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COVID-19 Increased Mortality Salience, Collectivism, and Subsistence Activities: A Theory-Driven Analysis of Online Adaptation in the United States, Indonesia, Mexico, and Japan

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Abstract

How does a life-threatening pandemic affect a culture? The Theory of Social Change, Cultural Evolution, and Human Development predicts that danger, as indicated by rising death rates and narrowing social worlds, shifts human psychology and behavior toward that found in small-scale, collectivistic, and rural subsistence ecologies. In particular, mortality salience, collectivism, and engagement in subsistence activities should increase as death rates rise and the social world retracts. Studies on the psychological response to the pandemic in the United States confirmed these predicted increases. The present study sought to generalize these previous findings by comparing the frequency of conceptually relevant linguistic terms used in Google searches and Twitter posts in the United States, Japan, Indonesia, and Mexico for 30 days before the coronavirus pandemic began in each country with frequencies of the same terms for 30 days after. Generally, we found that mortality salience increased to the extent that countries experienced excess COVID mortality; collectivism increased to the extent that countries experienced excess COVID mortality and increased mortality salience; and subsistence activities increased to the extent that countries experienced excess COVID mortality and/or stay-at-home-policies. Almost all these increases went beyond the general increase in internet use, which was a control variable in all analyses. These findings support a growing body of research documenting a human response to ecological danger.

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Introduction

How does danger shape culture? Research indicates that when environments become more dangerous, human psychology and behavior shift closer to that of the subsistence ecologies of early human history, characterized by high survival threat and small, relatively isolated communities (Greenfield et al., 2021). This effect occurred during COVID-19 in the United States as the hallmark characteristics of subsistence ecologies (high mortality salience, strong interdependence within the family household, high collectivism, and high engagement in subsistence activities) significantly increased during the pandemic (Evers et al., 2021; Greenfield et al., 2021). Evers et al. (2021) found many of these effects by scraping large quantities of natural language from the internet and comparing how the language Americans used on Google, Twitter, blogs, and forums changed during the first 70 days of COVID. Survey research revealed the same effects during stay-at-home orders in California and Rhode Island (Greenfield et al., 2021). The present study explores the possibility that these observed effects are universal elements of human nature by turning attention from a single Western, Educated, Industrial, Rich, Democratic (W.E.I.R.D. [Henrich et al., 2010]) culture with high life expectancy pre-COVID (United States) to multiple cultures that deviate to different degrees and in different ways from W.E.I.R.D. ecologies and had drastically varying mortality rates during COVID. We accomplish this goal by conducting replications of the U.S. social media study in Mexico, Indonesia, and Japan. In our four countries of interest, we compare how the frequencies of words and phrases indexing mortality salience, collectivism, and subsistence activities changed in Google searches and Twitter posts after the start of the COVID-19 pandemic.

We use the term "mortality salience" in this study to refer to the general psychological importance of mortality rather than Greenberg et al.'s (2014) philosophical idea integral to terror management theory that when one's mortality increases in salience, such debilitating anxiety results that individuals can only manage their fear by striving for symbolic immortality through identification with cultural values and institutions that will outlast them. Survival concern is one aspect of mortality salience and was assessed by specific questions in our survey study of COVID-19's effects (Greenfield et al., 2021). However, linguistic analysis is better suited to measure the general salience of mortality, rather than the more specific concept of survival concern.

Theoretical Background

Greenfield's (2009, 2016, 2018) Theory of Social Change, Cultural Evolution, and Human Development models the influence of ecological variables on cultural values and behavior. Ecological archetypes exist on a continuum from subsistence to commercial ecologies. Subsistence ecologies are small, isolated villages characterized by short life expectancies (including high infant mortality rates); as a consequence, mortality is highly salient. In subsistence ecologies, community members work together to produce and maintain their food supply, shelter, and clothing; in this way, they enact collectivistic values. These are the environments of early human history. In contrast, the commercial ecologies that our readers now call home are urban environments with large populations and contact with many strangers; life expectancies are substantially longer, reducing mortality salience; direct engagement in basic survival activities is negligible— people purchase food, shelter, and clothing; the independent individual is highly valued.

The prediction of the Theory of Social Change, Cultural Evolution, and Human Development was that the pandemic's increased death rate made mortality more salient, and that stay-at-home measures created small, interdependent households, relatively isolated from the outside world. These factors augmented collectivistic values and engagement in subsistence activities, moving them in the direction of subsistence ecologies. Structural equation modeling of COVID-19 survey data in California and Rhode Island showed that the rise of mortality salience was a direct predictor of an important form of collectivism prevalent in subsistence ecologies: family interdependence (Greenfield et al., 2021). Both the number of days of stay-at-home and increased mortality salience predicted an increase in subsistence activities during the first month of COVID (Greenfield et al., 2021).

Greenfield et al. (2021) saw mortality salience as a reflection of COVID mortality rates but did not directly measure mortality rate in that study. Since that time, we have worked with Ariel Karlinsky, the creator of the World Mortality Dataset and a member of the World Health Organization Technical Advisory Group on COVID-19 Mortality Assessment, to collect excess COVID mortality data for each country during the study period. Excess COVID mortality is the death rate during COVID that exceeds what was expected based on death rates in earlier years. It is the most accurate measure of COVID-related mortality because it does not rely on country differences in reporting COVID deaths and is not affected by underreporting (Msemburi et al., 2023). Excess mortality data provided a tool for making predictions and interpreting our findings.

Similarities to and Differences From Inglehart and Welzel

Inglehart and Welzel's (2005) revised modernization theory has one basic underlying similarity to our Theory of Social Change, Cultural Evolution, and Human Development, as we apply it to the pandemic. The inverse of our term mortality salience is their term existential security, the feeling that survival can be taken for granted. They note that, as existential security has risen in the world, societal cultures have come to value individual freedom or independence, including freedom from the family (Akaliyski et al., 2023). However, Inglehart and Welzel's theory differs in three important respects from our theoretical framework: (a) While it is similar in focusing on the sense of existential security vs. insecurity and on the value dimension of independence-interdependence, it leaves out the activity dimension (e.g., we predict that when death rates are higher, people engage in more subsistence activities), which makes our theoretical framework a unique one (Evers et al., 2021; Greenfield et al., 2003, 2021). (b) It is unidirectional: Social change always goes toward existential security and independence, whereas we empirically show that when environmental danger increases, psychology and behavior shifts in the opposite direction. (c) Its socialization hypothesis claims that influences on values diminish once individuals reach adulthood, whereas we have shown that the ecology of the pandemic has quickly shifted both behavior and values in adults (Evers et al., 2021; Greenfield et al., 2021).

Hypotheses and Methodology

Prior research on the effects delineated by the Theory of Social Change, Cultural Evolution, and Human Development, coupled with the empirical results of our U.S. studies of the psychological and behavioral shifts during the pandemic led us to the conceptualization that increased mortality as a result of COVID-19 would increase mortality salience across cultures. Increased mortality salience would, in turn, increase collectivism. Finally, our survey study indicated that both increased mortality salience and the narrowing of the social world through stay-at-home policies would be factors in augmenting subsistence activities. Therefore, increased mortality salience and/or the social isolation of households would increase engagement in subsistence activities. In this study, we measured these effects by analyzing the frequency of words and phrases associated

with these concepts in Twitter posts and Google searches in each study country and language. This conceptualization led to three specific hypotheses for Google Trends and Twitter:

Hypothesis 1: Compared with the 30 days before a COVID emergency was declared in each country, the 30 days following the declaration would see a significant rise in the psychological salience of mortality to the extent that countries experienced excess COVID mortality.
Hypothesis 2: Compared with the 30 days before a COVID emergency was declared in each country, the 30 days following the declaration would see a significant rise in references to collectivistic values to the extent that countries experienced excess COVID mortality and increased mortality salience.
Hypothesis 3: Compared with the 30 days before a COVID emergency was declared in each country, the 30 days following the declaration would see a significant rise in references to subsistence activities for countries that experienced excess COVID mortality and/or stay-at-home policies.

Because we examined whether the predicted trends were consistent across Google and Twitter and because high proportions of the populations of these countries use either Google or Twitter, this study is essentially a population-level analysis of each country (see Table 1).

Methodology Background

Language provides a window into individuals' thoughts, feelings, and actions. As a society is composed of individuals interacting and communicating through language, the study of language on a mass scale provides a window into a society's psychological processes. So, why is the study of massive language datasets to understand human societies only emerging now? The main reason is that large-scale text analyses were technologically infeasible until the rise of desktop computing and the internet in the 21st century (Pennebaker & Chung, 2014). Furthermore, a linguistic analysis documenting externally valid human behavior on this study's scale only became possible recently as the quantity of data in existence and the percentage of social interactions taking place online exploded exponentially. In 2020, when this study took place, over 70% of the world's online data had been produced in the previous 2 years (Holst, 2020). Over the same period, social media users went from being a minority of the world's population to the majority, moving considerable proportions of their social interactions online and recordable for potential analysis (Clement, 2020; Datareportal, 2020). Such large proportions of natural human behavior are now recorded by the internet that these datasets have become the most comprehensive way to quantitatively analyze large-scale human psychology or behavior.

Country and Language Selection

The first criterion for selecting our replication countries was our authors' and their informants' language and cultural expertise (see **Term Selection and Creation of Composite Variables**).

As Table 1 shows, Google has very high penetration in all four study countries. Although the Twitter penetration was lower and more variable from country to country, all four countries are in the top ten countries with the most Twitter users (Dixon, 2022). As of January 2022, the United States had 76.9 million Twitter users, Mexico had 13.9 million users, Indonesia had 18.45 million users, and Japan had 58.95 million users.

The United States and Japan have the least language diversity on Twitter, with English dominating in the United States and Japanese dominating in Japan (Poblete et al., 2011). Although Mexico has 68 languages in addition to Spanish and Indonesia has over 700 languages spoken throughout the archipelago (Halim, 1971), Spanish is the most popular language used on Twitter

Table 1. Penetration of Google and Twitter in the United States, Mexico, Japan, and Indonesia.

Country	Percentage of population: Google	Percentage of population: Twitter
United States	85	23
Mexico	92	11
Japan	74	47
Indonesia	95	7

Note. Data are from Dixon (2022), Kemp (2021), Odabas (2022), Statcounter (2022a, 2022b, 2022c, 2022d), Worldometer (2022a, 2022b, 2022c).

in Mexico (Poblete et al., 2011) and Indonesian is the most popular language used on Twitter in Indonesia (Palo Alto Research Center, n.d.). In addition, these four languages are the official languages of their respective countries and are used for education, government, and administration (Kirkpatrick & Liddicoat, 2019). These dominant languages were, therefore, used in our analyses of both Google Trends and Twitter in each country.

Study Design

Our time frame was the 30-day period before and after each country's COVID-19 emergency declaration. The 30 days before the emergency declaration were compared with the 30 days after. We shortened the analysis periods from the 70 days before and after that were used in Evers et al. (2021) to 30 days before and after because our Talkwalker subscription no longer provided access to 70 days before in the new countries. In addition, our survey in the United States indicated that these predicted effects started to be experienced in the first 30 days of the pandemic (Greenfield et al., 2021). To check on the adequacy of this time period, we re-analyzed our U.S. online data with the new 30-day study periods and were able to replicate the results we had found with 70-day study periods. We, therefore, concluded that the 30 days before and after COVID began constituted a sufficient sample. We considered the days of the emergency declarations transitional days and excluded them from the analysis in each country.

In the United States, the study period was February 12, 2020 to April 12, 2020, with President Trump declaring COVID-19 a national emergency on March 13, 2020 (Evers et al., 2021). In Japan, the study period was from March 8, 2020 to May 7, 2020, with Japan's prime minister declaring COVID a national emergency on April 7, 2020 (McCurry, 2020). In Indonesia, the study period was from February 14, 2020 to April 14, 2020, with the Indonesian president declaring a state of emergency in response to COVID on March 15, 2020 (CNN Indonesia, 2020). In Mexico, the study period was from February 29, 2020 to April 27, 2020, with the Mexican General Health Council declaring a national health emergency on March 30, 2020 (Walsh et al., 2020).

The independent variables were before versus after each country's emergency declaration. Our unit of analysis was the day, and our dependent variables were the average number of term mentions composing each composite variable for each day of the time frame, so we compared 30 daily measurements of average term mentions for each composite variable before the emergency declaration with 30 daily measurements of average term mentions for each composite variable after the emergency declaration. The creation of composite variables is described in the next section. We used multiple regression to compare mean frequencies for each composite variable for the 30 days before the COVID emergency declaration in each country with the mean frequencies for each composite variable for the first 30 days after the COVID emergency declaration.

Means and standard deviations for the before-COVID and during-COVID periods are provided for both Google searches and Twitter posts. Because Google puts its data on the same scale

in each country and time period (described in more detail in a later section titled "The Google Dependent Variable"), shifts can be compared across countries. However, Twitter data begin as raw counts of posts. Changes in the number of posts cannot be compared across countries because the total posts vary widely from country to country, depending on country population, internet penetration, and Twitter popularity. Therefore, for descriptive and comparison purposes, the Twitter results were transformed by calculating a percentage change score. These change scores will be presented in each Twitter results table for each country. Nonetheless, the before-COVID and during-COVID Google scores are not in themselves percentage change scores. For ease of comparing shifts across countries and comparing Google shifts with Twitter shifts, we calculated and will present percentage change scores in each Google results table for each country.

Because overall use of the internet increased by necessity during stay-at-home orders, we wanted to make sure that our predicted increases were not just a function of this overall increase. Therefore, we used as a control variable, in all analyses, relative frequencies of common words. These were posted words without content. The rationale was that the frequency of these content-less words would reflect overall increases in internet usage. To control for general increases in internet use, our covariate was the frequency of the 10 most common words in each country for each day over the same 60-day time span. Table 2 shows the 10 most common words in each country and the source of each list.

Term Selection and Creation of Composite Variables

We adapted terms from Study 2 in Evers et al. (2021) to the new countries. For that study, Evers et al. developed word lists for each concept based on survey items in our prior COVID study (Greenfield et al., 2021) and theoretical considerations (Greenfield, 2009, 2016).

Each English term was assessed for relevance in Indonesian, Mexican, and Japanese culture and, if relevant, translated into Indonesian, Spanish, and Japanese. Two terms were too idiosyncratic to the United States and required a cultural translation in addition to a language translation: "sourdough" and "Home Depot." "Sourdough" was translated to the dominant starch in each country: "tortilla" for Mexico, "お米"(rice) for Japan, and "nasi" (rice) for Indonesia. The term "sourdough" represents a staple within American households but an unconventional food in our other countries of interest. "Home Depot" is culturally central to the United States but does not exist or is a less popular option than local hardware stores in the other countries of interest. Therefore, "Home Depot" was translated to "ferretería" for Mexico, "toko bangunan" for Indonesia, and "ホームセンター" for Japan (all meaning "hardware store").

Felicity Gutierrez, a Spanish speaker, conducted the Mexican term selection with native Mexican family informants and Patricia M. Greenfield, who has lived intermittently in and studied Mexico since 1969. Note that much of the vocabulary would be specific to Mexico and would not necessarily be used in Spain or other Spanish-speaking countries. Qinyi Yuan, a Japanese speaker, conducted the Japanese term selection in consultation with two fluent Japanese speakers. Gabrielle Halim, an Indonesian speaker, residing in Indonesia, conducted the Indonesian term selection in consultation with two Indonesian relatives who were also native Indonesian speakers and had lived in Indonesia for more than 20 years.

To deal with linguistic differences in verb conjugations, we used the verb root for all verbs. For example, in English, we used "give" for the analysis instead of "giving," "gives," or "has given." The only exception to this rule is that we used "baking bread," as the U. S. data had already been collected and could not be recollected, and we wanted to replicate the U.S. analysis as closely as possible. Using the root was particularly important for Japanese because characters are not conjugated.

In addition to the initial selection of culturally relevant terms based on familiarity with a country and its culture, we also had two quantitative criteria: One for general cultural relevance and

Table 2. Ten Most Common Words in Each Language and Their Source.

Order of frequency	English	Spanish	Japanese	Indonesian
1	*the*	*de* (of)	の (possessive particle)	*aku* (I)
2	*be*	*la* (the, her)	に (in)	*tidak* (not)
3	*to*	*que* (that, what)	する (to do)	*yang* (which, who, whom, what [relative pronouns], one [impersonal pronoun])
4	*of*	*el* (he)	は (topic marker)	*kau* (you, your)
5	*and*	*en* (in)	を (direct object of action marker)	*ini* (this)
6	*a*	*y* (and)	が (sentence subject marker)	*itu* (that)
7	*in*	*a* (at)	と (and)	*di* (in, at, on)
8	*that*	*los* (the [plural]	年 (year)	*dan* (and)
9	*have*	*se* (Reflexive particle)	で (at)	*akan* (will, about to, going to)
10	*I*	*del* (of the)	だ (to be)	*apa* (what [interrogative pronoun])
Source	https://web.archive.org/web/20111226085859/http://oxforddictionaries.com/words/the-oec-facts-about-the-language	http://corpus.rae.es/lfrecuencias.html	https://flexiclasses.com/japanese/common-japanese-words/#chapter-1	https://www.lexisrex.com/Common-Indonesian-Words#google_vignette

one to statistically ensure that for each culture the words cohered as a single construct. For the general cultural relevance criterion, we eliminated all terms in a particular country with fewer than 20 average daily Twitter mentions in that country over the entire study period (60 days) or with insufficient valid data on the term's Google search history in that country in the same study period (see **Google Trends** for an explanation of how Google filters out externally invalid data).

The terms that were excluded based on this frequency criterion were "cooking directions" in the United States; "fear of death," "share," "grow vegetables," and "grow plants" in Japan; "seeds," "baking bread," "grow vegetables," and "grow plants" in Indonesia; and "farmland," "baking bread," "grow vegetables," "grow plants," and "cooking directions" in Mexico (marked n.a. in Tables 3–5).

Our quantitative criterion for the extent to which words in the composite variables cohered as a single construct was the item–total correlation. Applying the same quantitative criterion across all concepts in all countries provided a uniform criterion that did not rely on the intuitions of different cultural experts. We conceptualized the words comprising one construct as complementary alternatives, depending on the individual's experience and ecology. For example, the frequency of mentioning "garden" or "shovel" could not increase for individuals living in a high-rise apartment building, but could increase for people living in an environment with arable land. Therefore, we used item–total correlation to measure conceptual coherence; this statistic is the correlation of each item with the mean of the construct. Items with item–total correlations of .2 or more provide evidence that the item is contributing to the same construct measured by the other items included in the scale (Streiner et al., 2015). Therefore, items with $<.2$ correlation with the mean of the construct were dropped from the composite variable. The terms that met both criteria for inclusion in a construct in each country are shown in Tables 3–5, which also show which items were dropped because of not meeting the frequency criterion (marked n.a.) and which items were subsequently dropped for not meeting the item–total correlation criterion (marked with a dash). As you can see from the mean item–total correlations in the table notes, most item–total correlations were quite high.

Following Evers et al. (2021), we grouped the terms into composite variables for each hypothesis. We averaged the daily mentions of each term comprising the composite variable for each day in our analysis (see Tables 3–5 for the composite variables and term lists used in each country). Words listed in the tables for Japan, Indonesia, and Mexico are direct translations of the United States English word unless there is a different word in parentheses next to it, as occurs only in Table 5.

Inferential Statistical Analysis

For each composite variable, we have a sample of 30 scores (1 per day) in the before-COVID period and 30 scores (1 per day) in the during-COVID period. Because day, rather than person, is the unit of analysis, and because Google searches and Twitter data from adjacent days consist of input from large and constantly varying samples of internet users in each country, data from adjacent days are independent.

For each country, we conducted multiple regressions to assess the degree and statistical significance of shifts in each composite dependent variable—mortality salience, collectivism, and subsistence activities. We created dummy variables with pre-COVID as the baseline (dummy = 0 if pre-COVID; dummy = 1 if during-COVID). Because the Shapiro-Wilk test indicated that 7 out of 12 dependent variables, spread over all 4 countries, were not normally distributed, bootstrapping was used to handle nonnormality for all variables in all 4 countries. In each analysis, frequencies of common contentless words in each language was the covariate, as a control for general increase in internet use. Since there were four countries (United States, Japan, Indonesia, Mexico) and three dependent variables, there were 12 regressions in total.

Table 3. Terms Representing Mortality Salience.

Tested terms	United States[a]	Japan[b]	Indonesia[c]	Mexico[d]
survive	survive	生き	bertahan	sobrevivir
cemetery	--------	-----	----------	----------
fear of death	fear of death	n.a	takut mati	----------
death	death	死	kematian	muerte
bury	--------	-----	----------	enterrar

Note. The tested terms are the original list from Evers et al. (2021). The tabled terms for each country are the ones that met both frequency and item–total correlation criteria. --- = Either Google or Twitter data (or both) did not have item–total correlation of at least .2; n.a. = did not meet frequency criterion on both Google searches and Twitter.
Mean item–total correlations: [a] Google Trends .71, Twitter .71. [b] Google Trends .51. [b] Twitter .69. [c] Google Trends .62; Twitter .56. [d] Google Trends .55; Twitter .59.

Table 4. Terms Representing Collectivism.

United States[a]	Japan[b]	Indonesia[c]	Mexico[d]
sacrifice	-----	----------	sacrificar
share	n.a.	membagi	compartir
help	手伝	membantu	ayudar
give	あげ	memberi	dar

Note. All of the original terms used in Evers et al. (2021) met both frequency and item–total correlation criteria in the U.S. data. Hence it was not necessary to have a separate "tested term" column. The tabled terms for each country are the ones that met both frequency and item–total correlation criteria. --- = did not have item–total correlation of at least .2; n.a. = did not meet frequency criterion on both Google searches and Twitter.
Mean item–total correlations: [a] Google Trends .88, Twitter .83. [b] Google Trends .60, Twitter .59. [c] Google Trends .96; Twitter .67. [d] Google Trends .62; Twitter .56.

Excess Mortality

For our measure of daily excess mortality during the study period, we used all-cause-mortality data and excess mortality estimates from Karlinsky and Kobak (2021).

We sum up the reported COVID deaths and excess mortality in each country for 2020 to derive the undercounting ratio, defined as the ratio between excess mortality to reported COVID mortality. For example, during 2020 Mexico has reported about 147 thousand COVID deaths yet excess mortality was higher at 321 thousand, leading to an undercount ratio of 2.18. Conversely, in Japan 2020, COVID spread was low such that no significant excess mortality was observed, meaning that reported COVID deaths were not undercounted. Note that, in Indonesia, excess death estimates are based on data from the capital city, Jakarta, because this is the only part of Indonesia that has high-quality vital registration data.

Our estimated undercount ratio for the study countries is: 1, 1.38, 2.18, and 4.21 for Japan, United States, Mexico, and Indonesia, respectively. To obtain daily excess mortality figures, we multiply the daily COVID deaths in each country, as reported to the World Health Organization, by the undercount ratio.

Google Search Behavior Shifts in the Pandemic

Google Trends

As noted in Evers et al. (2021), Google Trends is a tool that enables interest analysis of a national population. It provides access to a representative sample of Google searches pulled from billions

Table 5. Terms Representing Subsistence Activities.

Tested terms	United States[a]	Japan[b]	Indonesia[c]	Mexico[d]
farm	farm	農場	-------	-------
shovel	shovel	------	-------	-------
garden	garden	菜園	-------	-------
recipes	recipes	レシピ	resep	recetas
cooking directions	n.a.	作り方	cara masak	n.a.
sourdough/rice/tortilla	sourdough	--------	-------	tortilla (tortilla)
cook	cook	料理	masak	cocinar
sewing machine	sewing machine	ミシン	mesin jahit	---------
sew	sew	縫う	jahit	---------
tools	------	道具	perkakas	---------
Home Depot/hardware store	Home Depot	ホームセンター (hardware store)	-------	ferreteria (hardware store)
farmland	-------	----------	-------	n.a.
seeds	seeds	種	n.a.	semillas
baking bread	baking bread	パンを焼く	n.a.	n.a.
grow vegetables	grow vegetables	n.a.	n.a.	n.a.
grow plants	grow plants	n.a.	n.a.	n.a.

Note. "Sourdough" and "Home Depot" were too idiosyncratic to the United States and required a cultural translation in addition to a language translation: "Sourdough" was translated to the dominant starch in each country: "tortilla" for Mexico, "お米" (rice) for Japan, and "nasi" (rice) for Indonesia. "Home Depot" was translated to "ferretería" for Mexico, "toko bangunan" for Indonesia, and "ホームセンター" for Japan (all meaning "hardware store"). The tested terms are the original list based on Evers et al. (2021). The tabled terms for each country are the ones that met both frequency and item–total correlation criteria. --- = did not have item–total correlation of at least .2 on both Google searches and Twitter; n.a. = did not meet frequency criterion on both Google searchers and Twitter.
Mean item–total correlations: [a] Google Trends .84, Twitter .52. [b] Google Trends .71, Twitter .59. [c] Google Trends .78, Twitter .40. [d] Google Trends .72; Twitter .46.

of daily searches ("FAQ About Google Trends Data," n.d.). The data are anonymized, categorized, and aggregated to accurately show Google interest in topics from a worldwide level down to a small-scale city level. The representative sample that Google Trends accesses is almost entirely unfiltered, except for some particular cases where Google purposefully filters out searches to improve its sample's external validity: It filters out searches made by very few people, duplicate searches by the same person in a short period, and searches with apostrophes and other special characters.

The Google Dependent Variable

Google Trends transforms its search frequency for each term in a given region and time into a metric called "search interest" or just "interest." The interest metric is a percentage based on a set time frame. Each day's search interest for a term is a percentage of peak interest in the selected time frame and geographical area. For example, an interest value of 100 means that on that date, the search term reached its peak popularity for a given time frame and geographical area, and a value of 50 means that on that date, the term was half as popular as its peak popularity in the same time frame. The Google study's time frames were 61 days, including the transitional day, with the same start and end dates as for the Twitter analyses. (see **Study Design**). Our dependent variables were, for every day of the time frame (excluding the transitional day) and every composite variable, the average search interest for the composite variables' terms. The independent variables were before vs. after each country's emergency COVID declaration.

Google Results

Hypothesis 1: Compared With the 30 Days Before a COVID Emergency Was Declared in Each Country, the 30 Days Following the Declaration Would See a Significant Rise in the Psychological Salience of Mortality to the Extent That Countries Experienced Excess COVID Mortality. In the first 30 days of the pandemic, Japan had almost no excess COVID mortality: less than one person per 100,000 (0.37/100k). Mexico had very slightly more, but still less than one person per 100,000 people (0.70/100k). Jakarta, Indonesia's excess COVID mortality was much larger—more than six people per 100,000 (6.22/100k). The United States had the largest excess mortality in the first 30 days of the pandemic—more than 9 people per 100,000 (9.48/100k).

Controlling for a general increase in internet use, the results, shown in Table 6, confirmed our hypothesis. The two countries that experienced the largest excess COVID mortality in this time frame, the United States (excess mortality of 9.48/100k) and Indonesia (excess mortality of 6.22/100k), experienced the largest increases in mortality salience (United States: 33% increase; Indonesia: 38% increase). Regression analysis showed both these increases to be significant at the .001 level. In Japan, a country that experienced virtually no excess mortality in this time frame (excess mortality of 0.37/100k), mortality did not become more salient. Mexico was intermediate in excess mortality (mortality of 0.70/100k) and intermediate in the rise of mortality salience (14% increase, $p = .043$; see Table 6).

Table 6. Google Search Interest for Mortality Salience Terms Before and During the COVID-19 Pandemic.

	Before COVID-19		During COVID-19		Percentage change	Regression with Bootstrap			
						Before vs. during COVID-19		Internet use	
Country	*M*	*SD*	*M*	*SD*		β	*p*	β	*p*
United States	56.57	8.98	74.97	6.33	33	15.26	<.001	0.49	.111
Japan	50.92	10.02	50.55	5.15	−1	−2.13	.526	0.47	.526
Indonesia	42.31	8.58	58.41	7.74	38	16.04	<.001	0.003	.987
Mexico	41.99	10.00	47.67	9.41	14	6.34	.043	−0.13	.387

Note. COVID-19 = coronavirus disease.

Hypothesis 2: Compared With the 30 Days Before a COVID Emergency Was Declared in Each Country, the First 30 Days Following the Declaration Would See a Significant Rise in References to Collectivistic Values, to the Extent That Countries Experienced Excess COVID Mortality and Increased Mortality Salience. The results mostly confirmed this hypothesis (see Table 7). After controlling for overall internet use, the United States, as predicted, showed a significant rise in the frequency of terms representing collectivism. As predicted, Mexico also showed a significant increase in collectivistic terms during COVID. As predicted, Japan, with no excess COVID mortality and no rise in mortality salience, did not show a significant rise in the use of collectivistic terms during this time period. Surprisingly, despite Indonesia having a large increase in the use of collectivistic terms during COVID-19, after controlling for Indonesia's similarly large general increase in internet use during the pandemic, Indonesia's increase in collectivistic terms was not statistically significant. Indonesia's increase in the use of collectivistic terms appears to be mainly due to increased internet use ($\beta = 2.16$, $p < .001$), rather than due to COVID-19 itself. Therefore, Indonesia did not confirm our prediction, despite experiencing a large raw increase in collectivistic term usage.

Table 7. Google Search Interest for Collectivistic Terms Before and During the COVID-19 Pandemic.

	Before COVID-19		During COVID-19		Percentage change	Regression with Bootstrap			
						Before vs. during COVID-19		Internet use	
Country	*M*	*SD*	*M*	*SD*		β	*p*	β	*p*
United States	67.39	5.91	82.42	7.93	22	4.81	.010	1.60	< .001
Japan	50.58	11.98	54.38	14.72	8	–0.08	.990	1.04	.259
Indonesia	39.11	6.86	76.02	16.02	94	–1.50	.379	2.16	<.001
Mexico	52.24	7.72	62.28	7.75	19	6.89	.003	0.62	<.001

Note. COVID-19 = coronavirus disease.

Hypothesis 3: Compared With the 30 Days Before a COVID Emergency Was Declared in Each Country, the First 30 Days Following the Declaration Would See a Significant Rise in References to Subsistence Activities for Countries That Experienced Excess COVID Mortality and/or Stay-at-Home Policies. This hypothesis was confirmed. Whereas Japan did not experience any excess COVID mortality during this period, the population was subjected to stay-at-home policies. Greenfield et al.'s (2021) structural equation model indicated that subsistence activities were predicted by the practice of stay-at-home. In accord with our hypothesis, all four countries experienced a significant rise in subsistence activities (Table 8). However, Indonesia and the United States had the extra factor of excess mortality driving increases in subsistence activities, as the structural equation model in Greenfield et al.'s (2021) U.S. survey study had shown. This additional factor may be responsible for the fact that their percentage increases are greater than those of Japan and Mexico.

Table 8. Google Search Interest for Subsistence Activities Terms Before and During the COVID-19 Pandemic.

	Before COVID-19		During COVID-19		Percentage change	Regression with Bootstrap			
						Before vs. during COVID-19		Internet use	
Country	*M*	*SD*	*M*	*SD*		β	*p*	β	*p*
United States	67.39	5.91	82.42	7.93	22	20.64	< .001	.59	.138
Japan	50.58	11.98	54.38	14.72	8	18.50	< .001	.15	.757
Indonesia	39.11	6.86	76.02	16.02	94	15.97	.044	.12	.745
Mexico	52.24	7.72	62.28	7.75	19	18.85	< .001	.137	.277

Note. COVID-19 = coronavirus disease.

Twitter Behavior Shifts in the Pandemic

Talkwalker Analysis of Twitter

We conducted three independent replications of the U.S. social media research in Indonesia, Japan, and Mexico. Although the original study examined data from Twitter, blogs, and forums, we excluded blogs and forums for cross-cultural replication because their usage rates were not high enough in Indonesia and Mexico.

Talkwalker, a social media scraping software, was used to collect term frequencies on Twitter in the United States, Indonesia, Japan, and Mexico. Terms, composite variables, statistical analysis, and hypotheses were the same as for the Google search data.

Twitter Results

Hypothesis 4: Compared With the 30 Days Before a COVID Emergency Was Declared in Each Country, the 30 Days Following the Declaration Would See a Significant Rise in the Psychological Salience of Mortality to the Extent That Countries Experienced Excess COVID Mortality. As with Google searches, the results confirmed this hypothesis (see Table 9). Controlling for a significant covariate effect, we found that references to mortality significantly increased in the United States, which had the largest increase in excess mortality. The rise in internet use was not a significant covariate in the other three countries. Across the four countries, the rank order of percentage change in mortality salience followed the rank order of excess mortality. Not far behind the 75% increase in mortality salience in the United States (excess mortality of 9.48/100k) was Jakarta, Indonesia with a 60% increase in mortality salience (excess mortality of 6.22/100k). There was some distance between Indonesia and the other two countries, Mexico and Japan, in both percentage change in mortality salience and excess COVID mortality (Mexico, 0.70/100k; Japan, 0.37/100k). The very low rate of excess mortality in Mexico and the even lower excess mortality in Japan were reflected in very small percentage changes in the frequency of mortality terms posted on Twitter.

Table 9. Frequency of Mortality Salience Terms in Twitter Posts Before and During the COVID-19 Pandemic.

	Before COVID-19		During COVID-19		Percentage change	Regression with Bootstrap			
						Before vs. during COVID-19		Internet use	
Country	*M*	*SD*	*M*	*SD*		β	*p*	β	*p*
United States	94,151	22,167	164,349	26,760	75	55,999.9	<.001	2,219.6	.013
Japan	213,177	31,441	208,302	15,924	–2	3,334.0	.597	–2,202.7	.198
Indonesia	6,135	3,608	9,814	3,277	60	2,855.6	.185	46.2	.642
Mexico	4,377	2,196	4,543	1,071	4	202.8	.632	–7.3	.780

Note. COVID-19 = coronavirus disease.

Hypothesis 5: Compared With the 30 Days Before a COVID Emergency Was Declared in Each Country, the First 30 Days Following the Declaration Would See a Significant Rise in References to Collectivistic Values to the Extent That Countries Experienced Excess COVID Mortality and Increased Mortality Salience. As with Google searches, the results confirmed this hypothesis (see Table 10). In all four countries, the posting of collectivistic terms increased on Twitter after the pandemic began. The shifts were statistically significant in the United States and Indonesia, the countries with the highest excess mortality and the largest augmentation of mortality salience. The percentage increase was, however, larger in Indonesia (75%) than the United States (44%). Corresponding to the low excess mortality in Mexico and Japan during our study period, Mexico experienced the second lowest (11%) and nonsignificant increase in posting collectivistic terms, while Japan experienced a nonsignificant 8% percent increase.

Table 10. Frequency of Collectivistic Terms in Twitter Posts Before and During the COVID-19 Pandemic.

	Before COVID-19		During COVID-19		Percentage change	Regression with Bootstrap			
						Before vs. during COVID-19		Internet use	
Country	*M*	*SD*	*M*	*SD*		β	*p*	β	*p*
United States	511,772	43,831	736,993	119,806	44	229,001.4	<.001	–591.0	.826
Japan	253,188	42,117	273,365	27,109	8	20,167.3	.116	2.5	1.000
Indonesia	7,804	2,763	13,631	4,537	75	5,388.6	.024	24.6	.852
Mexico	11,563	2,035	12,888	2,143	11	856.9	.090	91.7	.067

Note. COVID-19 = coronavirus disease.

Hypothesis 6: Compared With the 30 Days Before a COVID Emergency Was Declared in Each Country, the First 30 Days Following the Declaration Would See a Significant Rise in References to Subsistence Activities for Countries That Experienced Excess COVID Mortality and/or Stay-at-Home Policies. The results mostly confirmed this hypothesis (see Table 11). As with Google searches, it appears that the predictions indicated by Greenfield et al.'s (2021) structural equation model held true, and subsistence activities were sensitive to stay-at-home policies. The increase in subsistence activities was statistically significant in the United States, Indonesia, and Japan, and borderline in Mexico.

Table 11. Frequency of Subsistence Activities Terms in Twitter Posts Before and During the COVID-19 Pandemic.

	Before COVID-19		During COVID-19		Percentage change	Regression with Bootstrap			
						Before vs. during COVID-19		Internet use	
Country	*M*	*SD*	*M*	*SD*		β	*p*	β	*p*
United States	9,130	1,807	15,687	2,504	72	5,251.8	< .001	204.1	.015
Japan	21,622	3,151	36,147	5,217	67	1,333.5	< .001	319.7	.262
Indonesia	1,879	663	3,979	1,244	112	1,690.4	.002	23.6	.399
Mexico	486	295	729	336	50	146.3	.059	18.9	.007

Note. COVID-19 = coronavirus disease.

Discussion

In national samples of Google searches and Twitter posts from four distinct regions of the world, we confirmed theoretically and empirically derived predictions that, as a function of excess mortality and stay at home policies, COVID-19 would increase mortality salience, engagement in subsistence activities, and collectivistic values. Four of our six hypotheses were completely confirmed; the other two were mostly confirmed. We showed that the size of shifts in mortality salience and collectivism across the United States, Indonesia, Mexico, and Japan mirrored the specific cross-cultural pattern of COVID excess mortality.

In contrast, the pattern of increases in subsistence activities included the influence of stay-at-home policies. Despite the absence of COVID-induced mortality in Japan, the country was under

stay-at-home orders. Our prior COVID survey in the United States showed that the number of days each participant spent staying at home—a measure of the retraction of their social world—significantly predicted increased subsistence activities (Greenfield et al., 2021). Hence, the increases in this variable in Japan in both Google searches and Twitter posts were also consonant with our theoretical framework. In fact, it is interesting that subsistence activities showed the most consistent augmentation across all four countries. We interpret this finding as a function of the influence of shrinking community sizes as indicated by stay-at-home policies. The structural equation model from Greenfield et al. (2021) showed that both increased mortality salience and stay-at-home orders increase engagement in subsistence activities. Therefore, because all countries were under stay-at-home orders during the study period, the influence on subsistence activities was consistent across all countries.

Overall, the rise of collectivism in Japan was weaker than in the other three countries. These results likely occurred because, Japan, at this point in the pandemic, had by far the lowest excess COVID mortality, compared with the other three countries. This is consistent with the structural equation model, which showed that collectivism is dependent on mortality salience, but not on stay-at-home experience (Greenfield et al., 2021).

Replicability and Ecological Validity

Given concerns about replicability in psychological science (e.g., Makel et al., 2012), it is notable that we conducted replications with eight independent big data samples from four countries across several continents. A notable feature of the results is that the effects occurred incredibly fast, in the first 30 days of the pandemic, and the majority of the regression coefficients were large. The speed and size of the effects testify to the power of the theory to make scientifically important predictions, as well as to the power of the pandemic to create socially significant cultural and behavioral change.

These results have tremendous ecological validity because individuals in each country interacted naturally in familiar online environments. These are environments, moreover, in which people do not explicitly think anyone is recording their interactions. For this reason, our study shows that the Theory of Social Change, Cultural Evolution, and Human Development accurately conceptualizes and predicts behavioral and value responses to increased danger and the shrinking of the social world for internet-using humans worldwide. Combined with a significant and growing body of prior research on the cultural and behavioral effects of social change on several continents—with and without access to the internet, and at different historical periods—this study shows the theory's power to predict automatic shifts in psychology and behavior that would otherwise be difficult to explain (Abu Aleon et al., 2019; Garcia et al., 2015; Ionescu et al., 2023; Maynard et al., 2015; Weinstock et al., 2015; Zeng & Greenfield, 2015; Zhou et al., 2017).

The increase in mortality salience (thinking about one's death and the deaths of others) may be seen as a somewhat obvious response to real increases in countries' death rates. However, the rise in collectivistic values and subsistence activities across seemingly distinct contexts (growing edibles, food preparation, making/repairing clothes, and shelter maintenance) was not obvious (Greenfield et al., 2021).

A dramatic increase in collectivism would have been challenging to predict at the outset of the pandemic, and curiosity around this ambiguity led to the original study's development (Sweet, 2021). Without studying the psychological literature around mortality salience, it appeared that the pandemic would make humans more individualistic, and there were substantial behavioral indications to support that prediction. Worldwide, hoarding, a quintessentially individualistic phenomenon, was predominant. The start of the pandemic was marked by a "grocery-hoarding frenzy" (D'Innocenzio & The Associated Press, 2020) with

worldwide reports of supermarket panic buying (Bengali & Jennings, 2020; Loasana, 2020; Sault, 2020), shoppers in long lines at supermarkets waiting to be first through the doors, and shelves wiped out of essentials (Manning-Schaffel, 2020; Zagorsky, 2020). Sellers were also using this panic to engage in predatory capitalism. In response to the increased demand, N95 mask listing went from US$18.20 in mid-January to US$199.99 at the end of February; a dozen Purell bottles selling at US$30 in January skyrocketed to US$159.99 by March 3; and shoppers were being quoted astronomical shipping fees up to US$5,000 for next-day air (Tyko, 2020). However, people were not responding to the laws of supply and demand because household products were not generally at risk of low supply (Zagorsky, 2020).

What caused the hyper-individualists observed at the onset of the pandemic to become significantly more collectivistic? We would argue that they adapted to living in societies with high mortality rates and small social units. For example, around the time of Trump's emergency declaration, just over 50 people had died from COVID-19 in the United States. That figure increased 10-fold over the next week and up to over 16,000 by the end of our study period (Centers for Disease Control and Prevention, 2022). Massive increases in societal mortality appear to have caused death to become significantly more salient, as indicated by our research, which, in turn, predicted the adaptive shift toward collectivistic values observed in every country, except for Japan, where there was, in fact, no increase in COVID-related mortality during our study period.

Our theory is also unique in its ability to predict the significant increase in subsistence activities. Aside from moments during the initial supermarket panic and hoarding, there was never any time during the pandemic when people might have needed to become self-sufficient. Food delivery never stopped; no water shortage occurred; governments categorized supermarkets and home repair as "essential services"; almost everything was available online. Taking a big-picture approach, the only significant difference in worldwide commercial functions was that an unprecedented number of transactions moved online, and goods came as deliveries. Nonetheless, every country in our analysis engaged in significantly increased subsistence activities across various domains. The exception to this rule was Mexico on Twitter, which was still borderline significant ($p = .059$). Because these shifts happened so quickly, in about a month, we conclude that these responses reflect evolutionarily conserved adaptations to changing environmental conditions.

Social Movements in Light of This Study's Findings

One may expect a pandemic with government lockdowns to be a time of latency for social movements. However, this was far from the case. Increasing subsistence activities indicated a significant increase in the exercise of practical intelligence, and increasing collectivism augmented collectively oriented social intelligence to create a significant desire to solve problems that faced communities and to solve them using real-world action, which is the broad-strokes definition of a social movement (Evers & Greenfield, 2021). The social movements were as diverse in size and type as the communities that led them. In the United States, the George Floyd Protests were the "largest movement in U.S. History" by protest turnout (Buchanan et al., 2020). The 2020 United States Presidential Election had the highest voter turnout by percentage since 1900 for Democrats and Republicans (Evers & Greenfield, 2021). The 2021 United States Capitol Attack was the first mass breach of the U.S. Capitol since the War of 1812 (Evers & Greenfield, 2021).

Massive social movements spread internationally as well. For example, the Black Lives Matter movement spread in various forms from the United States to each of the countries in our study. In Indonesia, a "Papuan Lives Matter" movement focused on racial justice for the territory of West Papua on the island of New Guinea (Gunia, 2020). Although the movement was mostly online, non-Papuans took to the streets, calling for change (Pierson, 2020). In Mexico, Black

Lives Matter spread to Tijuana, where protesters gathered at the Palacio Municipal to raise awareness about "rampant racism toward and police brutality against Tijuana's Black migrant community" (Olvera Cáñez et al., 2020). In Japan, street protests against racism and police brutality against foreigners in the country took place in Tokyo and Osaka (Takahashi, 2020).

Implications of Our Findings for the Theory of Social Change, Cultural Evolution, and Human Development

Our findings show that the dramatic pandemic-induced shift in ecological conditions corresponded with equally dramatic shifts in mortality salience, engagement in subsistence activities, and collectivistic values, which occurred in a rapid time frame (30 days). For comparison, another study, supporting our theory, analyzed the text of millions of American English books and found that "obliged" (a strong collectivistic word) took 40 years to decline from 1960–2000 by proportions comparable to the 30-day decline in the collectivistic terms observed in America during this study (Greenfield, 2013). The most obvious difference between these two situations was the rate of ecological change: 40 years of gradually increasing life spans and community sizes in the United States versus less than a month of dramatically increased death rates and stay-at-home orders (Greenfield, 2013; Ninde, n.d.). Short life-spans and small communities are both hallmark signs of a subsistence ecology. The extraordinary speed with which psychology and behavior shifted indicates an automatic behavioral and cultural response to certain environmental conditions. Automatic responses of this kind make logical sense from the perspective of cultural evolution because social groups who had psychological responses optimized for their environments would have outcompeted those who did not. When the environment becomes more dangerous, if one group automatically starts planning and thinking more about survival (mortality salience), engages in activities that are most likely to improve their chances of survival (subsistence activities), and forms a tighter, stronger community (collectivism), they will likely outcompete other groups; and their characteristics will be a target of natural selection.

How lasting are these changes? Humans quickly adapted to the sudden pandemic-induced ecological changes, but as these conditions have reversed, we predicted that people would likely adapt in the opposite direction at a rate dependent on the speed of ecological reversal. To test this prediction, researchers should replicate this study to analyze these countries' recovery from the pandemic. The study design might have to change depending on countries' recovery speeds. However, despite our prediction that the population as a whole will readapt to the commercial ecology as it previously existed, prior research has shown that transitory ecological conditions have a lifelong impact on the values of individuals between 9 years old and early adulthood (Bianchi, 2014; Minoura, 1992).

Future Directions

Our main future direction, already begun, is to create a longitudinal model of our results using excess mortality in each country as the independent variable. We plan to make two models, one using the same dependent variables as we used here. The other model will explore the effect of the pandemic on concepts of family, authority, and religion; we have already developed a Twitter dataset on these concepts using the same timeline and the same four countries as in the present research. A newly published study (October 20, 2023) used the World Values Survey to explore effects of the pandemic on a similar set of values: family, authority, and religion, in Japan (Akaliyski et al., 2023). The basic idea is the same: that based on actual experiences of increased mortality, COVID created existential insecurity—what we term mortality salience—that moved these values in a direction opposite to the historically dominant direction of value change. We

will discuss their findings in our next article; that article will explore the effect of COVID on concepts of family, authority, and religion in our four study countries, one of which is Japan.

Limitations and Conclusion

This study measured the effects of the COVID-19 pandemic on psychology and behavior by analyzing how the language people used online changed in the first 30 days of COVID in the United States, Mexico, Japan, and Indonesia. Using such methods to represent human psychology and behavior has been validated in other studies and has substantial precedent; however, they are indirect measures. In addition, Twitter results skew toward internet users actively writing content because we are analyzing the words and phrases posted on Twitter. These users might be slightly different from passive Twitter users and the rest of the population.

Probably the most important limitation is that we had access to Talkwalker for only 30 days before and after the pandemic's start in each country, so that was our study period. Whereas this worked well in the United States and Japan, which had very high internet penetration, it probably caused some increases in Indonesia and Mexico to fail to reach statistical significance. This was especially the case on Twitter, which we believe is underpowered compared with Google because much lower proportions of the populations use Twitter in each country. This creates more noise on Twitter and a larger sample is required to find significant effects. This theory is supported by the fact that whenever an effect was significant on one platform but not the other, it was significant on Google and indicative (but not significant) on Twitter.

Another limitation is that we did not explore a list of individualistic words. However, we do not see this as a true limitation because individualism and collectivism are not necessarily opposites; both values, as expressed in texts, can increase at the same time (e.g., Zeng & Greenfield, 2015). For a number of reasons, notably, the rise in technologically mediated communication, we would not necessarily predict that individualism would decrease during the pandemic as collectivism increased.

A final limitation is that the original list of words for each construct came from the United States. Hence, not all words were relevant in all countries. Therefore, our tests of cultural relevance indicated that more words had to be eliminated in the other countries than in the United States. However, results concerning COVID-related shifts remained constant when words were eliminated. In conclusion, we believe this study to have accurately documented the human capacity for specific, rapid, and dramatic psychological and behavioral adaptations to ecological danger and shrinking social worlds, as predicted by the Theory of Social Change, Cultural Evolution, and Human Development.

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