

Emotion

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The Longest Year Ever: Emotions and Time Perception Interact to Predict How Frequently Individuals Engage in COVID-19 Avoidance Behaviors

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Affective states alter the perception of how quickly time is passing. However, previous studies have not examined the independent and interactive effects of emotion and time perception on behavioral outcomes. The current study sought to better understand the relationships between affect, time perception, and reported engagement in COVID-19 pathogen avoidance behaviors (e.g., social distancing, wearing a mask) over 1 year. The study sample was comprised of American adults ($n = 1,000$) recruited using Prolific. The majority of participants in the final sample (50.1% male, 46.8% female, 3.1% nonbinary/other) identified as White/Caucasian (78.9%) or Black/African American (11.9%). The average age in the sample was 34.4 years ($SD = 11.3$). Consistent with study hypotheses, approach-motivated affective states (happiness) were associated with time flying, and avoidance-motivated affective states (nervous, lack of control) were associated with time dragging. Moderation analyses revealed that reports of greater avoidance-motivated affect and time dragging, and reports of greater approach-motivated affect and time flying interacted to predict more frequent engagement in pathogen avoidance behaviors. These results contribute to the existing literature describing the affective and behavioral effects of the COVID-19 pandemic by suggesting both approach- and avoidance-motivated affective states have important implications for engagement in pathogen avoidance behaviors.

Keywords: emotions, time perception, health, social behavior

Supplemental materials: <https://doi.org/10.1037/emo0001230.supp>

Affect and Time Perception

Emotional states are closely linked to time perception, or the subjective experience of how quickly time is passing (Droit-Volet & Gil, 2009). Broadly, previous research has found that individuals in positive affective states reportedly perceive time passing more quickly, relative to negative affective states (Angrilli et al.,

1997; Droit-Volet et al., 2004; Noulhiane et al., 2007). The relationship between affective states and time perception has been examined experimentally by measuring differences in the perceived duration of stimuli presentation (i.e., how long a stimulus was presented). Previous studies utilizing this paradigm have shown participants experiencing feelings of boredom (Danckert & Allman, 2005), social rejection (Twenge et al., 2003), or anxiety

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The current study was approved by the University of Delaware Institutional Review Board (UD IRB #1620345-2). The authors confirm the submitted manuscript adheres to the ethics of scientific publication outlined by the American Psychological Association (2002).

Deidentified data, data analysis syntax, and supplemental materials for the study are publicly accessible at: <https://osf.io/wx3sy/> (Gable & Wendel, 2022).

Recent work in several fields of science has identified a bias in citation practices in the field (Chatterjee & Werner, 2021; Dion et al., 2018; Dworkin et al., 2020; Fulvio et al., 2021). We obtained the predicted gender of the first and last author of each reference by using databases that store the probability of a first name being carried by a woman (Dworkin et al., 2020;

Zhou et al., 2020). By this measure (and excluding self-citations to the first and last authors of our current paper), our references contain 27.52% woman(first)/woman(last), 21.21% man/woman, 17.04% woman/man, and 34.23% man/man. This method is limited in that names, pronouns, and social media profiles used to construct the databases may not, in every case, be indicative of the author's gender.

Christopher J. Wendel served as lead for formal analysis, visualization, writing—original draft and served in a supporting role for conceptualization, data curation, writing—review and editing. Philip A. Gable served as lead for conceptualization, data curation, funding acquisition, investigation, methodology, project administration, resources, supervision, writing—review and editing. Christopher J. Wendel and Philip A. Gable contributed equally to validation.

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(Bar-Haim et al., 2010) are more likely to overestimate stimulus durations.

Affect and Motivation

Motivation has been incorporated as an important component in well-established theories of emotion (Lang, 1995) and may have important implications for time perception. Specifically, the motivational dimensional model of emotion proposes some emotions evoke approach motivation, or an impetus to move toward something, while other emotions evoke withdrawal motivation, or an impetus to move away from something (Gable & Dreisbach, 2021; Gable & Harmon-Jones, 2009). For example, a breadth of past research has demonstrated associations between anger and approach motivation (Carver & Harmon-Jones, 2009), and sadness and approach motivation (Gil & Droit-Volet, 2009).

Motivation and Time Perception

The bulk of previous studies have examined the effect of emotional *valence* (i.e., pleasant vs. unpleasant) and arousal levels (high vs. low; Angrilli et al., 1997; Noulhiane et al., 2007) on time perception. In comparison, relatively few studies have examined the associations between motivational direction and time perception. However, recent evidence suggests that perceptual processes are influenced by motivational strength (see Gable & Harmon-Jones, 2010; Harmon-Jones et al., 2012 for review). More specifically, approach-motivated affect is associated with perceptions of time passing more quickly, and withdrawal-motivated emotion (e.g., boredom) is associated with perceptions of time passing more slowly. For instance, Gable and Poole (2012; Study 1) found that participants viewing pictures eliciting high approach motivation (e.g., desserts) experienced time passing more quickly when, compared to pictures eliciting low approach motivation (e.g., flowers) or high withdrawal motivation (Study 3).

The relationship between negative affective states characterized by withdrawal motivation and time seeming to pass more slowly has been demonstrated in previous research (Matsuda et al., 2020; Mioni et al., 2020). For example, when participants were exposed to an aversive, fearful tone, they were more likely to overestimate its duration relative to a neutral tone (Droit-Volet et al., 2010). Additionally, Gable et al. (2016; Study 3) found that disgust-inducing images high in withdrawal motivation were associated with lengthened perceptions of time relative to disgust-inducing images low in withdrawal motivation or neutral pictures. Furthermore, there is some evidence to suggest that motivational direction may be a more reliable predictor of time perception than affective valence. Specifically, across four studies Gable et al. (2016) found anger and sadness high in approach motivation were associated with perceptions of time flying compared to neutral (Studies 1 and 2), and low approach-motivated anger and sadness (Studies 4 and 5). Together, these results suggest that approach motivation, rather than positive or negative affect, causes time to “fly” relative to neutral motivation or withdrawal-motivated states.

Overall, it appears that approach motivation leads to the perception of time flying whereas withdrawal motivation leads to time

dragging. The association between motivational states and time perception may be associated with behavior as these relationships are thought to serve a functional role. Specifically, time passing quickly in an approach-motivated state may encourage goal pursuit and attainment (Gable & Poole, 2012). In contrast, time passing slowly in a withdrawal-motivated state may enhance the negative aspects of the environment and encourage avoidance actions.

Implications in the Context of COVID-19

Across the world, a myriad of emotional responses emerged (for review, see Wang et al., 2021) in response to the COVID-19 pandemic. Similar to the response to quarantining during SARS and H1N1 (Brooks et al., 2020), anxiety and depression have increased in response to the COVID-19 pandemic (Ahmed et al., 2020; Duan & Zhu, 2020; Wu et al., 2008). The interruption of daily life and worry about possible financial and academic consequences of the pandemic have been associated with increased anxiety among college students in China (Cao et al., 2020). Similarly, rates of post-traumatic stress were four times higher for families quarantined during health-related disasters compared to those who were not quarantined (Sprang & Silman, 2013). Quarantine during the SARS epidemic predicted post-traumatic stress symptoms for 3 years after the epidemic occurred for hospital employees (Wu et al., 2009).

Hence, changes in affective states associated with approach and avoidance motivation related to the COVID-19 pandemic may influence time perceptions. Several recent studies have revealed a pattern of results that partially support this notion. For example, Martinelli et al. (2021) found that heightened experiences of sadness and boredom related to a slowed sense of time passing in a self-report study among 1,332 French citizens during the lockdown in April 2020. Droit-Volet et al. (2020) found the slowing of time was the result of self-reported boredom and sadness, rather than stress or anxiety. However, few studies have examined these associations in the United States during the COVID-19 pandemic. It's possible that the relationships between affect and time perceptions in the United States differ substantially from those revealed in French samples, due to the differences in the measures implemented to limit the spread of the pandemic, for example.

In response to the COVID-19 pandemic, the U.S. Centers for Disease Control and Prevention (CDC) created guidelines to help people avoid infection (e.g., avoiding large gatherings) and mitigate the risk of spreading the virus to others (e.g., wearing a mask). Adherence to the CDC behavioral guidelines varied widely in the United States. Some research has been conducted to assess what factors predict adherence to public health guidelines, but these tend to focus on individual difference measures such as perceived vulnerability (De Coninck et al., 2020), pathogen disgust sensitivity (Olivera-La Rosa et al., 2020), and political leanings (Tybur et al., 2015). However, previous studies suggest avoidance-based affective states are associated with stricter adherence to avoidance health behaviors. For instance, those who feel generally more anxious about COVID-19 are more likely to perceive avoidance health behaviors as important (Makhanova & Shepherd, 2020). Indeed, general negative feelings (Zajenkowski et al., 2020) and fears about the COVID-19 pandemic (Harper et al.,

2021) are associated with greater self-reported compliance with government restrictions and health recommendations, respectively, during the pandemic.

However, the predominant focus on negative affect may be limiting a full understanding of the factors which predicted engagement in behaviors suggested by the CDC to limit the spread of COVID-19. For example, some behaviors recommended by the CDC may be better described as approach-motivated behaviors (e.g., wearing a mask), which allow individuals to engage in activities, while still limiting the risk of infection. It's possible that these behaviors are more reliably associated with approach-motivated affective states and perceptions of time flying. Examining these potential relationships more closely could inform public health initiatives aimed at reducing the spread of COVID-19 and expand our understanding of how affective experiences indirectly contribute to the spread of the COVID-19 pandemic. Hence, the current study was designed to assess the influence of affective states high in approach- and avoidance motivation on time passing during the pandemic in a North American sample.

The Present Study

The present study seeks to fill gaps in the literature by examining the relationships between affective states associated with approach and avoidance motivation, time perception, and pathogen avoidance in a sample of North American participants across nine timepoints during the COVID-19 pandemic. More specifically, the current study examines whether affective states high in withdrawal motivation and affective states high in approach motivation are associated with reported time perception. Consistent with models of motivation-time perception interaction, we hypothesized more frequent reports of approach-motivated emotions would be associated with time “flying” while more frequent reports of withdrawal-motivated emotions would be associated with time “dragging.”

Finally, we examine whether affective states high in approach- and avoidance motivation and time perception are associated with pathogen avoidance behaviors recommended by the CDC during the beginning of 2020, either independently or interactively. We hypothesized that reports of greater avoidance-motivated affect and time slowing would interact to predict greater engagement in pathogen avoidance behaviors. It's also possible that the interaction of low approach-motivated affect and time dragging would be associated with greater engagement in pathogen avoidance behavior. However, given the dearth of previous studies examining the role of approach-motivated behaviors in the context of COVID-19, we made no *a priori* hypotheses regarding the direction or magnitude of this effect.

Method

Open Practice Statement

The current study was not preregistered. The data used in the current study were collected as part of separate examination of the reliability of a novel approach-avoidance task over time published elsewhere (Zech et al., 2022). However, the relationships described here have not been previously reported. We report how we determined our sample size, all data exclusions (if any), all

manipulations, and all measures in the study. The authors declare no conflict of interest. All data have been made publicly available at: <https://osf.io/wx3sy/>.

Participants

Participants in the current study were recruited via *Prolific*, an online subject recruitment platform beginning in March 2020 to minimize the risks of research participation during the COVID-19 pandemic. To be eligible for the study, participants must have (a) currently resided in the continental United States, (b) listed English as a fluent language, (c) reported having an Android mobile phone or tablet, and (d) had a *Prolific* approval rating of at least 80%. The final inclusion criterion was included to maximize meaningful data collection. In total, informed consent was obtained from 1,006 participants who completed the first study session. However, responses from six participants were removed after visual inspection of the data revealed an unacceptably high amount of missing data (i.e., >50%). The majority of participants in the final sample ($n = 1,000$; 50.1% male, 46.8% female, 3.1% nonbinary/other) identified as White/Caucasian (78.9%) or Black/African American (11.9%). The average age in the sample was 34.4 years ($SD = 11.3$). Sample demographics across the nine study sessions are shown in Table 1.

On March 27, 2020, all eligible participants on *Prolific* were invited to take part in nine sampling sessions over the course of 12 months, the first of which would be completed immediately. One month later, the second session of the study was opened to all participants who had completed session one. This procedure was repeated monthly for the first 7 months. The last two sessions were conducted every 3 months because changes related to the pandemic were occurring less rapidly. There were a total of nine study sessions. As shown in Table 1, there was considerable attrition over the course of the nine study sessions. However, the results of post hoc power analyses (linear multiple regression: fixed model, R^2 increase) using G*Power (Faul et al., 2009) revealed excellent power ($1 - \beta = 0.99$) to detect a medium-sized interaction effect ($f^2 = 0.15$) with the final sample size at Session 9.

When participants accepted the *Prolific* invitation, they were directed to the Google PlayStore where they would install an Android application (app) on their Android device. Once the app was downloaded, they submitted the experiment name and their *Prolific* identification number. Participants were then provided a description of the study and expected duration of participation. After informed consent was obtained, participants were immediately directed to the study questionnaire which asked about their experiences during the COVID-19 pandemic. Once all questions within the app were completed, participants were debriefed and given a completion code to be submitted to *Prolific*. Each session took approximately 25 min. The data were then checked for completeness (reasonable time taken to complete the study, accuracy on attention check questions) and participants were compensated through the *Prolific* system. To foster participants' ability to fully complete the study survey within a reasonable amount of time, we prioritized face validity and easily understood response scales when selecting study questionnaires. The current study was approved by the University of Delaware Institutional Review Board (UD IRB #1620345-2).

Table 1
Sample Characteristics

Variables	Session 1 (<i>n</i> = 1,000)	Session 2 (<i>n</i> = 743)	Session 3 (<i>n</i> = 546)	Session 4 (<i>n</i> = 480)	Session 5 (<i>n</i> = 426)	Session 6 (<i>n</i> = 396)	Session 7 (<i>n</i> = 391)	Session 8 (<i>n</i> = 388)	Session 9 (<i>n</i> = 300)
Age									
<i>M</i>	34.44	35.14	35.83	35.89	36.47	36.40	36.87	37.21	38.80
<i>SD</i>	11.27	11.16	11.34	11.35	11.46	11.45	11.40	11.40	11.86
Sex									
Female, <i>n</i> (%)	468 (46.80)	357 (48.05)	259 (47.44)	231 (48.13)	206 (48.36)	191 (48.23)	184 (47.06)	179 (46.13)	144 (48.00)
Male, <i>n</i> (%)	501 (50.10)	368 (49.53)	275 (50.37)	241 (50.21)	214 (50.23)	198 (50.00)	201 (51.41)	202 (52.06)	150 (50.00)
Other, <i>n</i> (%)	31 (3.10)	18 (2.42)	12 (2.20)	8 (1.67)	6 (1.41)	7 (1.77)	6 (1.53)	7 (1.80)	6 (2.00)
Race/ethnicity									
American Indian, <i>n</i> (%)	9 (0.90)	4 (0.54)	3 (0.55)	2 (0.42)	1 (0.23)	3 (0.76)	2 (0.51)	3 (0.77)	1 (0.33)
Asian Indian, <i>n</i> (%)	14 (1.40)	8 (1.08)	6 (1.10)	5 (1.04)	4 (0.94)	4 (1.01)	3 (0.77)	6 (0.78)	3 (1.00)
Black/African American, <i>n</i> (%)	119 (11.89)	88 (11.84)	60 (10.99)	51 (10.63)	45 (10.56)	38 (9.60)	37 (9.46)	34 (8.76)	31 (10.33)
East Asian, <i>n</i> (%)	62 (6.19)	48 (6.46)	34 (6.23)	32 (6.67)	30 (7.04)	27 (6.82)	27 (6.91)	30 (7.73)	21 (7.00)
Pacific Islander, <i>n</i> (%)	7 (0.70)	4 (0.54)	4 (0.73)	2 (0.42)	2 (0.47)	2 (0.51)	2 (0.51)	1 (0.26)	2 (0.67)
White/Caucasian, <i>n</i> (%)	790 (78.92)	591 (79.54)	439 (80.40)	388 (80.83)	344 (80.75)	322 (81.31)	320 (81.84)	314 (80.93)	242 (80.67)

Measures

Time Perception

Time perception over the previous month was assessed by asking participants to indicate how time had seemed to pass on a 1–5 scale ranging from 1 (*time has dragged*) to 5 (*time has flown*).

Affective States

Participants were asked how often in the past month they had felt nervous or stressed, afraid or fearful, angry or upset, unable to control the important things in life, relaxed or calm, confidence in their ability to handle personal problems, and happy or glad. Affect questions were answered on a 1–5 scale ranging from 1 (*never*) to 5 (*very often*). Greater reports of feeling nervous or stressed, afraid or fearful, and unable to control the important things in life were considered to reflect greater withdrawal motivation. Higher reported feelings of relaxed or calm, confident in their ability to handle personal problems, and happy or glad were considered to reflect approach motivation.¹

COVID-19 Fear

Participant's fears about the lethality of the COVID-19 virus, availability of effective medical equipment, and the U.S. government's ability to limit the spread of the pandemic were assessed using three items. More specifically, participants were asked to rate the following items on a 5-point Likert scale ranging from 1 (*disagree*) to 5 (*agree*): "I associate high fatality with COVID-19," "The U.S. health system does not have enough medical equipment for treating COVID-19," and "The U.S. government will be able to control the COVID-19 epidemic." The latter two fear items were included based on previous research suggesting that lack of control and uncertainty are associated with fear (Lerner & Keltner, 2001). Responses on the government control item were reverse-scored prior to analyses.

COVID-19 Worry

Participants worry about personally contracting COVID-19, a family member contracting COVID-19, and the financial

consequences of the pandemic were assessed using three items. Specifically, participants were asked to rate the following items on a 5-point Likert scale ranging from 1 (*disagree*) to 5 (*agree*): "I am worried that I will contract COVID-19," "I am worried that my family members will contract COVID-19," and "I am worried that the pandemic will hurt my finances."

Pathogen Avoidance Behaviors

Health behaviors thought to be critical to stopping the spread of COVID-19 in the spring of 2020 were assessed. Specifically, participants were asked how often in the past month they washed their hands, how long they washed their hands, avoided touching their face, avoided gatherings of more than 10 people, avoided contact-based greetings, maintained social distancing (6 ft. between interpersonal interactions), and wore a mask in public. Participants also responded to health behavior questions on a 1 (*never*) to 5 (*always*) scale.

Statistical Analyses

Initial bivariate correlations were conducted to examine the relationships between affective states, time perception, and reported engagement in pathogen avoidance behaviors. Subsequent linear regression analyses were conducted to examine the effect of affective states on time perception, separately. There was considerable attrition over the course of the study, limiting our ability to draw conclusions from mediation analyses, which assume causal relationships between variables of interest (Hayes, 2009), or from multilevel modeling analyses examining longitudinal associations between the variables of interest. Hence, moderation analyses were conducted using the PROCESS macro (Hayes, 2017) to

¹ Due to the heightened levels of negative affect during the initial months of the pandemic, we chose not to include words assessing highly positive affect (e.g., excitement, enthusiasm, feelings of power). We thought this would distress some participants who were unable to feel such emotions during this time. During such states of uncertainty and distress, we felt milder approach-motivated positive emotions (e.g., happy and glad) would still accurately assess individual's approach-motivated positive affect.

examine whether approach- and avoidance-motivated affective states and time perception were associated with pathogen avoidance behaviors independently, or interactively. Significant interaction effects were probed using the Johnson–Neyman technique and visualized using the syntax generated from the PROCESS macro.

Furthermore, we have limited ability to account for the polarization of COVID-19-related topics or the sociocultural changes which unfolded in the United States following the initiation of this study. Therefore, we examine the relationships described above at the mean level over the course of the study. Additionally, the pathogen avoidance behaviors examined here were based on the CDC recommendations in early 2020. Several of the pathogen avoidance behaviors were removed from the CDC recommendations over the course of the study. Furthermore, hand washing frequency and duration, and sneezing into an elbow or tissue are pathogen avoidance behaviors that are not specific to the COVID-19 pandemic, limiting our ability to conclude engagement in these behaviors is associated with changes in affect and time perception related to COVID-19. Hence, the pathogen avoidance behaviors examined here include social distancing, avoiding large gatherings, avoiding contact-based greetings, avoiding touching one's face, and wearing a mask.

Results

An analysis of participants' average time perception across study sessions revealed that average approximately a quarter of respondents experienced time as dragging on average (23.9% reported 4 or 5 on the 1–5 scale on average) across study sessions and approximately a third of respondents experienced time as flying (36.9% reported a 4 or 5 on average). Frequencies of average time perception responses can be found in Figure 1.

The results of subsequent bivariate correlations examining the relationships between average reports of time perception, affect, and health behaviors across the study sessions are displayed in Table 1 in the online supplemental materials. Consistent with the first study hypotheses, affective states associated with approach motivation were associated with time flying and affective states associated with avoidance motivation were associated with time dragging. Specifically, feeling relaxed or calm ($r = .258$), more

confidence ($r = .129$), and happy or glad ($r = .247$) were associated with time flying. Whereas feeling more nervous or stressed ($r = -.271$), afraid or fearful ($r = -.255$), angry or upset ($r = -.193$), and unable to control the important things in life ($r = -.216$) were associated with time dragging. Similarly, average reports of greater COVID-19-related fear ($rs \geq .097$) and COVID-19-related worry ($rs \geq .175$) were associated with time dragging.

Consistent with the second study hypothesis, bivariate correlations revealed positive associations between COVID-19-related fear and social distancing ($rs \geq .114$), avoiding gatherings of more than 10 people ($rs \geq .179$), and avoiding contact-based greetings ($rs \geq .132$). Similarly, positive associations were revealed between COVID-19-related worry and social distancing ($rs \geq .087$), avoiding gatherings of more than 10 people ($rs \geq .063$), and avoiding contact-based greetings ($rs \geq .066$). Additionally, fear about the lethality of COVID-19, worry about personally contracting COVID-19 and worry about family members contracting COVID-19 were positively associated with wearing a mask in public ($rs \geq .096$) and avoidance of face touching ($rs \geq .078$). Positive associations were revealed between avoiding contact-based greetings and reports of feeling afraid or fearful ($r = .065$) and feeling unable to control the important things in life ($r = .073$). However, inconsistent with the second study hypothesis, the results of bivariate correlations revealed feeling that time was flying by was associated with more frequently wearing a mask in public ($r = .229$). Time perception was not significantly associated with the remaining avoidance health behaviors consistently across the study sessions, although statistically significant associations were revealed within study sessions (see Tables 2–10 in the online supplemental materials).

Additionally, reports of feeling nervous or stressed, afraid or fearful, angry or upset, unable to control the important things in life, relaxed or calm, and fear about the availability of effective medical equipment were negatively associated with wearing a mask in public ($rs \geq .061$). Similarly, reports of feeling nervous or stressed, angry or upset, being unable to control the important things in life, and a lack of confidence were negatively associated with avoidance of face touching ($rs \geq .064$). Finally, feeling angry or upset was negatively correlated with social distancing ($r = -.069$).

Linear Regression of Time Perception on Affect Variables

The results of separate linear regression analyses examining the relationships between the affect variables and time perception are displayed in Table 2. Consistent with H1, mean reports of feeling nervous or stressed ($\beta = -0.27, p < .001$), afraid or fearful ($\beta = -0.26, p < .001$), angry or upset ($\beta = -0.19, p < .001$), and unable to control the important things in life ($\beta = -0.22, p < .001$) were associated with time dragging. Similarly, greater fear about the lethality of the COVID-19 virus ($\beta = -0.13, p < .001$), availability of effective medical equipment ($\beta = -0.10, p < .001$), and the U.S. government's ability to limit the spread of the pandemic ($\beta = -0.18, p = .002$), and greater worry about personally contracting COVID-19 ($\beta = -0.18, p < .001$), a family member contracting COVID-19 ($\beta = -0.16, p < .001$), and the financial consequences of the pandemic ($\beta = -0.20, p < .001$) were associated with time dragging. Finally, consistent with H1, feeling more relaxed or

Figure 1
Distribution of Average Time Perception

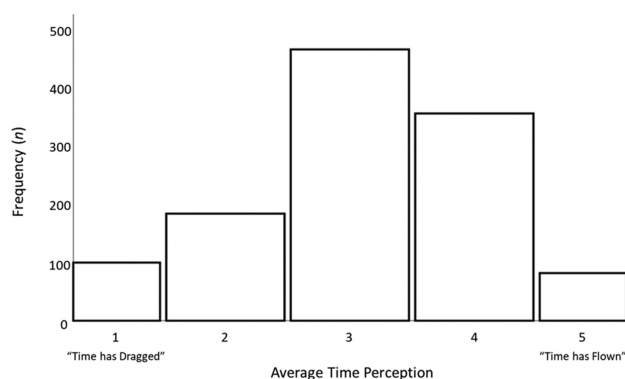


Table 2

The Effects of Avoidance and Approach Affect on Time Perception During the COVID-19 Pandemic

Affect variables	<i>B</i>	<i>SE</i>	β	95% CI	
				LL	UL
Nervous	−0.31	0.03	−0.27***	−0.37	−0.25
Afraid	−0.28	0.03	−0.26***	−0.34	−0.22
Angry	−0.23	0.04	−0.19***	−0.30	−0.17
Control	−0.26	0.03	−0.22***	−0.33	−0.19
Relaxed	0.33	0.04	0.26***	0.25	0.40
Confident	0.17	0.04	0.13***	0.09	0.25
Happy	0.34	0.04	0.25***	0.26	0.41
Lethality	−0.13	0.03	−0.13***	−0.19	−0.07
Gov't	−0.11	0.03	−0.10***	−0.17	−0.04
Equip.	−0.20	0.03	−0.18***	−0.26	−0.13
Self	−0.16	0.03	−0.18***	−0.21	−0.11
Family	−0.16	0.03	−0.16***	−0.21	−0.10
Finance	−0.19	0.03	−0.20***	−0.25	−0.14

Note. LL = lower limit; UL = upper limit. Control = unable to control the important things in life; Lethality = lethality of COVID-19; Gov't = government ability to stop the spread of COVID-19; Equip. = availability of effective medical equipment; Self = worry about personally contracting COVID-19; Family = worry about family member contracting COVID-19; Finances = worry about financial consequences of COVID-19.

*** $p < .001$.

calm ($\beta = 0.25$, $p < .001$), confident ($\beta = 0.13$, $p < .001$), and happy or glad ($\beta = 0.25$, $p < .001$) were associated with time flying.

Moderation Analyses: Approach Interactions

To further probe the second study hypothesis, moderation analyses were conducted to examine whether the interaction of time perception and approach-motivated affect predicted reported engagement in avoidance health behaviors. Feeling happy or glad significantly interacted with time perception to predict social distancing and avoiding touching one's face (Table 3). Specifically, at low levels of happy or glad, time dragging predicted social distancing (see Figure 2) and avoiding touching one's face (see Figure 3).

Table 3

Interactive Effect of Time Perception and Happiness and Pathogen Avoidance Behaviors

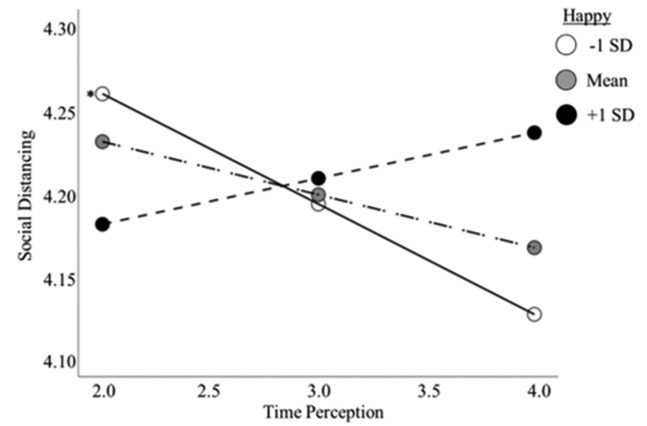
Predictors	Social distancing				Avoid touching face			
	<i>B</i>	<i>SE</i>	LLCI	ULCI	<i>B</i>	<i>SE</i>	LLCI	ULCI
Predictor								
Time Perception	−0.21**	0.08	−0.31	−0.06	−0.28**	0.10	−0.48	−0.08
Happy	−0.17*	0.08	−0.32	−0.02	−0.17	0.10	−0.37	−0.03
Time Perception × Happy	0.06*	0.02	0.01	0.11	0.08*	0.03	0.02	0.14
Conditional effects								
16%	−0.07**	0.03	−0.12	−0.02	−0.09**	0.03	−0.15	−0.02
50%	−0.03	0.02	−0.07	0.01	−0.04	0.03	−0.09	0.01
84%	0.07	0.03	−0.03	0.09	0.04	0.04	−0.04	0.11
J–N significance region	Value		% below	% Above	Value		% below	% Above
	2.86		26.59	73.41	2.87		26.59	73.41

Note. Happy = feeling happy or glad; LLCI = lower limit of bootstrapped 95% confidence interval; ULCI = upper limit of bootstrapped 95% confidence interval.

* $p < .05$. ** $p < .01$.

Figure 2

Interactive Effect of Happiness and Time Perception on Social Distancing



Note. Lines represent the effect of time perception on social distancing at standard deviation levels of happiness.

*Statistically significant effect of time perception on social distancing at $p < .05$ significance level.

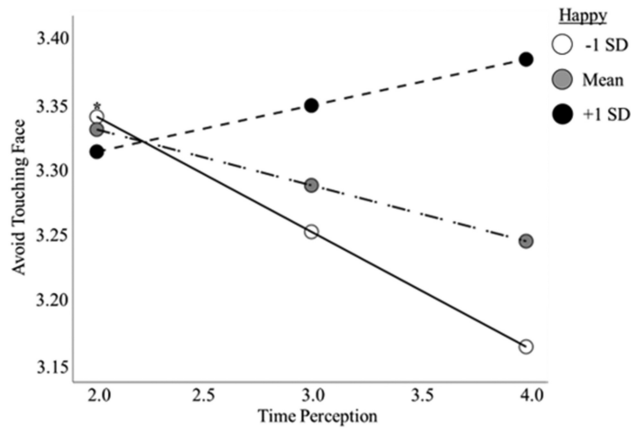
Similarly, feeling confident in the ability to handle personal problems interacted with time perception to predict social distancing ($B = 0.04$, $p = .050$; see Table 4). Specifically, at low levels of confidence, time dragging predicted social distancing (J–N region: 2.92, % below = 21.53, % above = 78.47). This interaction is displayed in Figure 4.

Moderation Analyses: Withdrawal Interactions

Subsequently, moderation analyses were conducted to examine whether the interaction of time perception- and avoidance-motivated affect predicted reported engagement in avoidance health behaviors. The results of these analyses revealed reports of feeling nervous or stressed significantly interacted with time perception to predict social distancing ($B = -0.05$, $p = .020$; see Table 5). As depicted in Figure 5, at high levels of nervous or

Figure 3

Interactive Effect of Happiness and Time Perception on Face Touching Avoidance



Note. Lines represent the effect of time perception on avoidance of touching one's face at standard deviation levels of happiness.

*Statistically significant effect of time perception on avoidance of touching one's face at $p < .05$ significance level.

stressed, time dragging predicted social distancing (J–N region: 3.86, % below = 62.08, % above = 37.93). Similarly, feeling unable to control the important things in life significantly interacted with time perception to predict avoiding touching one's face ($B = -0.06$, $p = .020$; see Table 6). As depicted in Figure 6, at high levels of feeling unable to control the important things in life, time dragging predicted avoiding touching one's face (J–N region: 3.45, % below = 70.27, % above = 29.73).

Discussion

Across the nine study sessions, correlational analyses revealed that frequency of emotional experiences is significantly associated

Table 4

Interactive Effect of Time Perception and Confidence and Pathogen Avoidance Behaviors

Predictors	Social distancing			
	<i>B</i>	<i>SE</i>	LLCI	ULCI
Predictor				
Time Perception	−0.17*	0.08	−0.32	−0.02
Confidence	−0.12	0.07	−0.26	0.03
Time Perception × Confidence	0.04*	0.02	0	0.09
Conditional effects				
16%	−0.06*	0.04	−0.10	0.04
50%	−0.03	0.02	−0.06	0.01
84%	0.01	0.03	−0.04	0.06
J–N significance regions		Value	% below	% Above
		2.92	21.53	78.47

Note. Confidence = confidence in the ability to handle personal problems; LLCI = lower limit of bootstrapped 95% confidence interval; ULCI = upper limit of bootstrapped 95% confidence interval.

* $p < .05$.

with participants' overall perception of time throughout the prior month. Specifically, more frequent feelings of approach-motivated affect (e.g., relaxed/calm, happy/glad) were consistently correlated with time flying, whereas more frequent feelings of withdrawal-motivated affect (e.g., afraid/fearful, angry/upset) were consistently correlated with time dragging. Linear regression analyses further confirmed the relationships between approach-motivated affect and time flying, and avoidance-motivated affect and time dragging. These findings are consistent with past research tying approach motivation to consistent under-estimations of time (e.g., Droit-Volet et al., 2010; Gable & Poole, 2012). These findings together provide support for our first hypothesis, suggesting that time flies when approach-motivated affect is frequently felt, whereas time drags when withdrawal-motivated affect is frequently felt.

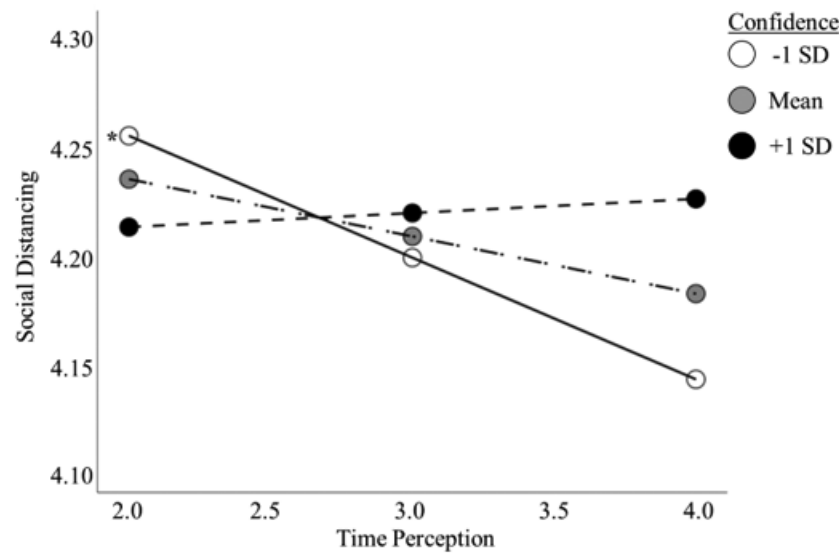
Previous research has revealed associations between withdrawal-motivated emotions and COVID-19 pathogen avoidance (see Harper et al., 2021; Makhanova & Shepherd, 2020; Zajenkowski et al., 2020) which in turn suggests that time dragging may be associated with avoidance health behaviors. However, the results of bivariate correlations revealed that feeling that time flying was associated with more frequent mask-wearing over the prior month. Hence, these results may offer a significant contribution to the literature by revealing that time flying may be associated with greater engagement in pathogen avoidance behaviors focused on limiting the risk of approach-motivated behaviors.

The relationships between time perception, affect and pathogen avoidance behaviors were explored using moderation analyses, which revealed a consistent pattern of results. Time dragging was associated with greater engagement in pathogen avoidance behaviors when participants reported low levels of approach-motivated affect. Additionally, time dragging was associated with greater engagement in pathogen avoidance behaviors when participants reported high levels of avoidance-motivated affect. In sum, the results of this study suggest that individuals more consistently engaged in pathogen avoidance behaviors when they reported low levels of approach-motivated affect or high levels of avoidance-motivated affect, and felt that time was dragging by.

Constraints of Generality

The present study is the first to the best of our knowledge to investigate the interactive effects of emotion and time perception on pathogen avoidance at multiple timepoints behavior during a pandemic. However, there are circumstances that limit the scope of the experiment and generality of results. Although the COVID-19 pandemic offered a unique opportunity to assess society-wide changes in affect, cognition, and behavior, the social restrictions put in place presented unique challenges for researchers. These challenges strongly influenced our study design and measurement selection, which may limit the generality of the results described here. For example, it's possible that the associations described here would differ had we assessed affective states more closely tied to the approach motivation construct (e.g., power, reward-focus). However, these constructs have the potential to be confusing, and our recruitment strategy made it difficult for participants to ask clarifying questions.

Figure 4
Interactive Effect of Confidence and Time Perception on Social Distancing



Note. Lines represent the effect of time perception on social distancing at standard deviation levels of confidence.

*Statistically significant effect of time perception on social distancing at $p < .05$ significance level.

Hence, we prioritized face validity when selecting study measures to address these concerns in our large community sample. Furthermore, it's possible we would have revealed differing relationships between emotion, time perception, and pathogen avoidance behavior if assessed experimentally in the laboratory.

Time perception and pathogen avoidance behaviors are neither pleasant nor unpleasant, per se. However, people in the United

States vary widely in their perception of time and their subjective assessment of pathogen avoidance behaviors, and it's possible these factors influenced the results found here. For example, it's possible that reports of mask-wearing were influenced by perceptions regarding the effectiveness and necessity of doing so. To mitigate these outside influences, standardized effects,

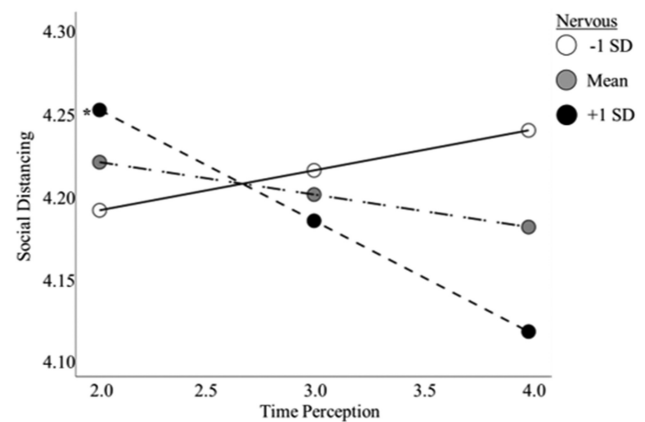
Table 5
Results of Moderation Analyses Examining the Effect of Time Perception on the Relationships Between Avoidance Affect and Avoidance Health Behaviors

Predictors	Social distancing			
	B	SE	LLCI	ULCI
Predictor				
Time Perception	0.14	0.08	-0.01	0.29
Nervous	0.13	0.07	-0.01	0.26
Time Perception × Nervous	-0.05*	0.02	-0.09	-0.01
Conditional effects				
16%	0.02	0.03	-0.04	0.09
50%	-0.02	0.02	-0.06	0.02
84%	-0.07**	0.03	-0.12	-0.02
J-N significance regions	Value	% below	% Above	
	3.86	62.08	37.93	

Note. Nervous = feeling nervous or stressed; LLCI = lower limit of bootstrapped 95% confidence interval; ULCI = upper limit of bootstrapped 95% confidence interval.

* $p < .05$. ** $p < .01$.

Figure 5
Interactive Effect of Nervousness and Time Perception on Social Distancing



Note. Lines represent the effect of time perception on social distancing at standard deviation levels of nervousness.

*Statistically significant effect of time perception on social distancing at $p < .05$ significance level.

Table 6

Results of Moderation Analyses Examining the Effect of Time Perception on the Relationships Between Avoidance Affect and Avoidance Health Behaviors

Predictors	Avoid touching face			
	<i>B</i>	<i>SE</i>	LLCI	ULCI
Predictor				
Time Perception	0.15	0.09	−0.02	0.32
Control	0.10	0.08	−0.06	0.27
Time Perception × Control	−0.06*	0.03	−0.11	−0.01
Conditional effects				
16%	0.03	0.04	−0.09	0.06
50%	−0.02	0.03	−0.08	0.03
84%	−0.08***	0.03	−0.15	−0.02
J–N significance regions		Value	% below	% Above
		3.45	70.27	29.73

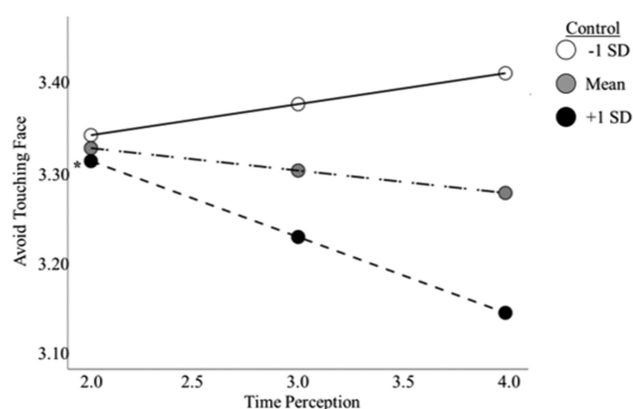
Note. Control = feel unable to control the important things in life; LLCI = lower limit of bootstrapped 95% confidence interval; ULCI = upper limit of bootstrapped 95% confidence interval.

* $p < .05$. *** $p < .001$.

interpretation of confidence intervals, and bootstrapping methods utilized by the PROCESS macro make it unlikely the results are spurious or the result of a general response bias, the utilization of structural equation modeling analyses would have increased confidence in the generalizability results. Despite these limitations, the current study provides novel and beneficial information about how people's affective experiences influence time perception and health behavior. These findings contribute to the existing literature and may help guide future studies examining these relationships with greater experimental control.

Figure 6

Interactive Effect of Control and Time Perception on Face Touching Avoidance



Note. Lines represent the effect of time perception on avoidance of touching one's face at standard deviation levels of control over important things in life.

*Statistically significant effect of time perception on avoidance of touching one's face at $p < .05$ significance level.

Conclusion

Data from this large, nationwide sample reveal that time flies when you feel approach-motivated, while time drags when you feel withdrawal-motivated. These emotional and temporal experiences interact to predict adherence to government-recommended pathogen avoidance behaviors. In other words, the results of the current study offer a description of how emotional and cognitive processes interact to predict engagement in behaviors recommended to limit the spread of COVID-19. These results may help to optimize public health initiatives and may generalize to engagement in pathogen avoidance behaviors more broadly.

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