistic expectation, and the next step in this line of research.

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Table 1
Descriptive statistics and zero order correlations of the self-report measures

	<i>M (SD)</i>	Pearson correlation with	
		Social rejection	Victimization of bullying
Study 1 (<i>N</i> = 86)			
Social Rejection	1.75 (.78)		
Victimization of bullying	1.51 (.54)	.52**	
Depression (BDI)	.55 (.48)	.54**	.40**
Study 2 (<i>N</i> = 162)			
Social Rejection	1.59 (.66)		
Victimization of bullying	1.56 (.60)	.51**	
Depression (BDI)	.52 (.45)	.54**	.48**

Note: ** = Correlation is significant at the 0.01 level (2-tailed). * = Correlation is significant at the 0.05 level (2-tailed).

Table 2
*Descriptive statistics of the 'About' section quantitative features and their correlations with Self-reported distress (*N* = 162)*

	<i>M (SD)</i>	Pearson correlation with		
		Social rejection	Victimization of bullying	Depression
Friends	534.26 (536.91)	.05	.13	.14
Check- In's	14.09 (16.44)	-.17*	-.13	-.16*
Sports	9.93 (25.29)	-.15~	.02	-.08
Music	35.44 (93.92)	-.03	-.01	-.06
Movies	12.75 (26.30)	.08	.03	.01
TV	18.42 (26.38)	-.01	.07	-.08
Books	2.52 (7.18)	.11	.12	.05
Apps	3.47 (6.78)	.04	-.03	-.16*
Likes	384.89 (558.18)	-.07	.05	-.05
Groups	8.08 (29.21)	-.01	-.05	-.09

Note: ** = Correlation is significant at the 0.01 level. * = Correlation is significant at the 0.05 level. ~ = Correlation approached significance ($p = .06$).

Table 3

Descriptive statistics of the 'About' section Content categories and their correlations with Self-reported distress (N = 162)

	M (SD) in %	Pearson correlation with		
		Social Rejection	Victimization of Bullying	Depression
Fun & news	65 (16.67)	.11	.16*	.08
Commercials	18.92 (13.38)	-.10	-.14	-.03
Belonging	7.57 (7.77)	-.08	-.11	-.08
Values & social engagement	7.06 (7.42)	-.09	-.08	-.09
Gothic & dark	0.70 (2.48)	.29***	.24**	.11
Extreme & offensive	0.74 (1.64)	.01	.02	.03

Note: Correlations are significant at a two-tailed p-level of * > .05, ** > .01 level or *** > .001.

Table 4

Descriptive statistics of the 'Timeline' Types of posts and correlations with Self-reported distress (N = 162)

	M (SD)	Person correlation with		
		Social Rejection	Victimization of Bullying	Depression
Overall Postings	10.62 (15.94)	.17*	.11	.04
Owner-Created	38.80% (28.04)	.10	.00	.05
Owner-Shared	16.84% (25.67)	.13	.09	.01
Others-Tagged	28.41% (26.60)	-.24**	-.12	-.05
Others-Created	12.19% (19.88)	.01	.06	-.06
Others-Total: Tagged & Created	40.61% (30.01)	-.21**	-.07	-.08

Note: * = Correlation is significant at the 0.05 level. ** = Correlation is significant at the 0.01 level. Overall Postings = The overall number of posts, including all types of posts. Owner-Created = posts, which were created and published by the participant her/himself. Owner-Shared = posts (usually, created by others), which were shared by the participant her/himself. Others-Tagged = posts (usually, created by others), in which other people "tagged" (attached) the participant name. Others-Created = post, which were attached by other people to the participant timeline.

Table 5

Descriptive statistics of the 'Timeline' posting characteristics and their correlations with self-reported distress (N = 162)

	Range	M (SD)	Pearson correlation with		
			Social rejection	Victimization of Bullying	Depression
Likes on posts	Sum	212.40 (503.64)	.08	.10	.14
Comments on posts	Sum	26.89 (60.94)	.01	.00	.09
First person single	Sum	6.24 (13.86)	.11	.24**	.08
First person plural	Sum	1.49 (5.44)	.07	.06	.06
Other people in pictures	Sum (1-4)	17.85 (22.55)	-.21*	-.18*	-.04
Valence of content	Sum (Positive – Negative)	2.44 (4.05)	.13	.12	.05
Attitudes towards others	Sum (Positive – Negative)	1.06 (2.27)	.18*	.14	.12

Note: * = Correlation is significant at the 0.05 level. ** = Correlation is significant at the 0.01 level. The Correlation with 'Other

people in pictures' was calculated on 131 participants who had at least one picture of themselves in their timeline. Sum (Positive – Negative) = a total, combined score, which subtracted the number of negative (valance/attitudes) posts from the number of positive (valance/attitudes) posts.

Pre-proof version