

The Mind Between Climate and Action

Designing climate communication around how people process, feel, and act.

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Question. Can the same climate facts be written with different communication designs that differ measurably in accessibility, emotional framing, and actionability?

Scope. This measures properties of AI-generated text. It does not test human comprehension, emotion, efficacy, intention, or behavior.

Design

3 climate topics $\times$ 5 prompt conditions $\times$ 5 messages = 75 messages. The facts are identical within a topic; only the instruction changes. Each prompt begins "Write a short public climate message (under 50 words) using only these facts." and then adds:

Condition	Added instruction
A. Baseline	None added (baseline)
B. Clarity	Use plain language, short sentences, and one idea.
C. Meaning	Frame it around what people value, with hope-based, values-oriented language and no exaggeration.
D. Action	Include one specific, doable step and why it works.
E. Integrated	Use plain language and short sentences, frame it around what people value with hope, and include one specific, doable step.

Facts held constant

Warming

Earth's average surface temperature has risen about 1.1 C (about 2 F) since 1880 (NASA GISS).

The warming is largely driven by carbon dioxide and other human-made emissions (NASA).

Sea level

Global sea level has risen about 8 inches (20 cm) since 1880 (NASA).

Sea level is projected to rise another 1 to 4 feet (30-120 cm) by 2100 (NASA).

Extreme heat

Hot extremes, including heatwaves, have become more frequent and more intense across most land regions since the 1950s (IPCC AR6 WGI SPM).

Some recent hot extremes would have been extremely unlikely without human influence on the climate (IPCC AR6 WGI SPM).

Measures

Linguistic accessibility: Flesch–Kincaid grade level and mean sentence length (Python ``textstat``). Cognitive-load theory motivates this dimension, but these are reading metrics, not measures of cognitive load.

Threat language: NRC Emotion Lexicon words tagged "fear" per 100 words.

Hopeful-language proxy: NRC words tagged joy, trust, or anticipation per 100 words. A lexical proxy, not a validated measure of hope.

Actionability index: action verbs + efficacy cues ("you can", "we can", ...) + specificity cues ("this week", "today", ...) per 100 words. Exploratory custom metric; word lists are in the code below.

Results

Means $\pm$ 95% t-intervals across 15 messages per condition (5 per topic). Descriptive only; inferential statistics are not interpreted because messages are nested within topic, generated by one model, and each prompt directly instructs the target design.

Condition	Reading grade	Words / sentence	Threat / 100	Hopeful proxy / 100	Actionability / 100
A. Baseline	13.3 $\pm$ 1.8	21.8 $\pm$ 4.7	1.0 $\pm$ 0.9	4.6 $\pm$ 2.0	0.0 $\pm$ 0.0
B. Clarity	3.3 $\pm$ 0.8	7.0 $\pm$ 0.8	0.7 $\pm$ 0.7	4.1 $\pm$ 2.6	0.5 $\pm$ 0.7
C. Meaning	7.5 $\pm$ 0.7	15.6 $\pm$ 1.5	1.3 $\pm$ 0.9	10.6 $\pm$ 3.1	2.0 $\pm$ 1.1
D. Action	6.4 $\pm$ 1.0	14.0 $\pm$ 1.6	1.3 $\pm$ 1.2	8.0 $\pm$ 3.5	15.4 $\pm$ 1.7
E. Integrated	4.6 $\pm$ 0.6	10.9 $\pm$ 0.7	1.8 $\pm$ 0.8	10.9 $\pm$ 3.6	12.4 $\pm$ 2.4

Linguistic accessibility (reading grade, lower = easier)

Reading grade by condition

Emotional framing (words per 100)

Threat and hopeful-language proxy by condition

Actionability (cues per 100 words)

Actionability index by condition

Reading. Prompt-controlled design produced distinct, measurable linguistic profiles from the same facts. This shows the prompts worked as instructed, not that any design is more effective for people.

All 75 messages

Warming (25 messages)

A. Baseline

According to NASA, Earth's average surface temperature has risen about 1.1°C (2°F) since 1880. This increase is largely driven by rising atmospheric carbon dioxide and other human-made greenhouse gas emissions, which have altered the planet's energy balance over the past century. Grade 11.3 · 20.5 words/sentence · threat 0.0 · hopeful proxy 4.9 · actionability 0.0

NASA's temperature records show that global average surface temperature has increased by roughly 1.1°C (about 2°F) since 1880. Scientists attribute this warming primarily to carbon dioxide and other greenhouse gases released by human activities such as fossil fuel combustion. Grade 12.2 · 19.0 words/sentence · threat 0.0 · hopeful proxy 2.6 · actionability 0.0

Since 1880, the global mean surface temperature has increased approximately 1.1°C (2°F), according to NASA analyses. The principal driver of this long-term trend is the accumulation of human-produced carbon dioxide and related emissions in the atmosphere. Grade 12.4 · 18.5 words/sentence · threat 0.0 · hopeful proxy 8.1 · actionability 0.0

Global surface temperatures have climbed about 1.1°C (2°F) above late nineteenth-century levels, NASA reports. The warming is predominantly caused by increased concentrations of carbon dioxide and other anthropogenic emissions resulting from industrial and energy-related activity. Grade 15.9 · 18.5 words/sentence · threat 0.0 · hopeful proxy 2.7 · actionability 0.0

NASA data indicate that Earth has warmed by approximately 1.1°C (2°F) since record-keeping began in 1880. This change is largely attributed to elevated levels of atmospheric carbon dioxide and additional human-generated greenhouse gases. Grade 13.0 · 17.0 words/sentence · threat 2.9 · hopeful proxy 0.0 · actionability 0.0

B. Clarity

Earth is warmer than it used to be. Since 1880, the planet's average temperature has gone up about 1.1°C. That is about 2°F. People caused most of this by burning fuels that release carbon dioxide. Grade 4.7 · 8.5 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 0.0

The planet has heated up. NASA says it is about 1.1°C (2°F) warmer than in 1880. The main cause is carbon dioxide. We add it to the air when we burn coal, oil, and gas. Grade 1.6 · 8.5 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 2.9

Here is the key fact. Earth's average temperature is up about 2°F since 1880. That is 1.1°C. Most of the rise comes from human-made carbon dioxide. Grade 3.3 · 6.5 words/sentence · threat 0.0 · hopeful proxy 3.8 · actionability 0.0

NASA measures Earth's temperature. It has gone up about 1.1°C since 1880. That is roughly 2°F. Burning fossil fuels adds carbon dioxide to the air. This extra gas traps heat. Grade 3.3 · 5.8 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 0.0

Our planet is about 2°F warmer than in 1880. That is 1.1°C. People are the main cause. Cars, power plants, and factories release gases that trap heat. Grade 3.2 · 6.5 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 0.0

C. Meaning

The world our grandparents knew is already changing. In just over a century, Earth has warmed by about 1.1°C, a shift mostly set in motion by human choices. That means the story of our climate is also a story about us, and about the future we decide to protect for the people we love. Grade 6.9 · 18.0 words/sentence · threat 0.0 · hopeful proxy 3.7 · actionability 3.7

Every child born today inherits a planet that has warmed by roughly 1.1°C since 1880, largely because of the carbon dioxide people have released. It is a sobering number, but it also tells us something hopeful: what humans changed, humans can help to heal. Grade 7.8 · 21.5 words/sentence · threat 0.0 · hopeful proxy 16.3 · actionability 2.3

Warmth is supposed to feel like home. Yet Earth has warmed about 2°F since 1880, mostly because of human emissions, and that change touches the places and seasons we cherish. Caring for this shared home is among the most meaningful things a generation can do. Grade 6.8 · 14.7 words/sentence · threat 2.3 · hopeful proxy 6.8 · actionability 0.0

Behind the 1.1°C of warming since 1880 are real places, real communities, and real futures. Because people drove most of this change, people also hold the power to shape what comes next, and that is a reason for hope. Grade 5.2 · 19.0 words/sentence · threat 2.6 · hopeful proxy 15.8 · actionability 2.6

We often think of climate as something far away. But the 1.1°C that Earth has warmed since 1880 is woven into the summers our families remember and the ones our children will inherit. Our emissions helped write this chapter, and together we can write a better one. Grade 6.6 · 15.3 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 6.5

D. Action

Earth has warmed about 1.1°C (2°F) since 1880, mainly from carbon dioxide emissions. You can reduce your share this week: switch your home to LED bulbs and set your thermostat two degrees lower in

winter. Lower energy use means fewer emissions. Grade 5.7 · 13.3 words/sentence · threat 0.0 · hopeful proxy 7.5 · actionability 20.0

NASA reports 1.1°C of warming since 1880, driven largely by human emissions. Take one step today: check whether your utility offers a renewable energy plan, and sign up. It takes about five minutes and cuts emissions from your electricity. Grade 8.2 · 12.7 words/sentence · threat 0.0 · hopeful proxy 2.6 · actionability 18.4

The planet is about 2°F warmer than in 1880, mostly because of carbon dioxide from human activity. Start with transportation. Walk, bike, or take the bus for one trip a week instead of driving, and track how much fuel you save. Grade 6.7 · 13.3 words/sentence · threat 0.0 · hopeful proxy 10.0 · actionability 20.0

Global temperatures have risen 1.1°C since 1880, largely due to human emissions. Here is one action: unplug idle electronics and use a power strip you can switch off. Less wasted electricity means less carbon dioxide released. Grade 7.6 · 11.7 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 11.4

Since 1880, Earth has warmed roughly 1.1°C because of rising carbon dioxide. Call or email your local representative this week and ask them to support clean energy. Your voice helps shape local decisions on emissions. Grade 6.4 · 11.3 words/sentence · threat 0.0 · hopeful proxy 11.8 · actionability 14.7

E. Integrated

Earth has warmed about 1.1°C since 1880, and people caused most of it. That is hard to hear, but it also means we can change it. This week, switch to a renewable energy plan from your utility. It takes five minutes and protects the summers we love. Grade 3.4 · 11.5 words/sentence · threat 2.2 · hopeful proxy 4.3 · actionability 10.9

The planet is 2°F warmer than in 1880, mostly because of human emissions. Our choices got us here, and our choices can lead us out. Try this: bike or walk one trip each week. Small trips add up to cleaner air for everyone you care about. Grade 4.5 · 11.2 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 13.3

Since 1880, Earth has warmed 1.1°C. The cause is human, and so is the power to respond. Start today: ask your family to lower the thermostat by two degrees. It saves money, cuts carbon dioxide, and shows your kids that change begins at home. Grade 4.5 · 10.8 words/sentence · threat 2.3 · hopeful proxy 9.3 · actionability 11.6

We have warmed our planet by about 2°F since 1880, but we also know exactly what to do. You can make a difference this week. Switch to LED bulbs, then tell a friend. Every bulb is a small act of care for the future. Grade 3.4 · 10.8 words/sentence · threat 0.0 · hopeful proxy 4.7 · actionability 9.3

Earth is 1.1°C warmer than in 1880 because of human emissions. Hope lives in what we do next. Join a local climate group this month, or sign up for a community energy program. Together, we can turn worry into progress. Grade 4.6 · 9.8 words/sentence · threat 2.6 · hopeful proxy 15.4 · actionability 10.3

Sea level (25 messages)

A. Baseline

NASA estimates that global sea level has risen approximately 8 inches (20 cm) since 1880, primarily due to thermal expansion of warming oceans and meltwater from glaciers and ice sheets. Projections indicate a further increase of 1 to 4 feet (30–120 cm) by 2100. Grade 12.3 · 18.5 words/sentence · threat 0.0 · hopeful proxy 2.7 · actionability 0.0

According to NASA, global mean sea level has increased by about 8 inches since 1880. The rise reflects ocean warming and the melting of land ice, and it is projected to continue, with an additional 1 to 4 feet anticipated by the year 2100. Grade 11.0 · 19.5 words/sentence · threat 0.0 · hopeful proxy 7.7 · actionability 0.0

Sea level has risen roughly 20 cm (8 inches) since 1880, according to NASA observations. Warming causes seawater to expand and glaciers to melt, contributing to a projected additional rise of 30 to 120 cm by 2100. Grade 11.1 · 15.5 words/sentence · threat 0.0 · hopeful proxy 3.2 · actionability 0.0

NASA's records show that average global sea level has gone up around 8 inches since 1880. Continued ocean warming and ice loss are expected to raise sea level by a further 1 to 4 feet before the end of the century. Grade 9.7 · 18.5 words/sentence · threat 2.7 · hopeful proxy 10.8 · actionability 0.0

NASA reports that the global ocean surface has risen about 8 inches (20 cm) since 1880, driven by thermal expansion and melting ice. Additional increases of 1 to 4 feet are projected by 2100. Grade 9.8 · 14.0 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 0.0

B. Clarity

The sea is rising. Since 1880, it has gone up about 8 inches. That is 20 centimeters. Warm water takes up more space. Ice on land is melting and flowing into the ocean. Grade 2.7 · 6.0 words/sentence · threat 0.0 · hopeful proxy 6.7 · actionability 0.0

NASA tracks the ocean. Sea level is about 8 inches higher than in 1880. By 2100, it could rise another 1 to 4 feet. Warmer water and melting ice are the causes. Grade 3.8 · 6.8 words/sentence · threat 0.0 · hopeful proxy 3.7 · actionability 0.0

Oceans are climbing. They are 8 inches higher than they were in 1880. Ice is melting. Water expands as it warms. Both push the sea up. Grade 1.4 · 4.8 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 0.0

Here is what NASA found. The sea has risen about 20 cm since 1880. It may rise 30 to 120 cm more by 2100. Melting glaciers add water. Warmer oceans swell. Grade 1.7 · 5.2 words/sentence · threat 0.0 · hopeful proxy 7.7 · actionability 3.8

Sea level is going up. It is 8 inches higher than in 1880. More rise is coming, maybe 1 to 4 feet by 2100. The reasons are simple. Oceans are warming, and ice is melting. Grade 2.6 · 6.0 words/sentence · threat 0.0 · hopeful proxy 6.7 · actionability 0.0

C. Meaning

Coastlines hold our memories: the boardwalk, the family beach, the neighborhood where we grew up. Since 1880, the sea has risen about 8 inches, and it may climb 1 to 4 feet more by 2100. Protecting these places means protecting the stories they hold. Grade 6.8 · 13.0 words/sentence · threat 0.0 · hopeful proxy 10.3 · actionability 0.0

For millions of people, the ocean's edge is home. Seas have risen roughly 20 cm since 1880 and are projected to rise further. Behind every inch is a community that cares deeply about its shoreline, and that care is a powerful force for good. Grade 7.0 · 14.0 words/sentence · threat 4.8 · hopeful proxy 14.3 · actionability 0.0

Imagine your favorite shoreline in the year your grandchild turns ninety. NASA projects another 1 to 4 feet of sea level rise by 2100, on top of 8 inches since 1880. What we value most is worth defending, and many are already rising to do it. Grade 7.3 · 13.7 words/sentence · threat 0.0 · hopeful proxy 17.1 · actionability 0.0

The sea has risen 8 inches since 1880, quietly reshaping the places where people live, fish, and gather. Hopeful communities everywhere are showing that a future with healthy coasts is something we can build together. Grade 10.1 · 16.5 words/sentence · threat 0.0 · hopeful proxy 9.1 · actionability 3.0

Every harbor town has a story. Rising seas, up 8 inches since 1880 with up to 4 feet more projected by 2100, are changing how those stories continue. Our love for these places can become the energy that carries us toward a safer shore. Grade 7.3 · 13.3 words/sentence · threat 0.0 · hopeful proxy 15.0 · actionability 0.0

D. Action

Sea level has risen about 8 inches since 1880 and may rise 1 to 4 feet more by 2100. Check your address on a free sea-level or flood map this week, and share it with your family so you can plan ahead. Grade 6.9 · 19.0 words/sentence · threat 2.6 · hopeful proxy 15.8 · actionability 13.2

NASA reports 20 cm of sea level rise since 1880, with more coming. Start with one step: look up whether your community has a coastal resilience plan, and attend one public meeting to ask how you can help. Grade 8.3 · 18.0 words/sentence · threat 0.0 · hopeful proxy 13.9 · actionability 19.4

The ocean is 8 inches higher than in 1880 and projected to rise another 1 to 4 feet by 2100. You can lower emissions that drive this rise. Replace one car trip a week with a bus ride or a walk. Grade 4.7 · 12.0 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 16.7

Global seas have risen roughly 8 inches since 1880. Protect your own home today: check your flood insurance coverage and write an emergency kit list. Then ask your town what it plans to do about rising water. Grade 6.1 · 11.7 words/sentence · threat 5.7 · hopeful proxy 5.7 · actionability 14.3

Seas are 20 cm higher than in 1880, and more rise is projected by 2100. Join a local beach or wetland cleanup this month. Healthy wetlands help buffer coasts, and you can sign up in minutes. Grade 4.2 · 11.0 words/sentence · threat 0.0 · hopeful proxy 3.0 · actionability 15.2

E. Integrated

The sea has risen 8 inches since 1880, and up to 4 feet more is projected by 2100. The places we love are worth protecting. This week, check your address on a free flood map, then talk with your neighbors about a plan. Together, we can be ready. Grade 4.1 · 11.0 words/sentence · threat 2.3 · hopeful proxy 9.1 · actionability 11.4

Our coastlines are changing: seas are 20 cm higher than in 1880. But communities are already adapting, and you can too. Attend one local meeting on flood planning this month and ask how you can help protect your shoreline. Grade 6.4 · 12.3 words/sentence · threat 2.7 · hopeful proxy 5.4 · actionability 16.2

Think of the beach where you learned to swim. Seas have risen about 8 inches since 1880 and may climb 1 to 4 feet more. Here is a way to help: sign up for a wetland or beach cleanup this month. It protects the coast we all share. Grade 2.4 · 11.0 words/sentence · threat 2.3 · hopeful proxy 15.9 · actionability 6.8

Rising seas are changing the coasts we cherish, up 20 cm since 1880. We can respond with care. Choose one trip this week to walk or bike instead of drive. Fewer emissions slow ocean warming, and that protects every shoreline. Grade 4.2 · 9.5 words/sentence · threat 0.0 · hopeful proxy 13.2 · actionability 18.4

Seas are 8 inches higher than in 1880, with more rise coming by 2100. Home is worth defending. Start today: look up your flood risk, share it with one family member, and ask your town about its coastal plan. Hope grows when we act together. Grade 4.0 · 10.5 words/sentence · threat 4.8 · hopeful proxy 23.8 · actionability 16.7

Extreme heat (25 messages)

A. Baseline

The IPCC's Sixth Assessment Report concludes that hot extremes, including heatwaves, have become more frequent and more intense across most land regions since the 1950s. Several recent extreme heat events would have been extremely unlikely to occur without human influence on the climate system. Grade 12.6 · 22.0 words/sentence · threat 2.3 · hopeful proxy 9.1 · actionability 0.0

According to the IPCC, heatwaves and other hot extremes have increased in frequency and intensity over most land areas since the 1950s. The assessment further finds that some recent hot extremes were extremely unlikely in the absence of human-induced climate change. Grade 12.0 · 21.0 words/sentence · threat 4.8 · hopeful proxy 2.4 · actionability 0.0

IPCC findings indicate that across most land regions, hot extremes have grown both more common and more severe since the 1950s, while human influence has substantially contributed to this trend, to the extent that certain recent events would have been extremely unlikely otherwise. Grade 20.4 · 43.0 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 0.0

Observational evidence assessed by the IPCC shows an increase in the frequency and intensity of heatwaves across the majority of land regions since the 1950s. Attribution analyses suggest that certain recent extreme heat events would have been extremely unlikely without anthropogenic influence. Grade 15.9 · 21.0 words/sentence · threat 0.0 · hopeful proxy 7.1 · actionability 0.0

As reported in the IPCC's Sixth Assessment Report, hot extremes including heatwaves have become more frequent and more intense over most land regions since the 1950s, and human influence is a key factor, with some recent events extremely unlikely without it. Grade 19.7 · 41.0 words/sentence · threat 2.4 · hopeful proxy 7.3 · actionability 0.0

B. Clarity

Heatwaves are happening more often. They are also getting hotter. This has been true on most land since the 1950s. Some recent heat events would have been very unlikely without human-caused warming. Grade 5.2 · 8.2 words/sentence · threat 0.0 · hopeful proxy 6.1 · actionability 0.0

The IPCC found a clear trend. Hot days are more common. Heatwaves are stronger. This is true across most of the world's land. People's emissions are a big reason why. Grade 1.7 · 6.0 words/sentence · threat 0.0 · hopeful proxy 13.3 · actionability 0.0

Extreme heat is rising. Since the 1950s, heatwaves have become more frequent and more intense in most places. Some recent ones almost surely would not have happened without human influence. Grade 6.0 · 10.0 words/sentence · threat 3.3 · hopeful proxy 13.3 · actionability 0.0

Here is what the science says. Heatwaves now come more often than in the 1950s. They are also hotter. Human-caused climate change helped make recent heat events far more likely. Grade 3.5 · 7.8 words/sentence · threat 3.2 · hopeful proxy 0.0 · actionability 0.0

Heat is getting worse. Most land areas now see more heatwaves than in the 1950s. They last longer and burn hotter. Some recent ones would have been extremely unlikely without human influence. Grade 4.9 · 8.0 words/sentence · threat 3.1 · hopeful proxy 0.0 · actionability 0.0

C. Meaning

Summer used to mean long evenings and open windows. Now, across most of the world's land, heatwaves arrive more often and burn hotter than they did in the 1950s. Behind each one are neighbors, workers, and children whose well-being matters, and caring for them is something we can do together. Grade 7.4 · 17.0 words/sentence · threat 0.0 · hopeful proxy 3.9 · actionability 2.0

Heat is not just a number. It is an older neighbor in a stuffy apartment, a farmworker in the afternoon sun. The IPCC finds heatwaves have grown more frequent and intense since the 1950s, with human influence

behind recent extremes. Our compassion for each other is our greatest strength. Grade 7.0 · 12.2 words/sentence · threat 4.1 · hopeful proxy 16.3 · actionability 0.0

A generation ago, a heatwave like today's might have been a rare event. The IPCC finds that human influence has made recent extremes far more likely. That truth carries responsibility, and also hope, because what we helped create, we can help calm. Grade 7.9 · 14.0 words/sentence · threat 0.0 · hopeful proxy 11.9 · actionability 4.8

Across most continents, hot extremes have grown more frequent and intense since the 1950s. Every community that looks after its most vulnerable people in the heat is writing a more hopeful story about what we can become. Grade 10.1 · 18.5 words/sentence · threat 2.7 · hopeful proxy 13.5 · actionability 2.7

Imagine a city that protects everyone from the heat. Today, heatwaves are more common and more intense than in the 1950s, and human influence is a major reason. Such cities can only exist because people care enough to build them. Grade 7.6 · 13.3 words/sentence · threat 2.5 · hopeful proxy 5.0 · actionability 2.5

D. Action

Heatwaves have become more frequent and intense since the 1950s, according to the IPCC. Prepare today: find your nearest cooling center, save its address in your phone, and check on one elderly neighbor during the next heat alert. Grade 8.9 · 19.0 words/sentence · threat 2.6 · hopeful proxy 21.1 · actionability 13.2

Hot extremes are rising across most land. Here is one step: during the next heat alert, close blinds by midday, drink water regularly, and avoid strenuous activity from noon to 4 p.m. Grade 8.7 · 16.0 words/sentence · threat 3.1 · hopeful proxy 6.2 · actionability 12.5

The IPCC finds heatwaves are more common and more intense than in the 1950s. You can plan ahead. Sign up for your local heat alerts and make a short list of cool places you can go. Grade 3.2 · 12.0 words/sentence · threat 5.6 · hopeful proxy 11.1 · actionability 11.1

Since the 1950s, heatwaves have grown stronger and more frequent. Take two minutes now to check that your fan or air conditioner works, and ask your landlord to fix it if it does not. Grade 5.6 · 17.0 words/sentence · threat 0.0 · hopeful proxy 0.0 · actionability 14.7

More frequent heatwaves are now a fact of life on most land. Call one friend or relative who lives alone and agree to check in on every hot day. Add their number to your favorites today. Grade 4.8 · 12.0 words/sentence · threat 0.0 · hopeful proxy 11.1 · actionability 16.7

E. Integrated

Heatwaves are now more frequent and more intense than in the 1950s, and human influence is a key reason. But we can protect each other. This week, text an older neighbor and offer to check on them during the next heat alert. Grade 5.6 · 14.0 words/sentence · threat 2.4 · hopeful proxy 9.5 · actionability 14.3

The IPCC finds that hot extremes have grown since the 1950s. That is worrying, yet communities that prepare get through it together. Start today: save your nearest cooling center's address, and share it with three friends. Grade 5.5 · 12.0 words/sentence · threat 2.8 · hopeful proxy 22.2 · actionability 13.9

More heat is here, but so is our ability to care for one another. Heatwaves have become stronger since the 1950s. Sign up for local heat alerts and invite a family member to do the same. Preparing together keeps everyone safer. Grade 6.5 · 10.2 words/sentence · threat 2.4 · hopeful proxy 9.8 · actionability 4.9

Extreme heat is more common than in the 1950s, partly because of human choices. Better choices are possible. Ask your city council to plant shade trees in your neighborhood. Shade protects the people we love. Grade 5.0 · 8.8 words/sentence · threat 0.0 · hopeful proxy 11.4 · actionability 8.6

Hotter, more frequent heatwaves are changing summer, yet people are responding with care. You can join them. Check on one neighbor each heat alert, keep water handy, and tell a friend to do the same. Small acts protect whole communities. Grade 4.8 · 10.0 words/sentence · threat 0.0 · hopeful proxy 10.0 · actionability 20.0

Analysis code

analyze.py (Python)

```
import re, json, numpy as np, pandas as pd, textstat, nrclex, os

from importlib import resources

from scipy import stats

import matplotlib; matplotlib.use("Agg")

import matplotlib.pyplot as plt

from matplotlib import font_manager

from messages import M

OUT = "/mnt/user-data/outputs/pilot"

LEX = json.load(resources.files("nrclex.data").joinpath("nrc_en.json").open(encoding="utf-8"))

THREAT = {"fear"} #NRC fear-tagged words

HOPE = {"joy", "trust", "anticipation"} #NRC proxy for hopeful/positive-future language

ACTION_VERBS = set("switch set lower check sign call email ask join walk bike take replace unplug
find save share text invite")
```

plant attend look write start try choose tell talk track protect prepare add close drink avoid keep support
reduce cut install vote

volunteer donate fix offer agree plan send repair drive"".split())

EFFICACY = re.compile(r"\b(you|we) can\b|byou could\b|blet's\b|bcan too\b|bpossible\b|bpower
to\b", re.I)

SPECIFIC = re.compile(r"\b(this week|this month|today|each week|every week|a week|minutes?)|each heat
alert|one (trip|step|action|neighbor|friend|family member))\b", re.I)

rows = []

for (topic, cond), msgs in M.items():

for i, t in enumerate(msgs, 1):

words = re.findall(r"[A-Za-z']+", t.lower())

n = len(words)

sents = [s for s in re.split(r"(?<=[.!?])\s+", t.strip()) if s]

tags = [e for w in words for e in LEX.get(w, [])]

per100 = lambda x: 100 * x / n

av = sum(w in ACTION_VERBS for w in words)

ef = len(EFFICACY.findall(t)); sp = len(SPECIFIC.findall(t))

rows.append(dict(topic=topic, condition=cond, run=i, text=t, words=n,

fk_grade=textstat.flesch_kincaid_grade(t), sent_len=n/len(sents),

threat_per100=per100(sum(e in THREAT for e in tags)),

hope_per100=per100(sum(e in HOPE for e in tags)),

action_verbs_per100=per100(av), efficacy_per100=per100(ef), specific_per100=per100(sp),

actionability=per100(av+ef+sp)))

df = pd.DataFrame(rows); df.to_csv(f"{OUT}/messages_metrics.csv", index=False)

```

metrics = ["fk_grade", "sent_len", "threat_per100", "hope_per100", "actionability", "words"]

def ci(x):

    x = np.asarray(x); return stats.t.ppf(.975, len(x)-1) * x.std(ddof=1)/np.sqrt(len(x))

summ = df.groupby("condition")[metrics].agg(["mean", ci]); summ.columns = ["_".join([a, b if
b=="mean" else "ci95"]) for a,b in summ.columns]

summ.round(2).to_csv(f"{OUT}/summary_by_condition.csv"); print(summ.round(2).T.to_string())

for m in ["fk_grade", "threat_per100", "hope_per100", "actionability"]:

    print(m, "Kruskal-Wallis p=%0.2g" % stats.kruskal(*[g[m].values for _, g in
df.groupby("condition")]).pvalue)

```

References

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