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# Reciprocal Relationships between Adolescents' Incidental Exposure to Climate-related Social Media Content and Online Climate Change Engagement


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Abstract: This study examined whether incidental exposure to climate content on social media can foster online climate change engagement among mid-to-late adolescents, using two-wave panel data (Nw1 & w2 = 574) gathered among Flemish adolescents (14-19). Structural equation analyses indicated that online climate change engagement positively predicted incidental exposure four months later, but not vice versa. Incidental exposure did not significantly relate to online engagement four months later, irrespective of level of climate interest. However, we observed an antecedent role for climate interest; Higher climate interest was reflected in more online climate change engagement. Moreover, climate interest translated into higher levels of incidental exposure and online engagement among adolescents reporting high levels of injunctive peer norms. These findings suggest that social media are reinforcing rather than equalizing gaps in online climate change engagement and demonstrate how dispositional and social factors interact in shaping adolescents' incidental social media exposure and online engagement.

Abstract

This study examined whether incidental exposure to climate content on social media can foster online climate change engagement among mid-to-late adolescents, using two-wave panel data ($N_{\text{w1 \& w2}}$ = 574) gathered among Flemish adolescents (14-19). Structural equation analyses indicated that online climate change engagement positively predicted incidental exposure four months later, but not vice versa. Incidental exposure did not significantly relate to online engagement four months later, irrespective of level of climate interest. However, we observed an antecedent role for climate interest; Higher climate interest was reflected in more online climate change engagement. Moreover, climate interest translated into higher levels of incidental exposure and online engagement among adolescents reporting high levels of injunctive peer norms. These findings suggest that social media are reinforcing rather than equalizing gaps in online climate change engagement and demonstrate how dispositional and social factors interact in shaping adolescents' incidental social media exposure and online engagement.


*Keywords*: Social media, incidental exposure, online climate change engagement, attention, climate-related interest, adolescents, longitudinal structural equation modeling

**Reciprocal Relationships between Adolescents' Incidental Exposure to Climate-related Social Media Content and Online Climate Change Engagement**

Social media platforms make it easy for users to select attitude/interest-congruent content and avoid or attentionally ignore counter-attitudinal information. Selecting content that aligns with pre-existing beliefs has been theorized to result in a mutually reinforcing spiral; selective media use is guided by pre-existing beliefs and interests, which in turn reciprocally influence the further selection of like-minded media content over time, creating a reinforcing spiral (Slater, 2007). Selective exposure and the resulting attitude reinforcement may give rise to issues such as social polarization, political fragmentation, and a "rich-get-richer" dynamic in audience formation. However, it has also been argued that social media may increase the possibility of incidental exposure to information. Such incidental exposure has the potential to decrease existing knowledge and participation gaps, as people may acquire new knowledge when being incidentally exposed to information and can be moved to action (e.g., political participation). Thus, while some argue that social media may sustain and even reinforce existing involvement gaps, others stress that social media may increase the chance that people become incidentally exposed to information and that incidental exposure may decrease knowledge and engagement gaps. This debate on the equalizing versus polarizing role of social media has resulted in two opposing theories (Barnidge, 2021). Theory on incidental exposure (e.g., Fletcher & Nielsen, 2018) suggests that instances of incidental exposure on social media will lead to online engagement, particularly among the least interested individuals. In contrast, theory about news algorithms (e.g., Thorson et al., 2021) suggests the reverse temporal ordering and an antecedent role for topic-specific interest; Interest in a particular topic enhances topic-related engagement, which in turn increases the chance of being incidentally exposed to related information. Expanding on this theoretical frame, the current study sought to examine the bidirectional longitudinal relationship between incidental exposure to climate-related content on social media and online climate change engagement (i.e., posting, sharing, liking, commenting on, and discussing climate-related social media content) among adolescents aged 14 to 18. In line with theory about news algorithms, we hypothesized that having high biospheric values (a well-validated proxy for interest in and concern about climate-related matters) positively relates to online climate-related engagement, which in turn positively relates to climate-related incidental exposure on social media. Drawing on theory of incidental exposure, we hypothesized that incidental exposure to climate-related content on social media positively relates to online climate-related engagement and that this relationship will be the strongest among adolescents with low biospheric values. In addition, recent extensions of theory of incidental exposure (e.g., PINE model, Matthes et al., 2020) emphasize that it is not first-level incidental exposure (i.e., scanning of incidentally encountered information on social media) but rather second-level incidental exposure (i.e., effortful processing of incidentally encountered information) that has the potential to cause individual change. In line with this, we expect a mediating role for attention (i.e., paying further attention to the climate-related information you accidentally came across) in the relationship between incidental exposure to climate-related content and adolescents' online climate-related engagement.

**Climate Change and Social Media**

Average global temperatures are rising with the world experiencing record hot temperatures and related extreme weather events in the last decade. All of these climate changes –caused by global warming –happen because people continue adding greenhouse gases to the atmosphere. Hence, there is an urgent need to call for action on global warming and search for ways to mobilize people to engage in climate-protective activities. Although each generation carries the responsibility to combat climate change and perform and promote sustainable behavior, especially younger people should be involved in creating a sustainable planet as they "are best-placed to define the long-term societal response to climate change" (Corner et al., 2015, p. 523). In this context, social media may be an ideal tool to raise awareness and facilitate engagement in addressing climate-related issues (e.g., Mavrodieva, Rachman, Harahap, & Shaw, 2019). Social media provide an opportunity to keep up with the news and discuss and share opinions on topical issues in an informal and low-cost way. With respect to climate-related information, studies have shown the dominance of social media as an important information source among youth (e.g., Corner et al., 2015; Wu & Otsuka, 2021), with adolescents using social media to seek and share information on environmental problems and encourage action on climate (e.g., Youth for Climate or Instagram hashtag #Savetheplanet, Biswas, 2021). Importantly, the extent to which climate-related information on social media can reach a wide network of adolescents depends in part on adolescent users' engagement in the message diffusion process (Dunn et al., 2018). Social media-enabled practices such as sharing, commenting on, liking, and creating content, enable adolescents to discuss and transmit social media content among online peer networks, increasing the reach and potential impact of social media. Besides message retransmission, adolescents' public engagement with social media content may also influence the behavior of others in their social network via processes of social norm expression and reinforcement (reception effects, e.g., Borg, Lindsay, & Curtis, 2020), as well as their own behavior (self-effects, e.g., Nabi et al., 2019). Given the potential positive outcomes related to online engagement, it is important to examine whether exposure to climate-related content on social media can facilitate adolescents' online engagement in climate-related issues (Wang et al., 2018).

To date, very few studies have examined the role of social media in users' online climate change engagement, with virtually none addressing this association among adolescents. One recent study examined how Twitter users engaged with climate-related information online (Pearce et al., 2014). The results showed that when exposed to climate-related information, Twitter users tend to engage with content supportive of their existing beliefs on climate change (e.g., initiating conversations with and commenting on like-minded users). Similarly, a social network analysis of social media users' climate change communication (Williams et al., 2015) showed that most users engage in discussions with like-minded users, leading to "self-reinforcing echo chambers". Existing research thus suggests a rather polarizing role of social media in online climate change engagement. However, it should be noted that these studies exclusively focused on users' purposeful exposure to climate content, overlooking the potential influence of incidentally encountered information on online climate change engagement. Although people may have a tendency to seek out and engage with attitude and interest-congruent content, it may be that incidental exposure to content on social media can motivate initially disinterested users to engage with that content as well, thus equalizing participatory gaps (e.g., Valeriani & Vaccari, 2016).

**Incidental Exposure and Online Climate Change Engagement**

The abundance of (shared) news and user-generated content on social media makes it increasingly likely that individuals incidentally encounter information without actively searching for it, as a byproduct of other social media activities serving different purposes. This incidental exposure can create opportunities for initially disinterested audiences to encounter and engage with news, potentially diminishing existing knowledge and engagement gaps (i.e., incidental social media exposure as online participation equalizer, Fletcher and Nielsen, 2018). However, evidence on the equalizing effect of incidental media exposure is mixed. While some research suggests that incidental exposure to information on social media can mobilize online engagement particularly among audiences with low levels of interest (e.g., Valeriani & Vaccari, 2016), other research suggests that those already interested and engaged in a particular topic are more likely to incidentally encounter topic-related news via social media (e.g., Kümpel, 2020). The debate on the equalizing versus reinforcing role of social media has resulted in two opposing theories. Theory of incidental media exposure argues that social media exposure is not only shaped by deliberate actions resulting from individual interests and/or beliefs (cfr. selective exposure), but also by accidental encounters with news and messages shared by network acquaintances. Thus, although one may not be interested in a particular topic and therefore not deliberately seek out and select content on that topic, one can come across topic-related content incidentally as a by-product of other social media actions (i.e., micro level incidental exposure; Mitchelstein et al., 2020), or via messages shared by other members of one's online social network (i.e., meso level; Mitchelstein et al., 2020). Theory of incidental media exposure further posits that such incidental exposure may induce online engagement, especially among disinterested users as they would normally not engage with information outside their interest scope.

To our knowledge, no research on incidental social media exposure and online climate change engagement exists. Most studies examining associations between incidental exposure and online engagement have focused on political engagement. Part of this research supports the idea of incidental social media exposure as online participation equalizer. For instance, Valeriani and Vaccari (2016) found that incidental exposure to political information on social media was positively associated with online political engagement and that this association was significantly stronger among individuals with low levels of political interest. Relatedly, another study found that incidental exposure to political news produced the largest knowledge gains among the least politically interested individuals, confirming that incidental news exposure can minimize existing knowledge gaps (Weeks, Lane, & Hahn, 2021). Drawing on this evidence, and in line with theory of incidental media exposure, we hypothesize (H1) that incidental exposure to climate-related content on social media positively relates to online climate-related engagement and that this relationship will be the strongest among adolescents with low biospheric values.

Other work, however, has found incidental exposure to widen existing gaps in knowledge and participation, lending support for the reinforcement hypothesis that the beneficial effects of incidental exposure to news on social media are most pronounced among politically interested and involved users (e.g., Heiss & Matthes, 2019). For instance, Barnidge (2021) found that the role of political interest in the association between incidental exposure and engagement is twofold. Political interest positively moderates the relationship between incidental exposure and online political engagement, and it also plays an antecedent role in that politically interested people are more likely to incidentally encounter political news due to higher levels of online political engagement. Likewise, other research (Lee & Xenos, 2020) suggests that incidental exposure is not completely incidental as much of social media users' online encountered political news is caused by prior off- and online political participation, conforming the idea of algorithm curation as amplifier of information homogeneity and online polarization (Thorson & Wells, 2016). Hence, in line with theory about news algorithms, we hypothesize (H2) that bio-spheric values (proxy for interest in and concern about climate-related matters) positively relate to incidental exposure to climate-related content on social media via increased levels of online climate change engagement.

It is important to note that mechanisms of mobilization (climate interest as a moderator of the association between incidental exposure and online engagement) and reinforcement (climate interest as trigger of online engagement and subsequent incidental exposure) are not mutually exclusive. To date only one study has examined reciprocal relationships between incidental exposure and online engagement (Lee & Xenos, 2020). The results indicated that the relationship between incidental exposure to political news on social media and online political engagement (e.g., liking/promoting political posts of other users, reposting political content, posting of own political thoughts) was reciprocal. In the current study we therefore examine the bidirectional relationships between incidental exposure to climate-related content on social media and online climate engagement.

**Second-Level Incidental Exposure: Mediating Role of Attention**

Existing research has produced inconsistent findings on the relationship between incidental exposure to social media news and online news engagement. In some cases incidental exposure results in online engagement, whereas in other cases incidental exposure does not lead to further engagement with the accidentally encountered content. This inconsistency may be attributed to the fact that some users pay further attention to the encountered content while others attentionally ignore the observed content. In line with this, recent studies suggest that online news engagement requires conscious attention (Matthes et al., 2020; Weeks & Lane, 2020). Thus, one can stumble upon information on social media without actively seeking for it or paying conscious attention; However, whether or not engagement (e.g., comment on a post, engage in discussions) takes place depends on the level of attention dedicated to the encountered information. For instance, it is rather difficult to comment on and discuss an online article without having read the article. Vice versa, we expect online engagement to positively relate to the level of attention devoted to particular information online. Individuals' –and especially adolescents' –social media use is often motivated by a need for peer validation, idealized self-presentation, and value sharing (promoting the things that one cares about) (Rodgers et al., 2020). Thus, when adolescents engage with content it seems plausible that they subsequently pay attention to related content to check for reactions and comments and feedback on their online identity performances. We therefore expect a reciprocal indirect relationship between incidental exposure to climate content on social media and online climate change engagement via level of attention (H3).

**Social Curation: Moderating Role of Peer Norms**

Lastly, due to the increased need to form close peer relationships during mid- to late adolescence, we expect peer norms to play an influential role in adolescents' online incidental exposure and engagement for two reasons. First, adolescents are more likely to form close ties with other peers who resemble them behaviorally and attitudinally (cf. friendship homophily, Hafen et al., 2011). In addition, research has shown that social media enable the formation of online identity bubbles "that reinforce shared identities, social homophily, and reliance on the information shared within the bubbles" (Kaakinen, 2020, p. 1). Thus, if one is interested in climate-related matters, it is likely that one's online peers are also interested to a certain degree in climate change. If so, adolescents interested in climate issues are more likely to come across climate-related content via messages shared by peers in their online social network (i.e., meso level; Mitchelstein et al., 2020). Therefore, we hypothesize (H4) that positive injunctive peers norms (i.e., adolescents' subjective beliefs about their peers' approval of climate change action) will positively moderate the relationship between interest in climate change and incidental exposure.

Second, as mentioned above, adolescents' social media use is often motivated by a need for peer validation and popularity. Social media affordances allow such reinforcement by peers via likes and comments, enabling adolescents to garner positive peer feedback. As a consequence, adolescents' online engagement is often driven by anticipated rewards, that is, adolescents post and share certain content online because they expect this content to elicit positive feedback from peers (e.g., Rousseau, 2021). Thus, if adolescents believe that their peers care about the environment and approve of climate change actions, they will expect peers to positively react to their posted/shared content. We therefore hypothesize (H5) that incidental exposure to climate content on social media will result in higher levels of online climate change engagement among adolescents who believe that their peers approve of climate change actions (high injunctive peer norms).

# METHOD

## Sample

Data were collected from a two-wave panel study conducted in Belgium. The first data collection (wave 1) took place in October 2019 and the second data collection (wave 2) took place in February 2020. Ethical approval for the study was obtained from the ethical committee of the host university. An online questionnaire was developed and distributed via the online survey software program Qualtrics. Prior to the data collection, Flemish secondary schools were randomly selected using a list of the Department of Education. Each selected school was sent an email including information about the study project and an invitation to participate in the study. After sending out the study invitation by mail, schools who expressed interest as well as schools that did not react were contacted by phone by the main researcher. More detailed information about the aim, content, and duration of the study was given. In total, 10 schools agreed to participate in the research project. All of the initially participating schools participated again in the second wave. Pupils and their parent(s) were given written informed consent forms in which the aim, duration, and procedure of the study was described and the voluntary and anonymous nature of participation was highlighted. Only participants who returned two signed consent forms –one of themselves and one of their parent(s) –were allowed to participate in the study and fill out the questionnaire. Participating schools were visited during school hours by the main researcher and two research assistants. During the researchers' visit, participants completed the online survey in a school classroom or computer laboratory on a laptop or tablet. Individual participants were not offered compensation, but, at school level, a workshop concerning social media use was offered for each participating class.

In total, 1248 adolescents completed the survey at baseline (wave 1) and 812 participants completed the survey at both data collections (response rate = 65%). From this sample 173 participants were excluded for failing the attention check questions, 45 because they completed less than 70% of the survey items, and another 20 because they reported not having an account on at least one of the following social media: Snapchat, Facebook, Instagram. The final analytical sample consisted of 574 participants (70% girls) aged 13 to 19 years ($M$ = 15.39, $SD$ = 1.34). Regarding the participants' nationality and parental education, the majority were born in Belgium (92.9%) and 4 in 10 participants had a mother (28.5%) or a father (27.1%) with a university degree.

A MANCOVA (controlling for age, gender, and BMI) using Pillai's Trace, $V = .004$, $F(5, 871) = .680$, $p = .639$, $\eta p^2 = .004$, showed no significant differences between those who participated only in the first wave and those who participated in both waves.

**Measures**

**First-level incidental exposure to climate-related content on social media.** To measure how often participants encounter or come across climate-related information on social media, they were asked the following question: "How often do you *come across* climate related information on [Facebook, Instagram, Snapchat]?" The question wording was identical to that used by recent research on incidental exposure (e.g., Barnidge, 2021; Broussard, Heath, & Barnidge, 2021). For each social media platform, answers were scored on a 5-point Likert scale ranging from 1 ([almost] Never) to 5 ([almost] Every day). Item scores were averaged to create an estimate of participants' first-level incidental exposure to climate-related content on social media.

**Second-level incidental exposure to climate-related content on social media**. Following Matthes et al (2020), we captured second-level incidental exposure by incorporating survey questions that tap the degree of attention and further engagement with incidentally encountered content. To measure whether participants further processed the incidentally encountered climate-related content on social media, they were asked the following question: "If you come across climate-related information on [Facebook, Instagram, Snapchat], to what extent do you pay attention to this content (e.g., click or scroll to read the full article)". For each social media platform, answers were scored on a 5-point Likert scale ranging from 1 (Very little attention) to 5 (A lot of attention). Item scores were averaged to create an estimate of participants' second-level incidental exposure, with higher scores indicating that participants tend to further process incidentally encountered climate-relate information on social media.

**Online climate change engagement**. In line with prior research (e.g., Heiss, Knoll, & Matthes, 2020), online climate change engagement was measured by asking participants how often they engaged with *positive* climate-related information on social media. More specifically, participants were asked to report the frequency with which they engaged in the following online activities; (1) post a climate-related message on social media, (2) share a climate-related message on social media, (3) like a climate-related message on social media, (4) positively comment on a climate-related message on social media, (5) engage in online discussions about topics related to climate change and global warming, and (6) engage in online discussions about climate-related messages on social media (e.g., talk online with friends about a news article on climate change). For each online activity, answers were scored on a 6-point Likert scale ranging from 1 ([almost] Never) to 6 ([almost] Every day). Item scores were averaged to create an estimate of participants' level of online climate change engagement. The scale showed good internal consistency ($\alpha_{w1}$ = .84, $\alpha_{w2}$ = .82).

**Biospheric values**. Biospheric values "reflect a concern with the quality of nature and the environment for its own sake, without a clear link to the welfare of other human beings" (Steg et al., 2014, p. 166) and operate as a strong predictor of climate concern, pro-environmental beliefs and attitudes, and engagement in climate actions (e.g., Bouman et al., 2020). In this study, we used biospheric values as a proxy for participants' interest and concern about climate change. Participants' biospheric value orientation was measured with four items of the biospheric value orientation subscale developed by de Groot and Steg (2008): "I strongly believe that people should care for the environment"; "It is important to me to adapt to and try to fit into nature"; "I believe that it is important to respect nature"; and "I believe that it is important to stop the pollution of our environment." Answers were scored on a 5-point Likert scale ranging from 1 (Does not apply at all to me) to 6 (Completely applies to me). The scale showed good internal consistency ($\alpha_{w1}$ = .82).

**Injunctive peer norms**. Following Ajzen (2006), participants estimated how many of their peers approve taking action for the climate. Using a 7-point Likert scales from 1 (Completely disagree) to 7 (Completely agree) participants were asked to rate how much they agreed with the following statements: "My friends expect me to take action for the climate by engaging in pro-environmental behavior" and "My friends believe it is important that I take action for the climate on a regular base". Both item scores were averaged to create an estimate of participants' subjective norms regarding climate action (Spearman–Brown coefficient $\rho_{w1}$ = .91).

**Control variables.** We controlled for age, gender, socio-economic status (SES), and frequency of social media use. Parents' education level (average of father's and mother's highest completed level of education) served as a proxy for participants' SES. With regard to frequency of social media use, participants evaluated the amount of daily time they spent on Facebook and Instagram using a 5-point Likert-scale ranging from 1 = *less than 10 minutes a day* to *5 = more than two hours a day.*

**Data Analysis**

To test the hypothesized relationships presented in Figures 1-3 we conducted path analysis (AMOS) using maximum likelihood estimation. Three fit indices were used to evaluate model fit: the chi-squared to degrees of freedom ratio ($\chi^2/df$), the root mean square error of approximation (RMSEA), and the comparative fit index (CFI).

To examine the reciprocal relationship between incidental exposure to climate-related content and online climate change engagement, we estimated a cross-lagged model (Figure 1) in which all variables at wave 2 were predicted by their preceding values at wave 1, and by the value of the respective independent variable at wave 1. We controlled for participants' gender, age, SES, average daily time spent on social media, and biospheric values by allowing covariances with each other and the exogenous variables, and by estimating predictive paths from them to all endogenous variables. We estimated covariances between variables measured at the same wave and allowed covariances between the measurement errors of the same indicators.

A similar procedure was applied to test the mediated cross-lagged model (Figure 3), in which the reciprocal relationship between incidental exposure to climate content and online climate change engagement is mediated by attention towards incidentally encountered climate content. To test for significant indirect relationships between incidental exposure, attention and online engagement, we first imputed missing data and then specified user-defined estimands using bootstrapping (Cheung & Lau, 2008).

To test the moderating role of biospheric values, we used the residual-centered two-step strategy for estimating latent interaction effects (Steinmetz, Davidov, & Schmidt, 2011). To test the interaction between incidental media exposure and biospheric values on online climate change engagement, we first multiplied each incidental media exposure indicator with each biospheric value indicator, resulting in 12 product terms. We then regressed each product term on all incidental media exposure and biospheric value indicators and saved the resulting residuals from these regressions. In the second step, the saved residuals were used as indicators of the latent interaction term (incidental media exposure × biospheric values).

The interaction term was then entered as an exogenous latent variable predicting the endogenous latent variable online climate change engagement.

Lastly, to test the moderating role of injunctive peer norms we conducted a multiple group analysis. Visual binning, using equal percentile cut point was applied to allocate respondents into low and high injunctive peer norms groups. Participants with a score on injunctive peer norms $\leq 4$ were assigned to the low perceived appearance-based peer acceptance group, those with scores $> 4.00$ were assigned to the high perceived appearance-based peer acceptance group. Having established metric invariance, we examined differences in CFI between the unconstrained model (model in which structural paths are allowed to vary across groups) and the constrained model (model in which structural paths were fixed to be equal across groups. If $\Delta\chi 2$ was significant ($p < .05$), a path-by-path analysis was performed to examine whether the relationships significantly differed between adolescents with high and low levels of injunctive peer norms.

**Results**

The results revealed that data were missing for 16 respondents (2.79%). For most of those respondents (97.21%) this was a single missing value. All variables revealed < 5% missing data. The value for Little's MCAR test was not significant ($\chi^2 = 73.24$, $df = 65$, $p = .226$), meaning that missing values were missing completely at random. Therefore, we used the unimputed dataset for the cross-lagged and moderation analysis, and only used the imputed dataset for the mediation analysis as bootstrapping (in AMOS) requires complete datasets.

Table 1 presents the descriptive statistics and zero-order correlations between incidental exposure to climate content on social media, online climate change engagement, attention (i.e., second-level incidental exposure), biospheric values, and injunctive peer norms.

[Table 1 about here]

**Hypothesized Models**

A first model tested the reciprocal relationship between incidental media exposure and online climate change engagement. The observed structural model, presented in Figure 1, showed an acceptable fit: $\chi^2(305) = 901.49$, $\chi^2/df = 2.96$, $p < .001$, CFI = .91, RMSEA = .06. Online climate change engagement (wave 1) significantly predicted incidental exposure to climate content on social media (wave 2), $\beta = .14$, $B = .09$, $SE = .04$, $p = .04$. This relationship was not reciprocal however, incidental exposure to climate content on social media (wave 1) was not significantly related to online climate change engagement (wave 2), $\beta = -.04$, $B = -.06$, $SE = .06$, $p = .29$.

A second model tested the double role of biospheric values in the cross-lagged model. More specifically we tested biospheric values' antecedent relationship with online climate change engagement as well as its moderating role in the relationship between incidental media exposure to climate content on social media and online climate change engagement. The observed structural model, presented in Figure 2, showed a good fit: $\chi^2(668) = 1311.11$, $\chi^2/df = 1.96$, $p < .001$, CFI = .94, RMSEA = .04. In line with hypothesis 2, biospheric values (wave 1) significantly predicted online climate change engagement (wave 1), $\beta = .38$, $B = .35$, $SE = .05$, $p < .001$, which, in turn, positively predicted incidental exposure to climate content on social media (wave 2), $\beta = .14$, $B = .09$, $SE = .04$, $p = .04$. No evidence was found for the moderating role of biospheric values, the latent interaction variable (biospheric values * incidental exposure) did not significantly predict online climate change engagement (wave 2), $\beta = -.03$, $B = -.03$, $SE = .03$, $p = .25$. We could not confirm hypothesis 1 that incidental exposure to climate-related content on social media positively relates to online climate-related engagement and that this relationship will be the strongest among adolescents with low biospheric values.

A third model estimated the mediating role of second-level incidental exposure (i.e., giving further attention to incidentally encountered climate content) in the reciprocal relationship between incidental exposure to climate content and online climate change engagement. The observed structural model, presented in Figure 3, showed an acceptable fit: $\chi^2(454) = 1359.11$, $\chi^2/df = 2.99$, $p < .001$, CFI = .90, RMSEA = .06. Both incidental exposure (wave 1), $\beta = .40$, $B = .54$, $SE = .09$, $p < .001$, and online climate change engagement (wave 1), $\beta = .44$, $B = .44$, $SE = .06$, $p < .001$, were positively related to attention (wave 1); however, over time, only online engagement (wave 1), $\beta = .14$, $B = .12$, $SE = .06$, $p = .04$, significantly predicted attention (wave 2). In turn, attention (wave 2) was positively related to incidental exposure (wave 2), $\beta = .59$, $B = .48$, $SE = .07$, $p < .001$, and online engagement (wave 2), $\beta = .22$, $B = .24$, $SE = .05$, $p < .001$. However, this relationship was not found longitudinally: neither incidental exposure (wave 2), $\beta = -.12$, $B = -.09$, $SE = .05$, $p = .09$, nor online engagement (wave 2), $\beta = -.01$, $B = -.01$, $SE = .06$, $p = .87$, were significantly predicted by attention (wave 1). A further mediation analysis showed that the indirect relationship between online engagement (wave 1) and incidental exposure (wave 2) via attention (wave 2) was significant (standardized indirect effect = .05, $SE = .02$, 95% CI [.002, .088]. Hence, we could only partially support the hypothesis (H3) of a reciprocal indirect relationship between incidental exposure to climate-related content on social media and online climate change engagement via level of attention.

Lastly, a final model tested the moderating role of injunctive peer norms in the relationship between a) biospheric values and incidental exposure and b) incidental exposure and online engagement. The moderated model showed a good fit to the data: $\chi^2(1336) = 2744.01$, $\chi^2/df = 2.05$, $p < .001$, CFI = .88, RMSEA = .04. When comparing the unconstrained model with the constrained structural model, results suggested that our hypothesized model significantly differed between adolescents with low and high levels of injunctive peer norms, $\Delta\chi^2(22) = 74.51$, $p < .001$. Path-by-path analyses revealed that the relationship between biospheric values (wave 1) and incidental exposure (wave 1) significantly differed between both groups, $\Delta\chi^2(1) = 8.01$, $p = .005$. Biospheric values was positively related to incidental exposure among adolescents reporting high levels of injunctive peer norms, $\beta = .29$, $B = .34$, $SE = .13$, $p = .012$, but not among adolescents reporting low levels of injunctive peer norms, $\beta = .03$, $B = .02$, $SE = .04$, $p = .654$, supporting hypothesis 4. Contrary to what we expected (H5), injunctive peer norms did not moderate the relationship between incidental exposure (wave 1) to climate content on social media and online climate change engagement (wave 2), $\Delta\chi^2(1) = .79$, $p = .375$. Although not initially hypothesized, we also observed a significant moderating role for injunctive peer norms in the relationship between biospheric values (wave 1) and online climate change engagement (wave 1), $\Delta\chi^2(1) = 11.30$, $p = .001$. Biospheric values was more strongly related to incidental exposure among adolescents reporting high levels of injunctive peer norms, $\beta = .41$, $B = .93$, $SE = .21$, $p < .001$, compared to adolescents reporting low levels of injunctive peer norms, $\beta = .27$, $B = .18$, $SE = .04$, $p < .001$.

## Discussion

Scholarly debate persists as to whether incidental exposure to news on social media has the potential to equalize participatory gaps by motivating initially disinterested users to engage with incidentally encountered news. This study aimed to contribute to this debate by examining whether incidental exposure to climate content on social media reinforces or equalizes existing gaps in online climate change engagement among a mixed gender group of mid-to-late adolescents. The results showed that online climate change engagement positively predicted incidental exposure to climate-related content on social media four months later, but not vice versa; incidental exposure did not significantly predict online engagement. When examining the role of climate-related interest (operationalized as having high biospheric values), we observed an antecedent role for climate-related interest. Higher levels of climate interest were reflected in more online climate change engagement which, in turn, led to increased levels of incidental exposure to climate content four months later. No evidence was found for a moderating role of climate-related interest; Incidental exposure did not significantly relate to online engagement and this relationship did not differ between high- and low-interest adolescents. Taken together, these results suggest that incidental exposure to climate content on social media is reinforcing rather than reducing or equalizing online climate change engagement gaps. Furthermore, taking into account the role of second-level incidental exposure, the results indicated that the relationship between online climate change engagement and incidental exposure was fully mediated by increased levels of attention (i.e., paying closer attention to the initially encountered climate information). Lastly, given the importance and influence of peers in adolescence, we also examined how injunctive peer norms (i.e., the belief that peers attach importance to and approve of climate-related actions) relate to both incidental exposure and online engagement. We observed a significant positive relationship between climate-interest and incidental exposure to climate content on social media in adolescents reporting high, but not low, levels of injunctive peer norms. In the next section, we outline three take-home messages from our findings.

**Incidental Exposure on Social Media Reinforces Online Engagement Gaps**

Contrary to research that suggests an equalizing role for incidental exposure in existing participation gaps, our study could not confirm that adolescents who are less interested in climate-related matters are more likely to engage with incidentally encountered climate information than their more interested peers. Level of interest did not significantly moderate the relationship between incidental exposure to climate content on social media and online climate change engagement. However, we could observe an antecedent role for interest; higher levels of climate-related interest indirectly related to higher levels of incidental exposure to climate content on social media via increased online climate change engagement. Those who are already interested in climate-related matters are more inclined to engage with climate-related content online and therefore more likely to incidentally encounter climate information on social media. Taken together, these results imply that social media reinforce rather than attenuate existing engagement gaps and emphasize the role of algorithms in adolescents' incidental social media exposure. More specifically, the finding that online climate change engagement fully mediated the positive association between climate interest and incidental exposure to climate content highlights the role of algorithmic curation in shaping adolescents' incidental social media exposure. It seems that adolescents' prior online engagement behavior (e.g., liking, commenting on, sharing content) largely guides which content gets displayed in their social media feed, supporting previous research on social media's customization algorithms (DeVito, 2017). Expanding on the current study results and consistent with recent scholarly criticism (e.g., Kümpel, 2020), we cautiously question the accidental nature of *incidental* social media exposure and point to the potential polarizing role of algorithms in creating homogenous information environments and maintaining engagement gaps (e.g., Thorson & Wells, 2016).

**Second-Level Incidental Exposure: Online Engagement Facilitates Attention**

Being incidentally exposed to climate content on social media does not necessarily guarantee that one will engage with the incidentally encountered information. As shown in this study, incidental exposure to climate content on social media did not significantly relate to online climate change engagement four months later. In line with this, Matthes et al (2020) suggested that mere incidental exposure may not be enough to trigger online engagement and equalize existing participatory gaps. Rather, paying closer attention to and intentionally processing incidentally encountered information –i.e., second-level incidental exposure –has the potential to stimulate online engagement. The current study contributes to this literature by showing that online engagement, but not incidental exposure, positively relates to second-level incidental exposure four months later. The observation that online climate change engagement, but not incidental exposure, motivates adolescents to process incidentally encountered climate information in more detail may be attributed to the cognitive process of relevance appraisal (Knoll, Matthes, & Heiss, 2020). Adolescents can stumble upon climate information when using social media, however, whether or not the encountered information may heighten attention depends on the extent to which the information is evaluated as relevant (cfr. motivationally relevant cues, Lang, 2000, 2006). If adolescents engage with climate content on social media by liking, sharing, discussing or commenting on content, this creates the motivation to further scan the social media environment for similar climate-related information as well as feedback on posted/shared content (e.g., Throuvala et al., 2019). In turn, motivationally relevant cues elicit an orienting response and are more deeply processed (Lang, 2000, 2006), thus facilitating second-level incidental exposure. In contrast, even if one lacks interest in climate-related matters (and thus climate-cues are not motivationally relevant), one can still be incidentally exposed to climate-related information. As a consequence, mere incidental exposure is less likely to result in surveillance motivations (i.e., further scanning the environment for topic-relevant information) and may therefore not lead individuals to process incidentally encountered information with high levels of attention and elaboration (Eveland, 2001). Based on our results and previous theoretical and empirical work (Eveland, 2001; Oeldorf-Hirsch, 2018), we conclude that online engagement stimulates attention to and elaborative processing of topic-related social media content, as those who are motivated to engage with and expose themselves to particular social media content are more likely to engage in information-processing strategies about that content.

**Peer and Personal Factors Jointly Shape Incidental Exposure and Online Engagement**

Climate-related interest was positively associated with incidental exposure to climate content on social media among adolescents reporting high injunctive peer norms, but not among those reporting low injunctive peer norms. Thus, among adolescents who believe that their friends attach importance to and approve of climate action, higher interest in climate change translates into more incidental exposure to climate content on social media. Whereas online engagement seems to be mainly driven by personal interest, it appears that incidental exposure is largely shaped by curational forces –in this case, the peer network –outside the adolescent. This finding supports ecological models of incidental exposure (Weeks & Lane, 2020) stating that individual (e.g., interest) and environmental (e.g., peer network) factors interact in shaping the information individuals incidentally encounter on social media. Although not initially hypothesized, the results also showed a significant interaction between climate interest and injunctive peer norms in predicting online climate change engagement. The positive relationship between climate interest and online climate change engagement was almost twice as strong among adolescents reporting high levels of injunctive peer norms compared to those reporting low injunctive peer norms. We suggest that adolescents' intrinsic motivation to engage with climate content will actually result in higher levels of online climate change engagement if they expect their online actions to elicit approval and positive feedback from peers. Contrary to what we expected, injunctive peer norms did not moderate the relationship between incidental exposure and engagement. This may be explained by the fact that one can be exposed to climate content without having any interest in or motivation to interact with this content. Thus, although social curation can enable incidental exposure, it is rather insufficient in stimulating online engagement among the uninterested (e.g., Heiss & Matthes, 2019). An intrinsic motivation (i.e., interest) to engage with the incidentally encountered information is essential for online engagement to take place.

Taken together, the results show how dispositional and social factors interact in shaping adolescents' incidental exposure and online engagement, supporting the usefulness of ecological models when examining these relationships, and emphasize the role of interest as a necessary precondition for online engagement.

**Implications and Future Research**

The current findings have a number of methodological and practice implications. First, the extent to which climate content on social media can reach a wide network of adolescents depends in part on adolescents' engagement in the message diffusion process (e.g., sharing, commenting on, liking, and creating climate-related content). In addition, via their positive engagement with climate-related content, adolescents publically pronounce their opinion to their peer network and cultivate specific norms that influence their own and others' on- and offline behavior. Hence, in order to raise adolescents' climate change awareness and mobilize them for action it is important get them involved in the climate change online discourse (Wang et al., 2018). In this respect, the results showed that mere exposure to climate content does not induce online climate change engagement and pointed to motivation as a key trigger for online engagement. From a practice perspective, it is therefore important to not only create and disseminate climate change information online, but to also make the issue of climate change personally relevant to adolescents. In addition, the current study showed how peer norms and expectations can influence the extent to which adolescents' are being exposed to and engage with social media content. Thus, despite the critical role of individual dispositions (e.g., interest and motivation), educators should also capitalize on the influence of peers to promote and communicate positive norms regarding climate change and trigger climate change engagement among adolescents. In line with this, Stevenson et al (2019) argue that "teaching climate literacy topics through group discussions or projects or providing informal learning activities that allow for peer interaction may build individual concern for climate change as well as form group attitudinal norms through peer interactions" (p. 840).

Second, the finding that online engagement, but not incidental exposure, was positively related to attention over time suggests that second-level incidental exposure (i.e., paying further attention to the incidentally encountered information) is to a large extent driven by motivational relevance. Thus, from a methodological perspective, we would recommend future research to continue including measurements of attention and motivational relevance when examining relations between incidental exposure and online engagement (Matthes et al., 2020). Moreover, we also encourage scholars to differentiate between first and second-level incidental exposure and examine the conditions –both situational and dispositional –under which incidental exposure may give rise to second-level incidental exposure.

**Limitations**

Although the longitudinal design is a strength of the current study, it was limited by the fact that the indirect relationships between incidental exposure and online engagement were tested with data gathered at two time points. We recommend future studies to replicate our findings with data gathered at three time points. Second, this study used self-reported measures (i.e., survey items) to capture adolescents' attention to and further engagement with incidentally encountered information. Although this approach is more suitable when conducting research among adolescents, future studies should simultaneously include different measures of second-level incidental exposure (e.g., self-reports, eye-tracking) and compare whether self-reported measures of attention reflect visual attention patterns (e.g., Vraga, et al., 2019).

## Conclusion

The current study aimed to examine whether incidental exposure to climate content on social media has the potential to stimulate online climate change engagement among adolescents reporting low levels of climate-related interest. The results showed that adolescents already interested in climate-related matters are more likely to engage with climate content online which in turn results in higher levels of incidental exposure. Moreover, climate-related interest translated into higher levels of incidental exposure and online engagement among adolescents reporting high levels of injunctive peer norms. Taken together, these findings suggest that social media are reinforcing rather than equalizing existing gaps in online climate change engagement and demonstrate how both dispositional (interest) and social (peer norms) factors interact in shaping adolescents' incidental social media exposure and online engagement.

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Table 1

*Descriptive Statistics and Zero-Order Correlations*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 Incidental exposure w1 | 1 | .36*** | .29*** | .19*** | .53** | .27*** | -.01 | .09* |
| 2 Incidental exposure w1 | | 1 | .13** | .25*** | .27*** | .50*** | .05 | -.02 |
| 3 Online engagement w1 | | | 1 | .69*** | .46*** | .32*** | .38*** | .44*** |
| 4 Online engagement w2 | | | | 1 | .35*** | .39*** | .24*** | .28*** |
| 5 Attention w1 | | | | | 1 | .50*** | .21*** | .27*** |
| 6 Attention w2 | | | | | | 1 | .20*** | .16*** |
| 7 Biospheric values w1 | | | | | | | 1 | .49*** |
| 8 Injunctive peer norms w1 | | | | | | | | 1 |
| Range | 1-5 | 1-5 | 1-6 | 1-6 | 1-5 | 1-5 | 1-5 | 1-7 |
| *M* (*SD*) | 2.73 (1.07) | 2.61 (1.06) | 2.25 (.89) | 2.04 (.87) | 2.54 (.99) | 2.38 (.93) | 4.34 (.62) | 3.74 (1.38) |

*Note*. *w1* = wave 1; *w2* = wave 2
*$p$ < .05. **$p$ < .01. ***$p$ < .001

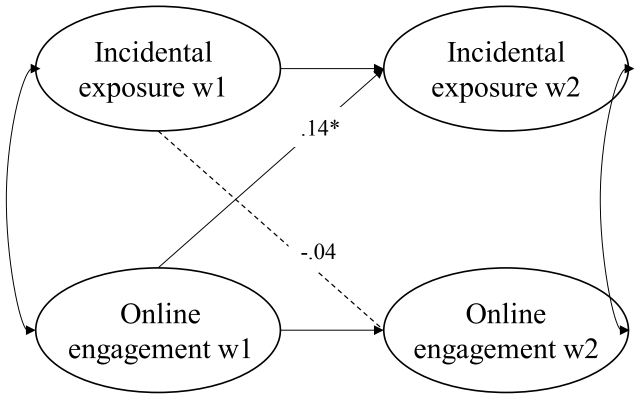


*Figure 1*. Reciprocal relationship between incidental exposure to climate-related content and online climate change engagement.

*Note*. Values reflect standardized coefficients; dotted lines represent non-significant relationships; ***p* < .01, *** *p* < .001; w1 = wave 1; w2 = wave 2. For clarity, control variables, indicators, and error terms are not shown.

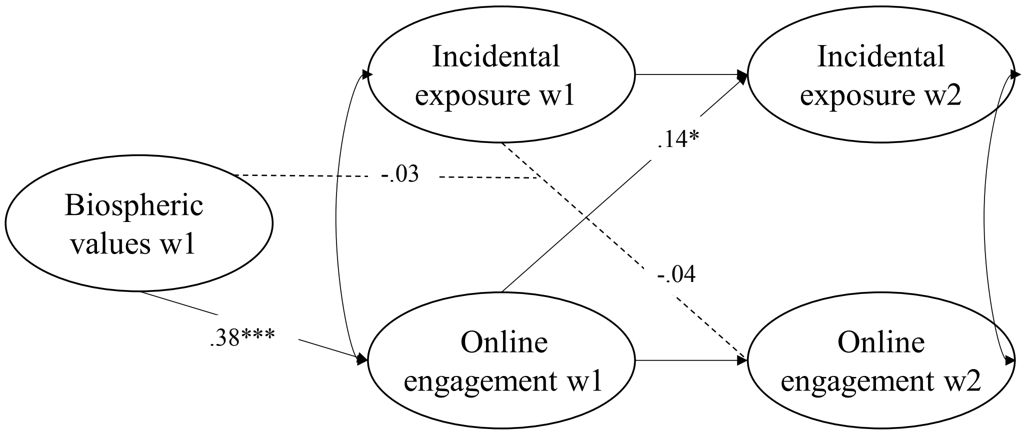


*Figure 2.* The antecedent and moderating role of biospheric values in the reciprocal relationship between incidental exposure and online climate change engagement.

*Note*. Values reflect standardized coefficients; dotted lines represent non-significant relationships; $**p < .01$, $*** p < .001$; w1 = wave 1; w2 = wave 2. For clarity, control variables, indicators, and error terms are not shown.

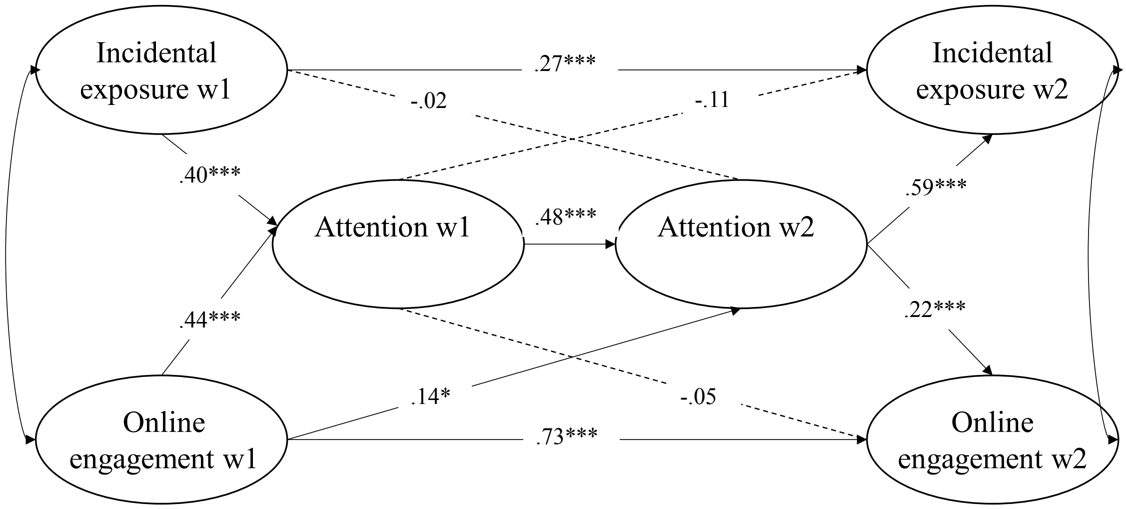


*Figure 3.* The mediating role of attention in the reciprocal relationship between incidental exposure and online climate change engagement.

*Note*. Values reflect standardized coefficients; dotted lines represent non-significant relationships; **$p < .01$, *** $p < .001$; w1 = wave 1; w2 = wave 2. For clarity, control variables, indicators, and error terms are not shown.