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Google Doodles and Covid-19

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Abstract: In the period April-September 2020, Google showed several doodles on its home page, illustrating specific actions individuals could take to reduce the spread of Covid-19 (such as handwashing, staying home and wearing masks). Rather than showing these Covid-19-related doodles in all countries, Google showed most of these in some selected countries only, and over time changed the set of countries in which the doodles were shown. In this paper, we analyze which countries were more likely to be 'treated' by the Google doodles and whether the Google Doodle that recommended people to 'Stay Home: Save Lives' affected people's mobility.

Keywords: Google Doodles, Covid-19, social marketing

JEL Classifications: I1, M3

Conflict of Interest Statement: This paper has benefited from free access to Google Docs, Google Search, the Google Doodle archive, the Google Doodle YouTube channel, Google's Covid-19 open data and Google Mobility reports.

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I. Introduction

After the World Health Organization declared Covid-19 a global pandemic (WHO, 2020), Google announced various initiatives to ease access to information and to quash misinformation (Murnane, March 17, 2020).

As part of its information campaign, Google featured a series of Covid-19-related doodles on its home page, reminding people to wash hands, stay home, wear masks, and thanking various groups for their efforts during the pandemic. While Google's first Covid-19-related doodle appeared globally on March 20, 2020, subsequent doodles were only shown in subsets of countries and at various dates. As a consequence, there has been a substantial variation in how many Covid-19-related doodles each country has been exposed to, and in the exact dates of exposure for each country.

This is rather surprising: since Covid-19 has spread globally, Google's Covid-19-related information is likely to be relevant to people in all countries. In other words, it seems that Google could have maximized its contribution to the war against Covid-19 by treating all countries with the same dose of doodles, rather than withholding some doodles from some countries.

In this paper, we explore the geography of Google's doodles, analysing which country characteristics made it more likely for countries to receive Google's Covid-19-related doodles. Such analysis can help us to understand why Google decided to show these doodles in subsets of countries but not globally, contributing to the academic literature that analyses the marketing decisions of multinationals (see for example, Kashani, 1989 and Powers and Loyka, 2010), to the academic literature on purpose-led marketing (see for example, Sidibe, 2020) and the academic literature that analyses the extent of variation in Covid-19-related policy responses across countries (see for example Elgin et al. 2020, Benmelech and Tzur-Ilan, 2020, Ferraresi et al, 2020).

Second, we analyse the impact of Google doodles and investigate whether differences in exposure to Google's doodles can explain differences in Covid-19-related outcomes. More specifically, we analyse whether exposure to doodles that urged people to stay at home was associated with decreases in mobility in the countries that were exposed to these doodles, thus contributing the literature on mobility during Covid-19 (f.e. Askitas et al., 2021, Mendolia et al. (2021)).

We find only limited evidence that Google's decisions about where or when to show Covid-19-related doodles were related to the spread of Covid-19 or to how governments reacted to the Covid-19 pandemic. Instead, we find that countries with bigger or richer populations and/or countries that got more doodles in 2019 were shown more Covid-19-related doodles. We further find that while Google's doodles reach a lot of individuals, and it is likely that some people changed their behavior because of Google's Covid-19-related doodles, there is little evidence that the Google doodles that urged people to stay home were associated with a decline in mobility at the country level.

The remainder of the paper is organized as follows. Section II introduces Google doodles, while section III presents the timeline of Google's Covid-19-related doodles, discussing the variation in Google doodle exposure across countries and time. Section IV focuses on the geography of Google doodles while section V focuses on the impact of Google's Covid-19-related doodles on mobility. Section VI concludes.

II. An introduction to Google doodles

While Google's landing page for its search engine, features typically only the Google logo, on some days the Google logo is replaced by a "Google doodle", a variation of the Google logo, and typically used to commemorate important people or events.

On August 30, 1998, the first doodle was displayed, showing a blue stick figure of a man behind Google's second "O" letter. Google founders Sergey Brin and Larry Page created the doodle to inform users that they were visiting the Burning Man festival (Google, n.d.).

While at the beginning doodles commemorated special days (Halloween, Mother's Day, etc.), over time, doodles have been used to celebrate birthdays of famous artists and scientists, to inform about important contemporary events (like the discovery of water on Mars or the start of the Olympic games), and to launch Google products. In addition, while initially doodles were simple static images, later doodles became more sophisticated and include animation, videos, and even interactive games. In 2016, a team of 16 artists, designers, illustrators, animators, and engineers, also known as 'doodlers', was responsible to create and manage the doodle project. As mentioned in Google (2017), the "team meets weekly for brainstorming sessions but four times a year does an official review of all the ideas to come up with a schedule

of about 90 doodles", thus producing around 360 doodles per year, or a doodle per day on average.

Historical information about Google's doodles can be obtained from the Google Doodle archive.[1] The information that is provided includes the topic and motivation for the doodle and its geographic reach, that is, in which countries the doodle was shown.[2] Notably, in some cases the archive does not include links to multiple versions of the same doodle, that is, if a doodle was shown on multiple days in different sets of countries, only the original doodle is included in the archive. The repeat doodles appear in Google search, however, and can still be viewed if one knows their direct URL. These URLs are a combination of the original URLs and a date, so we exhaustively tried all date combinations to find the additional doodles.

Finally, there are only a few academic papers about Google doodles. We are aware of 3 papers, Elali, Keiser, & Odag (2012) studies the relation between the Google doodles and Google's 'corporate visual identity', Cifuentes (2012) focuses on the types of interactions between doodles and the user and Jessen (2015) performs a typographic analysis of the 439 doodles that were displayed on the Denmark homepage (google.dk) between 1998 and 2013.

III. The Covid- 19-related Google doodles

The first Covid-19-related Google doodle was shown in 183 countries on March 20th, 2020 and recognized Hungarian physician Ignaz Semmelweis and the importance of washing hands for disease prevention.

[Insert Table 1 – The Timeline of Google's Covid-19-related doodles about here]

As the doodle explained, Semmelweis was the "first person to discover the medical benefits of handwashing."

[1] https://www.google.com/doodles#archive

[2] Since 2017, Google shows you by default the local version of its homepage even if you use the url of Google in a different country (https://www.blog.google/products/search/making-search-results-more-local-and-relevant/)

Figure 1: The Ignaz Semmelweis doodle

This was followed by a 'Stay Home – Save Lives' doodle on April 4th which was initially shown in 88 countries, and then, between April 13th and April 17th in 3 more countries.

Figure 2: The 'Stay Home – Save Lives' doodle

Between April 20th and April 24th, the same doodle was again shown in 55 countries, 47 of which had already seen the Doodle on April 4th. Some of these 55 countries were shown the doodle only on one day between April 20 and April 24th, others were shown the doodle two, three or four days. So there was considerable variation in the exposure to this doodle campaign both across space and across time.

A similar variation across time and space can be seen in the 'Thank You' series of doodles which ran between April 6th and April 26th. On April 6th, public health workers and researchers in the scientific community were thanked in 50 countries.

Figure 3: doodle to thank public health workers and researchers in the scientific community

The next day, doctors, nurses and medical workers were thanked in 74 countries, followed by emergency services workers who were thanked on April 8th in 80 countries. Various groups were thanked in the following days, with packaging, shipping and delivery workers being thanked in 89 countries on April 15th. Finally, all coronavirus helpers are thanked in 40 plus countries on April 20th and again on the 25th and the 26th.

Following the "Thank You" doodles, Google ran "Stay and Play at Home" doodle games, between April 27th and May 8th, again varying the number of countries that see the various games. These ranged from 25 countries that are shown the Garden Gnomes game and 72 countries being shown the Pacman game. These game doodles had already been used in pre-Covid-19 times and were thus recycled for covid-19. Interestingly, the locations where specific games were shown in the Covid-19 period differs from where these games were shown before Covid-19 (see table 2).

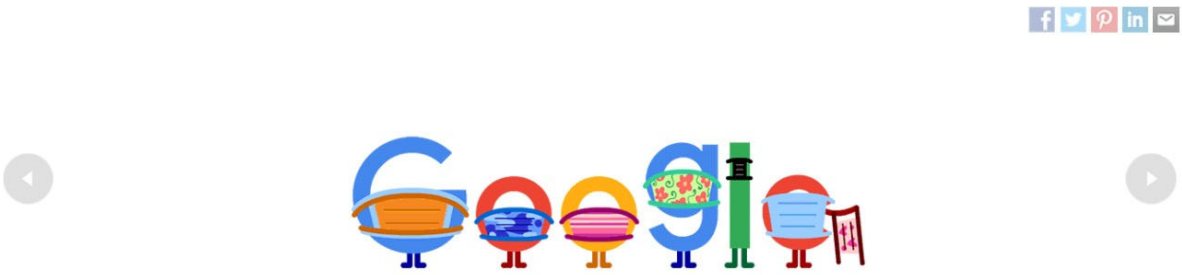
Table 2: Comparing Covid-19 campaigns and earlier campaigns

Title of original doodle	number of countries	Title of the corresponding Covid doodle	number of countries 2020
celebrating-50-years-of-kids-coding	186	stay-and-play-at-home-coding-2017	71
icc-champions-trophy-2017-begins	19	stay-and-play-at-home-cricket-2017	31
oskar-fischingers-117th-birthday	161	stay-and-play-at-home-fischinger-2017	53
clara-rockmores-105th-birthday	35	stay-and-play-at-home-rockmore-2016	36
celebrating-garden-gnomes	161	stay-and-play-at-home-garden-gnomes-2018	25
wilbur-scovilles-151st-birthday	70	stay-and-play-at-home-scoville-2016	71
celebrating-loteria	30	stay-and-play-at-home-loteria-2019	44
halloween-2016	54	stay-and-play-at-home-halloween-2016	36
44th-anniversary-of-the-birth-of-hip-hop	184	stay-and-play-at-home-hip-hop-2017	60
30th-anniversary-of-pac-man	179	stay-and-play-at-home-pac-man-2010	72

For example, the Pacman game was shown worldwide pre-Covid-19 but in only 72 countries during Covid-19, while the Cricket game doodle was shown in more countries during the Covid-19 era than during the pre-Covid-19 era. These differences over time suggest that the decision of where to show a Covid-19 doodle was intentional, rather than just a repetition of choices made before Covid-19.

Finally, on August 5th, 61 countries are shown a 'Wear a mask – Save Lives' doodle.

Figure 4: The 'Wear a mask – Save Lives' doodle



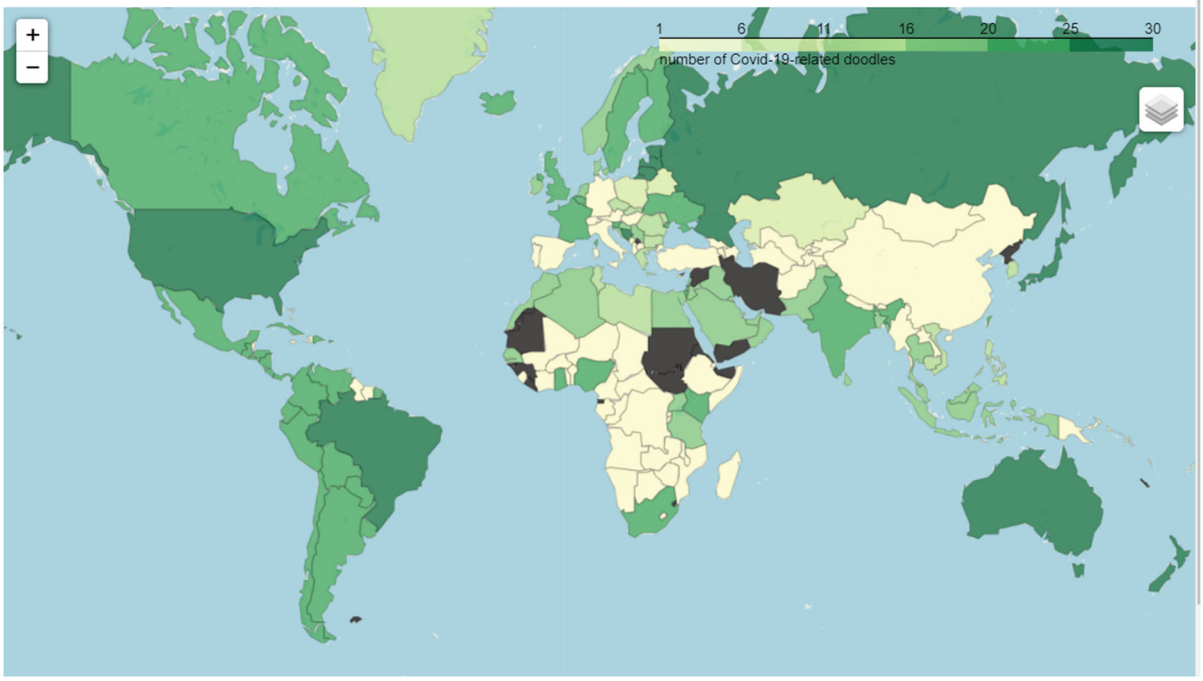
To get a better understanding which countries were shown a doodle on a given day, one can click on the icon of video 1 which shows, for each day, which countries were shown a doodle.

Video 1: the geography of Covid-19-related doodles over time.

To give an idea of the variation in the total exposure to Google doodles, figure 5 gives a color-coded map which reflects for each country, the total number of days a country was shown a Covid-19-related doodle in 2020.[3,4]

[3] We exclude countries where Google did not show any Covid-19-doodle (which are tiny countries like Andorra) or countries where Google is not active like Iran and North Korea.
[4] Some doodles were shown on more than one day – hence we count the number of days of exposure rather than the number of doodles shown.

Figure 5: the number of Covid-19-related doodles across countries

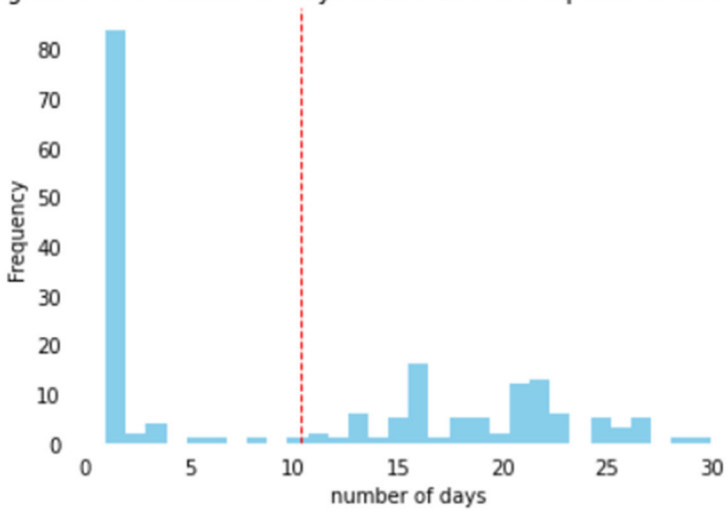


Countries in black are countries where Google never has shown a Doodle.

Many countries were only shown a few doodles, but some like Brazil, Russia or the USA got many days of Covid-19-related doodles.

In fact, as the histogram in figure 6 shows, over 80 countries only got one doodle, the doodle related to Ignaz Semmelweis and handwashing, but a handful of countries got more than 25 days with doodles. On average, a country was shown doodles for 10 days (median: 7), with the standard deviation across countries being close to the mean (10.3 versus 9.7).

Figure 6. Histogram of the number of days countries were exposed to Covid-19-related Doodles



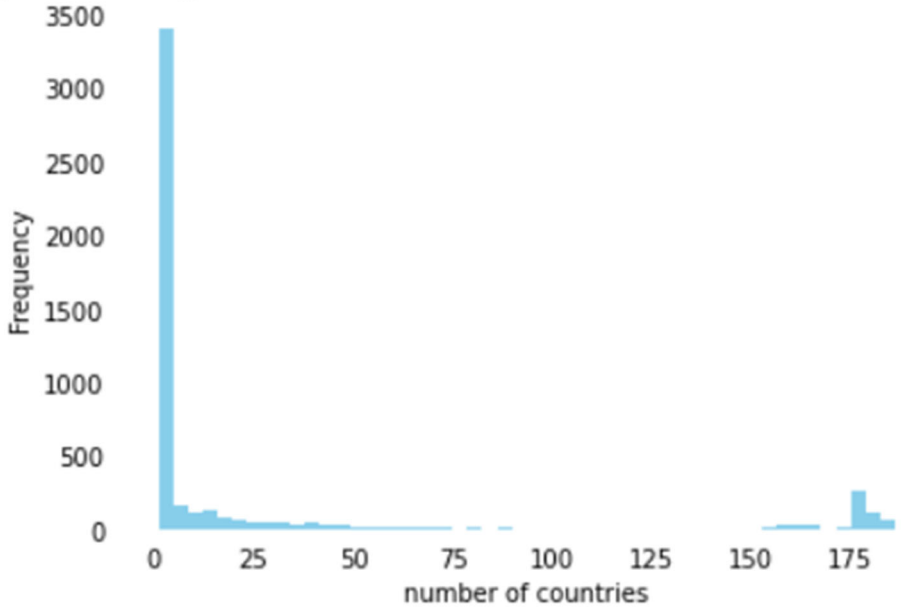
IV. What countries were more likely to be exposed to Google doodles related to Covid-19?

So far, we have shown that there was substantial geographical variation in the exposure to Covid-19-related Google doodles. Here we analyze Google's decisions of where to show doodles, by analyzing which country characteristics predict a country being treated with Google doodles.

Before focusing on Covid-19 related doodles, we first focus on the geography of all 4851 doodles published between August 30th, 1998 (when the first Doodle was published) and March 19, 2021 (when we scraped the doodle data).

Figure 7 gives the histogram of the number of countries in which a doodle is shown. It illustrates the bimodal distribution, with most doodles shown in a few countries and some doodles shown in almost all countries.

Figure 7. Histogram of the number of countries doodles have been shown in

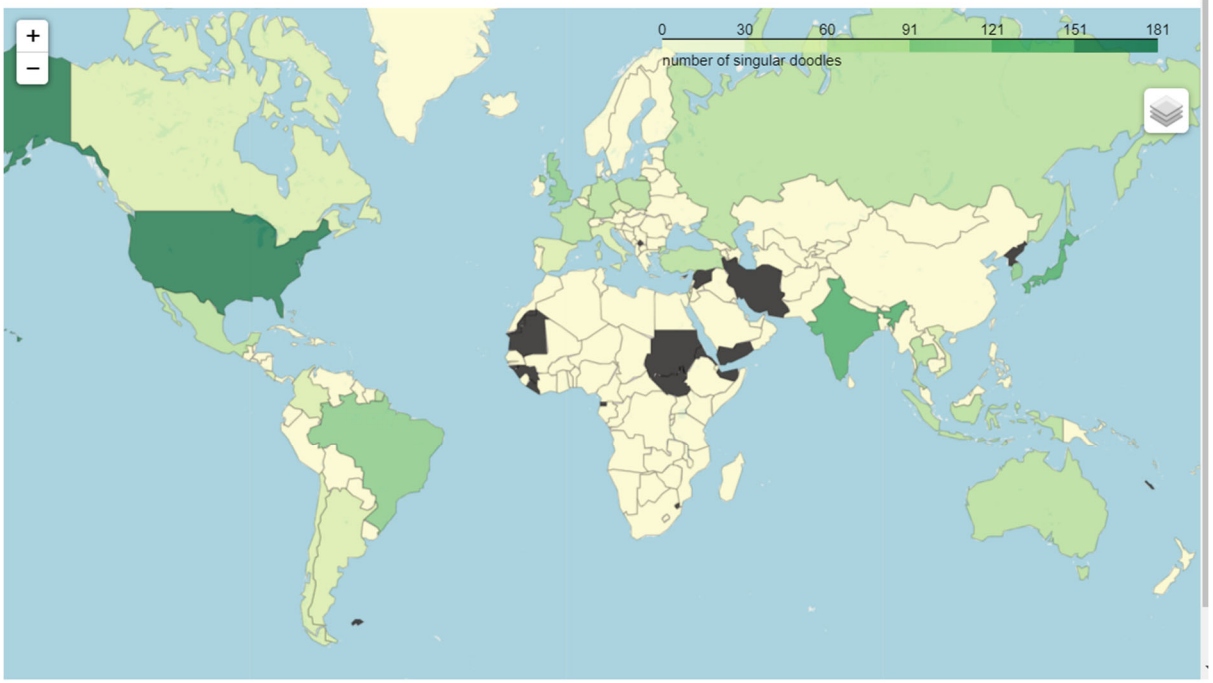


More specifically, 74.2% of doodles were shown in less than 10 countries, while 11% of doodles were shown in 150 countries or more. Hence, it's clear that it is not Google's default to show all countries the same doodles. The Google doodles that are shown globally are those with a global relevance: reminders of Earth Day, international women's day or New Year's Eve, but also of scientific discoveries like evidence of water found on Mars, the start of the Olympics or the birthday of world-famous individuals like Edison or organizations like Google.

The doodles that are shown in a few countries are mostly celebrating national holidays or famous people whose fame is limited or relevant to a single country or a subset of countries. In fact, about 60% of doodles are "singular" — they are only shown in one country.[5]

Interestingly, the distribution of doodles across countries is very uneven. Figure 8 illustrates the distribution of the number of singular doodles across countries: while many countries (those in light colors) get no doodle that is targeted to them, 181 doodles were just shown in the United States (in dark green).

Figure 8: distribution of the number of singular doodles across countries (1998-2021)

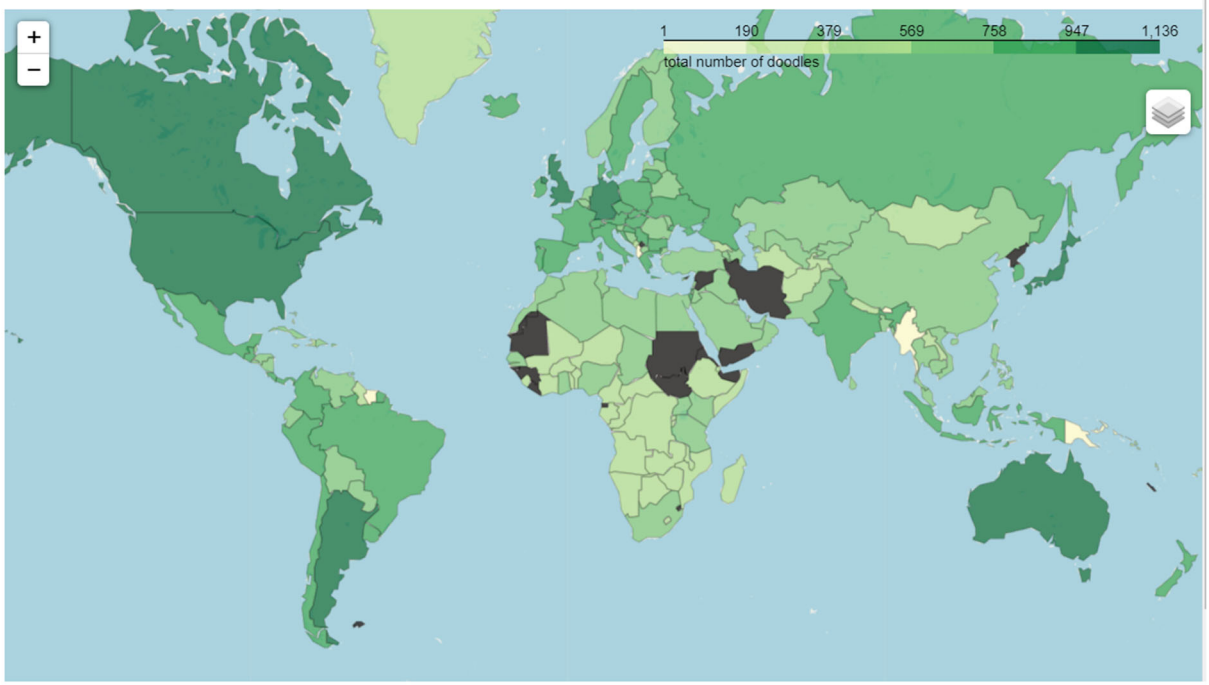


Countries in black are countries where Google never has shown a Doodle.

Figure 9 illustrates the distribution of the total number of doodles over the period 1998-2020 across countries: while 1136 doodles were shown in the United States (in dark green), some countries (in light yellow) were shown only a few doodles.

[5] This number includes doodles that are shown to different countries but on different days.

Figure 9: distribution of the total number of doodles across countries (1998-2021)

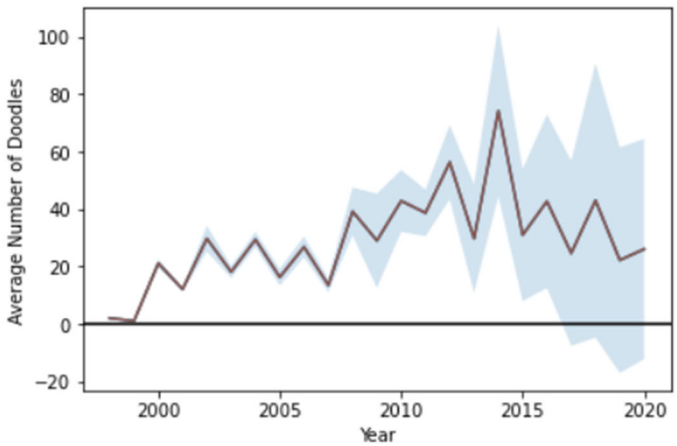


Countries in black are countries where Google never has shown a Doodle.

Figure 9's greener colors show that the inequality in overall doodles is less than the inequality in singular doodles (figure 8).

Note further that over time, the average number of doodles a country has been exposed to has increased, and also the variation across countries has increased. In 2019 (and 2020), the standard deviation in the number of doodles was about as big as the mean of the number of doodles a country was exposed to (see figure 10[6]).

Figure 10. Evolution of the mean and standard deviation of the average number of doodles shown to a country



[6] The grey zone around the mean reflects 2 times the standard deviation.

To analyze the correlates of the number of doodles a country is shown, we first focus on the 2019 doodles. Table 3 presents the result of a regression analysis where we try to explain the number of doodles shown to a country in 2019 (ranging from 5 to 91, with a median of 25, an average of 24, and standard deviation of 20).[7]

As explanatory variables we use:

- a dummy representing whether or not Google has an office in a country: Google (nd) notes that 'For local doodles running in a specific country (ex: France, Japan, Russia) the doodler is paired with a Googler in that country's office. The local Googler helps advise on cultural relevancy and the doodler takes care of the design.' Given the importance of local advice, having an office in a given country might be important. We scrape the information about which countries have a google office from https://careers.google.com/api/v2/locations/?hl=en_US
- GDP per capita: an indicator of how rich a country is. Richer countries are likely to have more business potential for Google. Developing a new doodle is costly so the return on investment is likely to be bigger in richer countries. Data are from Google's open Covid-19 data.[8]
- Size of the country, proxied by the population. If there are more people in a country, Google can reach more people in this country meaning both more potential to do business but also more potential to reach people and spread the message Google wants to spread. Data are from Google's open Covid-19 data.
- Share of people with access to the internet at home in a country: the potential to reach people is limited by how many people have access to the internet in the country. Data are from Google's open Covid-19 data.
- The market share of Google in a country: the doodle is more likely to reach more people if the market share of Google is higher in the country. We scraped the data on Google's market share in December 2019 from https://gs.statcounter.com/search-engine-market-share . Note that the variation in this variable is limited, with the mean being 95% and

[7] The sample includes 158 countries for which all data are available. We exclude China from the sample – while China is included in Google doodles' data, Google is only available in Macau and Hong Kong. Hong Kong is available as a separate entity in Google doodles' data but Macau is not. It's thus not entirely clear what population we should allocate to China.
[8] https://github.com/GoogleCloudPlatform/Covid-19-open-data

the standard deviation only 5%. This is a testimony to Google's search monopoly in most of the world, with China and Russia being important exceptions.

- Press Freedom in a country: in countries where what is published is more regulated, Google doodles have a higher chance to lead to controversy, something Google might prefer to avoid. We use the 2020 score (which refers to 2019) from Reporters without Borders' Press Freedom Index (https://rsf.org/en/ranking), which ranges between 0 and 100, with 0 being the most free country.

Table 3 presents the results of both OLS regressions, which have the advantage of being easy to interpret, and negative binomial regressions, which take into account the discrete nature of the count of the number of doodles.[9] We use the logs of the abovementioned explanatory variables to accommodate possible non-linearities and to be able to interpret the coefficient estimates of the negative binomial regressions as elasticities.

Column 1 of Table 3 shows that, in an OLS regression, having a Google office in one's country can explain about half of the variation in the number of doodles, and that having a Google office in one's country is associated with an increase of 29 doodles in 2019. Similarly, when using a negative binomial regression (column 2), we find that having an office increases the expected number of doodles 3-fold (i.e. exp(1.07)).

Since office location can be jointly determined by other determinants of the number of doodles, column 3 and 4 regress the number of doodles on more exogeneous variables like GDP per capita, population, internet penetration, Google's market share and the index of press freedom. Column 5 and 6 then add the dummy reflecting the presence of an office to these more exogeneous variables. Clearly, how rich a country is, how many people live in a country, and Google's market share are all associated with the number of doodles a country got in 2019. We find mixed evidence for the importance of internet penetration and having a Google office in-country, and no support for the idea that internet penetration or press freedom matters.

[9] The significant estimate of alpha in table 3 suggests a negative binomial model is more appropriate than a poisson model in our case.

Table 3: correlates of the number of doodles in 2019

	(1)	(2)	(3)	(4)	(5)	(6)
const	15.25***	2.72***	-143.76***	-4.12***	-109.98***	-3.36***
	(1.27)	(0.07)	(19.58)	(0.96)	(17.65)	(1.07)
offices	29.05***	1.07***			11.12***	0.21
	(2.81)	(0.12)			(3.45)	(0.14)
populationlog			6.31***	0.30***	4.51***	0.26***
			(0.59)	(0.03)	(0.66)	(0.04)
gdp_per_capitalog			8.48***	0.30***	6.49***	0.26***
			(1.47)	(0.06)	(1.41)	(0.07)
google_sharelog			21.00*	1.53**	21.90*	1.54**
			(12.59)	(0.61)	(11.52)	(0.61)
internetlog			2.11	0.39***	2.40	0.40***
			(2.22)	(0.12)	(2.00)	(0.12)
presslog			-1.51	0.00	1.25	0.05
			(2.95)	(0.11)	(3.08)	(0.12)
alpha		0.44***		0.25***		0.24***
		(0.05)		(0.03)		(0.03)
R-squared	0.46		0.59		0.62	
R-squared Adj.	0.46		0.58		0.60	
Pseudo R2		0.054		0.119		0.120
N	158	158	158	158	158	158

Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01
OLS Standard errors are heteroscedasticity consistent (HC1).

We get similar results if we restrict the sample to countries with a population of more than 1 million or focus on the number of singular doodles, i.e. the doodles shown to one country only on a given day.[10]

Next, we focus on the Covid-19-related doodles. Given how Covid-19 turned into a global pandemic, one could have expected a relative increase in global doodles, as Covid-19-related doodles should be of interest to people in most if not all countries.

Of course, even if Google believes its doodles help to reduce the spread of Covid-19, there are several reasons why Google might decide not to show the doodles everywhere. Table 4 tries to shed some light on this.

Table 4 gives various statistics for the group of countries that were shown the first doodle of the overall campaign (and similarly, for each of the 4 separate doodle campaigns ('Stay Home: Save Lives' (SHSL), 'Stay Home and Play Games' (SHPG), 'Wear Masks: Save Lives' (WMSL), 'Thank You' (TY)), and compares these with those statistics for the countries that were not shown those first doodles at the start of the campaign.[11] For example, out of 153

[10] For the former sample, having a Google office is always significant, for the latter sample, Google's market share is not significant in the OLS regressions.
[11] Note some countries were shown those doodles later in the campaign which explains why the average number of campaign doodles shown is bigger than zero for the No group.

countries for which all statistics are available, 84 countries were shown the Stay Home: Save Lives doodle on April 4th. These 84 countries, on average, were shown 17.4 Covid-19-related doodles in 2020.[12] In contrast, the countries that did not get to see the Stay Home: Save Lives doodle on April 4th, on average, would only be shown 2.25 doodles in 2020.

A first possible reason for the geographic differentiation might be that Google only wanted to show the doodles in places where Covid-19 was already causing the death of many people. Table 4 shows that, consistent with this hypothesis, countries that were shown more doodles tend to have higher total Covid death numbers on April 4th (the start of the first Stay Home campaign) and similarly at the start of each of the four campaigns. For example, the median number of victims was more than 1000 for the countries that were shown the Wear Masks: Save Lives doodle on August 5th, but less than 100 for those countries that were not shown the Wear Masks: Save Lives doodle on August 5th.

Table 4: COVID Doodle Campaigns and Explanatory Variables

Variable Name	Covid Doodle - Yes	Covid Doodle - No	SHSL Doodle - Yes	SHSL Doodle - No	TY Doodle - Yes	TY Doodle - No	SHPG Doodle - Yes	SHPG Doodle - No	WMSL Doodle - Yes	WMSL Doodle - No
Number of countries	84	69	84	69	47	106	67	86	58	95
Mean number of Doodles shown	17.42	2.25	2.57	0.26	10.96	3.16	6.25	0.62	1.07	0.01
Standard deviation of number of Doodles shown	6.21	6.06	1.74	0.90	1.22	4.30	2.64	1.89	0.36	0.10
Median Number of Deceased	34.00	1.00	34.00	1.00	36.00	5.00	64.00	7.50	1139.50	68.00
Mean Stay at Home Requirements Score	1.73	1.49	1.73	1.49	1.70	1.66	1.78	1.59	1.17	0.97
Mean Facial Coverings Score	0.61	0.39	0.61	0.39	0.70	0.53	1.45	1.23	2.59	2.46
Mean Stringency Index	81.06	75.63	81.06	75.63	81.80	78.14	81.94	77.22	60.57	56.00
Number of Doodles Shown in March - September 2019	17.46	4.14	17.46	4.14	16.40	9.26	17.12	7.05	19.22	6.72
Number of non-Covid Doodles Shown in March - September 2020	10.25	2.16	10.25	2.16	9.28	5.42	9.97	3.98	10.79	4.04
Mean GDP Per Capita	23993	5314	23993	5314	27234	10397	18380	13379	19478	13182
Mean Share People with Internet	0.73	0.39	0.73	0.39	0.78	0.48	0.68	0.49	0.66	0.52
Mean Market Share Google	0.96	0.95	0.96	0.95	0.95	0.96	0.96	0.95	0.95	0.96
Share of Countries with a Google Office	0.51	0.10	0.51	0.10	0.47	0.26	0.45	0.23	0.60	0.16
Press Freedom Index	31.61	35.18	31.61	35.18	31.42	34.02	33.91	32.69	31.15	34.49

SHSL: 'Stay Home: Save Lives'; SHPG: 'Stay Home and Play Games'; WMSL: 'Wear Masks: Save Lives'; TY: Thank You'. Explanatory variables are measured at the start of the campaign: April 4 for SHSL, April 6 for TY, April 27 for STPG and August 5 for WMSL. The Yes group is the group of countries that was exposed to the doodle at the date of measurement. Some countries were shown those doodles later in the campaign.

Second, maybe Google is constrained by political economy considerations and will only show doodles in countries where there are official government regulations that are consistent with

[12] This excludes the Semmelweis doodle of March 2020, which was shown to all countries.

what is shown in a doodle. That is, if a country does not require its population to stay home, maybe showing a doodle that explicitly recommends staying at home might lead to trouble for Google. Again the data in table 4 are consistent with this – countries that were shown the doodles had on average a somewhat higher stringency index, a somewhat higher average level of stay home requirements (for the SHSL and SHPG campaigns) and somewhat stricter facial covering requirements.[13]

Third, factors unrelated to Covid-19, like the ones we used to explain the number of doodles in 2019 in table 3, might have determined Google's decision about where to show Covid-19-related doodles. Table 4 indeed suggests that countries where the various Covid-19 doodles were shown were countries that also had been exposed to more doodles in 2019, are on average richer, more populated, have better access to the internet and are more likely to have a Google office. Note further that during the Covid-19 doodle period in 2020, countries which were shown lots of Covid-19-related doodles also were shown lots of non-Covid-19-related doodles.[14]

In an attempt to distinguish between the various hypotheses, tables 5 present the results of a negative binomial regression analysis that regresses the number of days a country was exposed to a Covid-19-related doodle on the log of such explanatory variables.[15]

[13] Data on government measures come from the Oxford COVID-19 Government Response Tracker (Hale et a.l, 2020) (https://www.bsg.ox.ac.uk/research/research-projects/Covid-19-government-response-tracker)

[14] On some days on which a Covid-19-related doodle was shown, countries that were not shown the Covid-19-related doodle, were shown some other doodle, for example, a doodle celebrating the independence day of that country. Note this happens rarely and the correlation between a country's number of non-Covid-19-related doodles on days other countries were shown Covid-19-related doodles, and the number of covid-19-related doodles the country was shown is 0.01. A relative measure (number of days with a Covid-19-related doodles shown divided by 35 days (the number of days a Covid-19-related doodle was shown anywhere) minus the number of days a non-covid related doodle was shown on any of these 35 days) has a correlation of 0.997 with the number of days with a Covid-19-related doodles.

[15] The sample consists of 153 countries for which all variables are available.

Table 5: correlates of the number of days with a Covid-19-related doodle.

	(1)	(2)	(3)	(4)	(5)
const	-0.84***	-8.91***	2.44	-2.02	-5.48
	(0.26)	(3.03)	(2.31)	(1.64)	(3.62)
nr19log	1.27***			1.25***	
	(0.10)			(0.13)	
offices		-0.41			-0.37
		(0.34)			(0.33)
populationlog		0.58***			0.50***
		(0.12)			(0.14)
gdp_per_capitalog		0.30*			0.24
		(0.18)			(0.19)
google_sharelog		3.46***			3.75***
		(1.27)			(1.27)
internetlog		1.26***			1.26***
		(0.33)			(0.32)
presslog		0.03			0.13
		(0.31)			(0.31)
meanstringencylog			-0.27	0.27	-0.53
			(0.55)	(0.38)	(0.42)
meandeceasedlog			0.22***	0.01	0.09
			(0.05)	(0.04)	(0.06)
alpha	0.98***	1.72***	2.30***	0.98***	1.68***
	(0.19)	(0.26)	(0.33)	(0.19)	(0.26)
N	153	153	153	153	153
Pseudo R2	0.091	0.054	0.019	0.092	0.057

Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01

Column 1 shows that 1% more doodles in 2019 is associated with 1.27% more Covid-19-related doodles. Column 2 uses the explanatory variables of table 3 and shows that bigger, richer countries where Google has a higher market share and more people have internet at home get more Covid-19 related doodles. Column 3 shows that Covid-19-related variables (the log of the average of the government regulation stringency index on the days where any Covid doodle was shown anywhere in the world and the log of the average of the (cumulative) total number of Covid-19-related deaths) are less good at explaining the number of Covid-19-related doodles, than the 'business-as-usual' models of column 1 and 2, which have much higher pseudo R-squared. Similarly, column 4 shows the covid-19-related variables are not significant when added to the non-covid-19-related variables of column 1 or 2. Similar results are obtained when restricting the sample to the 137 countries with a population of 1 million or more.

Table 5 focused on the overall number of Covid-19-related doodles a country was shown. For those countries that received at least 1 Covid-19 related doodle, we can also analyze whether the timing of the doodles is related to the Covid-19 situation. Table 6 gives the results of a regression of a binary variable that indicates whether or a not a doodle was shown on a given day in a given country on the Covid-19 death count for that country and that day, and the level of the stringency index for that country and that day[16]. We further control for day and country fixed effects.

Table 6: Covid-19 related correlates of countries' chance of being shown a Covid-19-related doodle.

	OLS	LOGIT
const	0.70***	0.29
	(0.12)	(0.98)
stringency_index	0.00	0.02**
	(0.00)	(0.01)
new_deceased	0.00	0.00***
	(0.00)	(0.00)
R-squared	0.46	
R-squared Adj.	0.44	
N	3430	3430
Pseudo R2		0.450

Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01
OLS Standard errors are clustered at the date and country level.
Date and Country Fixed Effects Included

While the OLS coefficient estimates are insignificant, the Logit estimates are positive and significant suggesting countries that were shown Covid-19-related doodles were more likely to be shown a doodle at times they had more deaths and/or stricter governmental Covid-19-related regulations. The size of the effects are fairly limited, however, with the logit coefficients implying that a one standard deviation increase in deaths is associated with 1/6th of a standard deviation increase in the probability of being shown a Covid-19-related and a one standard deviation increase in stringency of regulations is associated with 1/10th of a standard deviation increase in the probability of being shown a Covid-19-related doodle.

Summarizing the discussion so far, we have shown that historically, there has been a substantial variation across countries in how many doodles are shown and that this variation has persisted during Covid-19 times despite the global scale of the pandemic. We also have shown that there is substantial evidence that non-Covid-19 related factors continued to influence the distribution of Covid-19 related doodles and that there is some evidence that countries which were shown

[16] We do not use logs here as we include country fixed effects and hence focus on the within country variation.

at least one Covid-19-related doodle were more likely to be shown a Covid-19-related doodle on days when they suffered more from Covid-19 or had more restrictive Covid-19 policies in place.

V. The impact of Google doodles

So far we have focused on trying to explain the geographic variation in doodle exposure, next we analyze whether this variation in exposure has a potential impact on the spread of Covid-19.

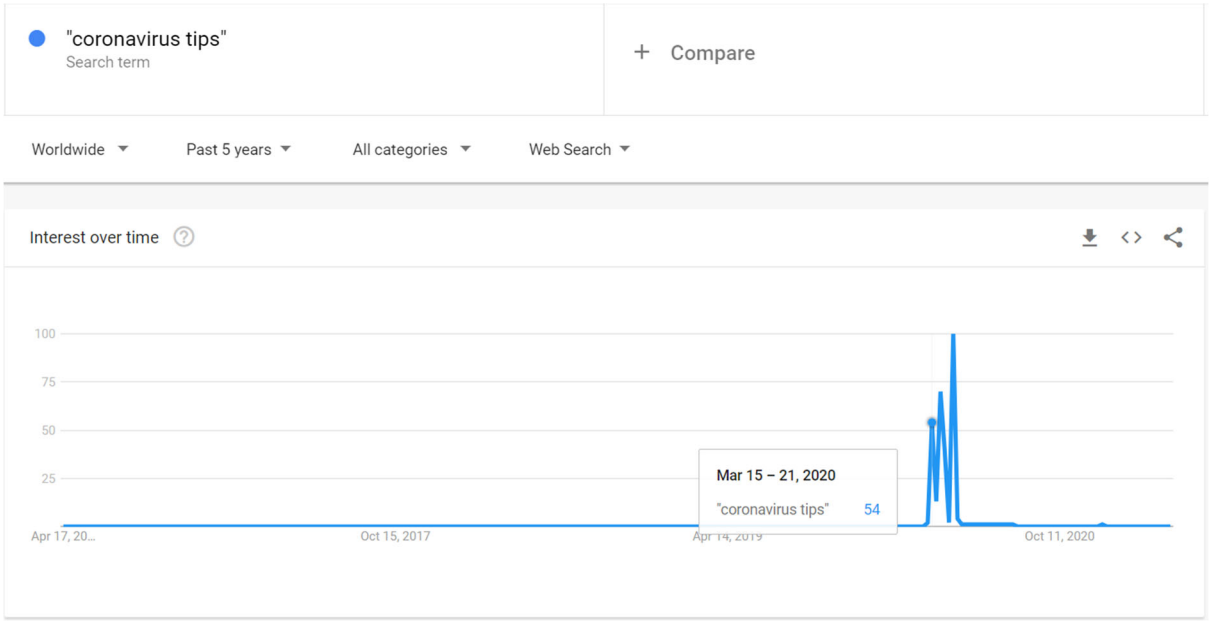
The most straightforward way to analyse the impact of a Google doodle would be to analyze how many people have seen the doodle when visiting the Google homepage. Google does not provide any statistics related to its homepage or to doodle exposures, however. Moreover, Google makes it difficult to find statistical information related to doodles. Specifically, while it seems standard practice for YouTube to show how many times a video has been viewed, the view count for doodle videos —YouTube videos associated with some doodles — are not publicly available. As far as we know, the doodle videos are the only videos on the YouTube platform with hidden view counts. YouTube is owned by Google. [17]

Google Trends does show a substantial increase in the searches for 'coronavirus tips' (see figure 11), the page many of the Covid-19-related doodles refer to, starting in the week of March 20th, when the first Covid-19-related doodle was shown.[18]

[17] https://www.youtube.com/user/googledoodles

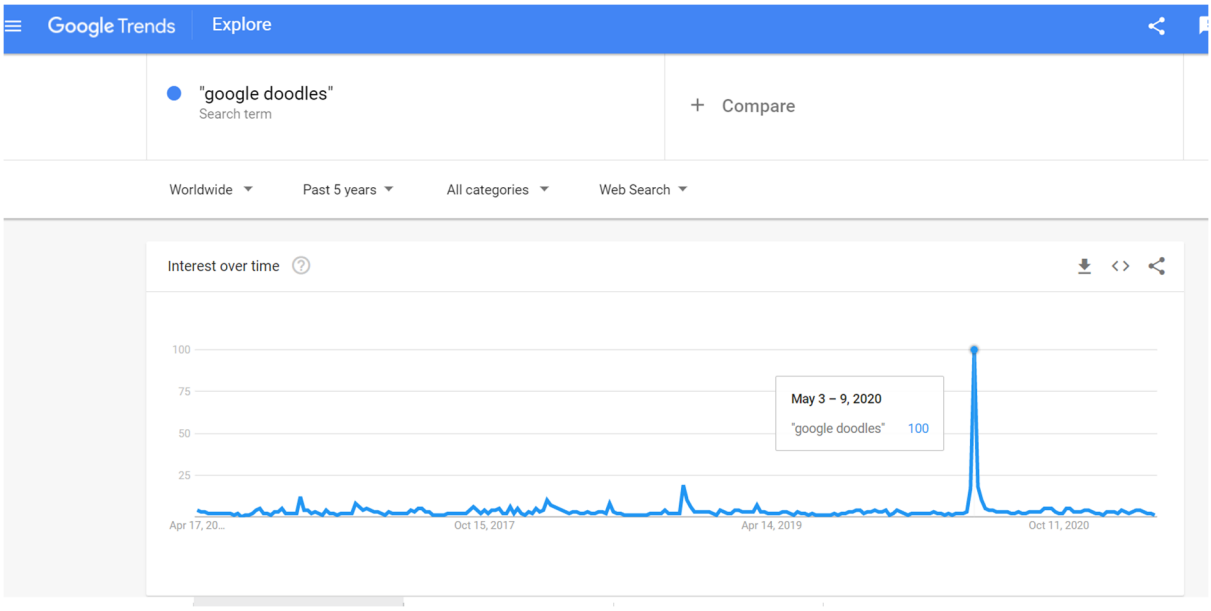
[18] For the Covid-19 related Google doodles, Google could analyze how visits to the page with Covid-19 tips change when a doodle linking to them is present, potentially also using countries that were not exposed to a doodle as a control group.

Figure 11: the evolution of the search intensity of ‘coronavirus tips’.



Similarly, Google trends shows a spike in searches for “google doodles” in the first week of May when the Stay Home and Play Games doodle series was active (see figure 12).[19]

Figure 12: the evolution of the search intensity of ‘google doodles’.



[19] Google trends data is available since 2004 - only in August 2012, when a series of games doodles related to the 2012 olympics were shown search intensity was somewhat higher.

But Google Trends does not show the absolute number of searches, it only shows the evolution over time of the relative number of searches..[20]

While Google does not provide precise information about how many people view or interact with the doodles, there is quite some anecdotal evidence that Google's doodles are seen by many people.

Fricker (2010) argues that over the 3 days that Google featured Pac-Man in a doodle in 2010, over one billion people played the game. Similarly, RescueTime, a company that makes employee-monitoring software, estimated that while employees spend, on average, about 4 and a half minutes on Google, they spent 36 seconds more on Google.com on the day the Pac-Man doodle was available (Wagner (2010)) and 26 seconds more on the day the Les Paul Guitar Doodle was available (Knowledge@Wharton, 2011).

Coupé (2021) further documents that, when a Google Doodle commemorated Nobel Prize winner Arthur Lewis, search intensity for Arthur Lewis dwarfed the search intensity for other top economists, while previously the search intensity for Arthur Lewis was only a fraction of the search intensity of other top economists.

Besides spending time playing with/exploring the doodles, there is also anecdotal evidence people act upon the information provided by the Google doodles. The 40th anniversary edition paperback of 'Silent Spring' written by Rachel Carson saw a huge increase in sales after the author's 107th birthday was commemorated in a doodle, with the Amazon book sales ranking going from the 3,294th place to the 375th place (Publisher's weekly, 2014)

Given the above evidence and the fact that there are about 5 billion Google searches every day (Georgiev, 2021), it is likely that a substantial number of people will have received Covid-19 related recommendations and/or entertainment via the doodles. These recommendations might have been new to the viewers or might have refreshed knowledge they already had.

To be effective in the fight against Covid, however, spreading information is not enough. To have a 'real' impact, these doodles need to change people's behavior. Here we will focus on

[20] Page view or click-through information underestimates the true reach of the doodles, as often doodles are covered in the press. For example, on May 1, 2019, the New York Times ran an article titled 'Who Is Ruth Asawa, the Artist in Today's Google Doodle?'.

the two campaigns that urged people to stay home, the 'Stay Home: Save Lives' campaign and the 'Stay Home and Play Games' campaign.

For these campaigns to have an impact, they should have caused people to stay home. Fortunately, we can test whether Google's Stay Home doodles affected mobility because detailed mobility data is available from Google's community mobility reports[21]. Google's mobility reports "show how visits and length of stay at different places change compared to a baseline. We calculate these changes using the same kind of aggregated and anonymised data used to show popular times for places in Google Maps. Changes for each day are compared to a baseline value for that day of the week: The baseline is the median value, for the corresponding day of the week, during the five week period 3 Jan – 6 Feb 2020."[22]

To estimate the impact of the Stay Home campaigns, we focus on the period March 27th (a week before the first stay-home related doodle) – May 15th (one week after the last Stay home doodle on May 8th) and focus on the countries that had at least one Stay Home doodle and for which mobility data are available throughout the period for the various mobility indicators. For this period, we evaluate whether mobility is lower on days when a country is exposed to a Stay Home doodle. As control variables, we include

- a stay-home dummy that is 1 when a stay-home doodle was shown in the country and zero when not.
- country level dummies to control for differences across countries in overall levels of mobility over the sample period.
- day level dummies to capture day of the week effects as well as effects of holidays like International Workers' Day (also known as Labour Day or May Day, celebrated on May 1st).
- a country-specific quadratic time trend.
- dummies for the level of stay-at-home requirements.

[21] https://www.google.com/Covid19/mobility/

[22] Google further notes that "We continue to improve our reports as places close and reopen. We updated the way that we calculate changes for groceries and pharmacy, retail and recreation, public transport stations and parks categories. For regions published before May 2020, the data may contain a consistent shift (up or down) which starts between 11–18 April 2020." Very few of the doodles we analyze were shown in that week.

- an indicator of the overall stringency of Covid-19 regulations, other than the stay-at-home requirements, in a country.[23]

As for table 6, we cluster standard errors at the level of country and date.

Table 7: Stay Home doodles and mobility.

	grocery+pharmacy	parks	transit_stations	retail+recreation	residential	workplaces
Intercept	8.16	-33.13***	-35.21***	-16.36*	8.87**	-16.68*
	(9.97)	(9.03)	(8.13)	(8.27)	(3.46)	(8.36)
stayhome	0.90	-2.04	0.68	0.22	-0.40	0.90
	(0.83)	(1.66)	(0.49)	(0.55)	(0.40)	(1.04)
C(stay_at_home_requirements)[T.1.0]	-1.99	-5.69	-3.11	-2.39	0.13	1.49
	(4.17)	(4.31)	(2.58)	(2.91)	(1.03)	(2.84)
C(stay_at_home_requirements)[T.2.0]	-3.01	-10.50***	-5.53**	-5.81**	1.46	-1.77
	(3.57)	(3.81)	(2.43)	(2.73)	(0.90)	(2.57)
C(stay_at_home_requirements)[T.3.0]	-9.84*	-15.00***	-9.73***	-10.25***	3.73***	-6.35**
	(5.16)	(4.43)	(3.03)	(3.45)	(1.33)	(3.12)
stringnostayhome	-0.46***	-0.08	-0.31***	-0.42***	0.16***	-0.31**
	(0.12)	(0.13)	(0.10)	(0.11)	(0.05)	(0.12)
R-squared	0.76	0.88	0.92	0.91	0.89	0.83
R-squared Adj.	0.74	0.87	0.92	0.91	0.89	0.82
N	4300	4350	4350	4350	4300	4350

Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01
OLS Standard errors are clustered at the date and country level.
Date and Country Fixed Effects and country specific quadratic time trends are included

Table 7 shows little evidence that being exposed to a Stay Home doodle is associated with decreased mobility. The estimated coefficients are small in size, vary in sign across mobility types and are statistically not significant.[24]

At the same time, table 7 suggests government regulations do seem to matter, a finding in line with Askitas et al., 2021. While governments just recommending to stay at home (level 1), is not associated with a statistically significant decrease, we can see sizable and statistically significant changes associated with governments requiring people to stay home (level 2 which allows some exception or level 3, which allows only minimal exceptions). We find such a negative association with all types of mobility except for residential mobility for which we find a positive association (which is in line with Askitas et al., 2021). Similarly, other changes in government regulations, which do not aim directly at convincing people to stay at home, also are found to be associated with mobility.

One possible explanation for the lack of impact of doodles on mobility could be that while, in absolute numbers, many people see and even act upon doodles, relative to the size of the

[23] We use the data and methodology from the Oxford COVID-19 Government Response Tracker (Hale et al, 2020) to compute their stringency index without the home-requirement index.
[24] As we have shown in the earlier sections, it is unlikely that which countries were shown Covid-19-related doodles and when countries were shown Covid-19-related doodles was the result of a random allocation. Hence the associations we find do not necessarily reflect causal effects.

population, these big absolute numbers remain small. To explore this explanation, we refine and update Shmueli (2017)'s analysis. Shmueli (2017) analyzes how page views of Wikipedia pages related to the subjects of the Google doodle change when the doodle is made public. Clicking on a doodle usually triggers a Google search for the doodle's topic. In many cases, the Wikipedia page on the subject will be the top search result, hence increases in Wikipedia page views can be used as a measure of people's engagement with a doodle[25].

We focus on 2019 doodles that celebrate the birthday of a person, and analyze how big the change in Wikipedia page views is, not only in absolute terms but also relative to the number of people the doodle has been exposed to. We compute the absolute change in Wikipedia page views as the difference between the number of page views in the week around the publication of the doodle and the number of page views in the prior week[26]. The number of people exposed to the doodle is the sum of the population of the countries which were exposed to the doodle. The ratio of the absolute impact to the population exposed gives us a rough estimate of an 'intention-to-treat' click-through rate. That is, we assume Google would like to 'treat' the whole population and each person who reacts to the treatment only visits the Wikipedia page once that week.

Tables 8a and 8b shows these statistics for the 2019 birthday doodles with the highest and lowest number of extra visitors.

Table VIIIa: Doodles with lowest click-through

Name	Absolute Number of WikiViews	Exposed to	Relative Number of WikiViews	Absolute Number of WikiViews before Doodle
abidin-dinos-106th-birthday	3055	82003882	0.000037	463
semiha-berksoys-109th-birthday	3659	82003882	0.000045	69
lucky-akhands-63rd-birthday	4238	164689383	0.000026	159
carolina-maria-de-jesus-105th-birthday	5324	543562056	0.000010	321
na-hye-soks-123rd-birthday	9407	51269183	0.000183	798

Table VIIIb: Doodles with highest click-through

Name	Absolute Number of WikiViews	Exposed to	Relative Number of WikiViews	Absolute Number of WikiViews before Doodle
friedlieb-ferdinand-runges-225th-birthday	1457235	2490703032	0.000585	338
rene-favaloros-96th-birthday	1665429	1001808158	0.001662	4057
olga-ladyzhenskayas-97th-birthday	1749609	2767043052	0.000632	418
joseph-plateaus-218th-birthday	2495653	2855677580	0.000874	888
steve-irwins-57th-birthday	2855634	3011741431	0.000948	96408

[25] Note that searches on Google also often show 'knowledge panels' which give some info about the search. So one can get extra information without clicking on an extra page. Clicking on the wikipedia pages thus reflects a certain level of interest.

[26] If several language versions of a page exist, we sum the pageviews of those pages.

Wikipedia page views are the extra views during a one week period.

Tables 8a and 8b illustrate the huge variation in the success of doodles. Some birthday doodles lead to a couple of thousand extra Wikipedia page views, while others get a couple of million. But these tables also show that even birthday doodles that have a high impact in absolute numbers, still have low click-through rates - that is, compared to the population of the countries where the birthday doodle was shown, the number of Wikipedia views is small, suggesting that even Google's influence is limited, on average. More specifically, while the average extra views of the Wikipedia page related to the birthday doodle is about 300 thousand (median 85 thousand), on average a birthday doodle targets over 660 million people. The average click-through rate is about 6 out of 10 thousand only.

VI. Conclusions

Google has put lots of effort and money to help individuals, companies and governments around the globe to reduce the spread of Covid-19. In this paper, we focus on one of Google's initiatives: Google's Covid-19-related doodles.

We show that in some countries, visitors of the google.com website most often are shown the standard Google homepage, while in other countries visitors are regularly shown a beautified homepage, where Google's logo has been replaced by a Google doodle, which commemorates a specific event or person. This was true before the Covid-19 pandemic, but Google also chose to show its Covid-19-related doodles, which recommended people to stay home or to wear masks, only to some selected countries.

While we do not know Google's reasons for exposing doodles selectively, we find that countries with bigger populations, countries that are richer, or have a higher internet penetration or Google market share, are shown more doodles and find little evidence that countries with stricter Covid-19-related regulations or more Covid-19-related deaths were shown more Covid-19-related doodles.

We further show that while it is likely that many people have seen the Google doodles, and that this has affected the behavior of some people, we do not find much evidence that country-level mobility was affected much by exposure to doodles that recommended staying at home. In the same time period, governmental regulations that required people to stay home were associated

with a major change in mobility, suggesting that at least in the case of Covid-19-related measures, the power of Google is still small relative to the power of national governments.

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Table 1. Timeline of Google's Covid-19 related doodles.

#	Doodle	date	nr	original/repeat
1	recognizing-ignaz-semmelweis-and-handwashing	3/20/2020	183	original
2	stay-home-save-lives	4/4/2020	88	original
3	thank-you-public-health-workers-and-to-researchers-in-the-scientific-community	4/6/2020	50	original
4	thank-you-doctors-nurses-and-medical-workers	4/7/2020	74	original
5	thank-you-emergency-services-workers	4/8/2020	80	original
6	thank-you-custodial-and-sanitation-workers	4/9/2020	73	original
7	thank-you-farmworkers-and-farmers	4/10/2020	72	original
8	thank-you-grocery-workers	4/13/2020	72	original
9	thank-you-doctors-nurses-and-medical-workers-april-13	4/13/2020	10	repeat
10	stay-home-save-lives-april-13	4/13/2020	2	repeat
11	thank-you-public-transportation-workers	4/14/2020	80	original
12	stay-home-save-lives-april-14	4/14/2020	2	repeat
13	thank-you-packaging-shipping-and-delivery-workers	4/15/2020	89	original
14	stay-home-save-lives-april-15	4/15/2020	1	repeat
15	thank-you-food-service-workers	4/16/2020	86	original
16	stay-home-save-lives-april-16	4/16/2020	2	repeat
17	thank-you-teachers-and-childcare-workers	4/17/2020	88	original
18	stay-home-save-lives-april-17	4/17/2020	2	repeat
19	thank-you-coronavirus-helpers	4/18/2020	48	original
20	stay-home-save-lives-april-20	4/20/2020	26	repeat
21	stay-home-save-lives-april-21	4/21/2020	27	repeat
22	stay-home-save-lives-april-23	4/23/2020	43	repeat
23	stay-home-save-lives-april-24	4/24/2020	49	repeat
24	thank-you-coronavirus-helpers-april-25	4/25/2020	43	repeat

25	thank-you-coronavirus-helpers-april-26	4/26/2020	43	repeat
26	stay-and-play-at-home-with-popular-past-google-doodles-coding-2017	4/27/2020	71	original
27	stay-and-play-at-home-with-popular-past-google-doodles-cricket-2017	4/28/2020	31	original
28	stay-and-play-at-home-with-popular-past-google-doodles-fischinger-2017	4/29/2020	53	original
29	stay-and-play-at-home-with-popular-past-google-doodles-rockmore-2016	4/30/2020	36	original
30	stay-and-play-at-home-with-popular-past-google-doodles-garden-gnomes-2018	5/1/2020	25	original
31	stay-and-play-at-home-with-popular-past-google-doodles-scoville-2016	5/4/2020	71	original
32	stay-and-play-at-home-with-popular-past-google-doodles-loteria-2019	5/5/2020	44	original
33	stay-and-play-at-home-with-popular-past-google-doodles-halloween-2016	5/6/2020	36	original
34	stay-and-play-at-home-with-popular-past-google-doodles-hip-hop-2017	5/7/2020	60	original
35	stay-and-play-at-home-with-popular-past-google-doodles-pac-man-2010	5/8/2020	72	original
36	thank-you-coronavirus-helpers-july-5	7/5/2020	1	repeat
37	wear-a-mask-save-lives-aug-5	8/5/2020	61	original
38	wear-a-mask-save-lives-aug-14	8/14/2020	1	repeat
39	thank-you-coronavirus-helpers-sep-14	9/14/2020	1	repeat
40	wear-a-mask-save-lives-sep-16	9/16/2020	2	repeat
41	wear-a-mask-save-lives-sep-17	9/17/2020	2	repeat
42	thank-you-coronavirus-helpers-sep-15	9/15/2020	1	repeat