The influence of visual representation and topic relevance on graph understanding and decision-making in COVID-19 health communication

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Abstract

Health communication, specifically in the COVID-19 pandemic, is often conveyed with the help of graphs. The present study researched the effects of different types of visualization (stock and flow) and levels of topic relevance on people's understanding of graphs and their decision-making, with the aim of finding ways to optimize health communication graphs. An experiment in the form of an online survey was conducted with 162 inhabitants of the Netherlands as participants. For each type of visualization, a graph with fictional data on the number of COVID-19 infections over the course of a couple of weeks was constructed. Topic relevance was constructed by telling the participants the graph was either about the Netherlands (high relevance) or Zambia (low relevance). Based on Romano et al. (2020), objective understanding was measured. Additionally, participants were asked to take a COVID-19 related decision based on the graph. Although main effects and interaction effects were expected for all variables, only effects of visual representation on understanding and decision-making were observed by the conducted two-way ANOVAs. The stock graph was more understandable and participants who had seen the stock graph were more supportive of stricter regulations. Even though age was a cofounding variable for decision-making and age was distributed unevenly over the visual representation conditions, the effect size for this was so small that the effect of visual representation on decision-making still holds. Further studies on communication via visualization could build upon the present findings and focus mainly on investigating topic relevance, for which no effects were found in the present study.

Introduction

The 27th of February 2020, the first patient in the Netherlands was officially diagnosed with COVID-19 (Rijksinstituut voor Volksgezondheid en Milieu [RIVM], 2020). Since then, government policies regarding the fight against the virus have changed constantly, due to an ever changing number of cases and progressive insights. The government in the Netherlands has mainly communicated via its press conferences. However, these are not the only source of information that people use to get an idea of the situation or make decisions. Indeed, all throughout daily life, people are confronted with many different news sources. For example, many media have daily updates on the number of infections, which are important as the regulations in the country are based on them. These numbers are usually communicated with the help of a graph, comparing the cases of the last 24 hours to the last weeks or even months. Because vaccination in the Netherlands and other countries has not been completed yet, the most effective way of fighting the virus is by modifying behaviour. Some regulations in the Netherlands to prevent the virus from spreading are therefore keeping 1.5 metres distance and wearing face masks in public buildings. However, the government cannot always enforce these rules, especially in the private sphere, which has resulted in many infections (RIVM, 2020). This means it is very important to raise consensus amongst the population so people will voluntarily adhere to the regulations. Although graphs could seem like a good way to make the developments in infections clear to the public, various studies (on COVID-19 communication but also on visual communication in general) have shown that variations in graphs can alter the way people understand them, which could ultimately lead to them making different decisions. This means that the design of such graphs should be considered carefully and be adapted to the goal(s), which are in this case information and ultimately persuasion.

Even though the COVID-19 pandemic is yet quite young, some research on the use of visualized data in this health communication context has already been done. Romano et al. (2020) researched the impact of different graph scales on understanding, attitude and policy preferences in a COVID-19 related context. They presented participants with a graph about the number of COVID-19 patients per 24 hours. Each participant saw one graph, either with a linear or a loglinear scale. Romano et al. (2020) found that people who had seen the graph with the linear scale had better understanding of the graph, made better predictions for future COVID-19 cases, were more worried about the health crisis, and had other policy preferences than those who had seen the graph with a loglinear scale. The viewers of the linear graph were less supportive of closing the stores, but more willing to prolong existing closures, and were

less willing to wear masks. The researchers hypothesized these findings to be due to the fact that these participants thought it would take longer for the number of cases to sink to an acceptable level. Thus, they likely thought that the financial impact of closing stores would be too high, but knew that it would not make sense to reopen already closed stores with still a high rate of cases. Additionally, this study was conducted in the beginning of the pandemic, when there were not enough masks in the United States. Therefore, these participants probably wanted to save the masks for medical situations.

In the Netherlands, the graphs related to COVID-19 cases are almost exclusively linear graphs. As the results from Romano et al. (2020) indicate this is the best version of such a graph to make people agree with regulations, there is no room for improvement regarding this type of visual representation. However, there are more factors that affect the look of a graph. For example, graphs that show developments over time (as is the case with graphs depicting the amount of positive COVID-19 tests) can visually represent data either in a stock or a flow format. In a graph with stock representation, the amount per time unit is given. In a graph with flow representation, the change in amount compared to the last time unit is given. This results in very different-looking graphs. In the Netherlands, the graphs regarding the positive COVID-19 tests are usually stock graphs with bars. However, it might be worth considering using flow graphs instead, as these could potentially provide people more insight into the effect certain regulations have. The problem with flow graphs, however, is that previous research has shown that people often do not fully understand the way the data is presented.

In 2000, Booth Sweeney and Sterman conducted a study in which they showed participants a picture of a bathtub with graphs depicting the in- and outflow from that bathtub. Even though the in- and outflow patterns were very simple (e.g. linear and constant), the majority of the participants did not understand the stock- and flow relationships. For example, they thought that the water level would sink when the inflow sank, even though outflow sank even lower, thus resulting in a rising water level. Sterman and Booth Sweeney (2007) reinforced that people make many mistakes with stock and flow visualizations. In their study, they asked people to make predictions on climate change based on graphs about greenhouse gas (GHG) emissions with stock- and flow visualizations. Again, people failed to understand these patterns. Most participants thought that the GHG concentrations could be stabilized, even though the inflow of GHG into the atmosphere continuously exceeded the outflow. This shows a lack of understanding regarding the concept of stock and flow in visualizations.

Going beyond merely understanding graphs, Spiller et al. (2019) hypothesized that stock and flow would also interfere with people's decision-making. They researched the effects of stock and flow on people's assessments by constructing different graphs about the employment in the United States from 2007 to 2013. First, the understanding of the graphs was measured and next, the participants were asked to evaluate the influence of former President Obama on the economy.

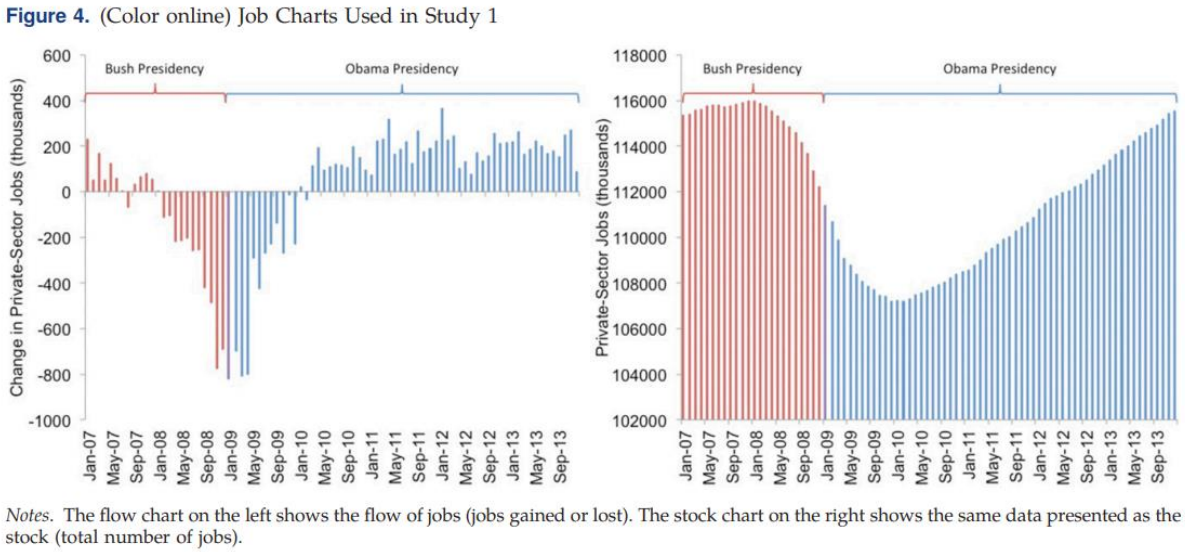


Figure 1. The graphs Spiller et al. (2019) used in their study. Original title: Job Charts Used in Study 1.

Spiller et al. (2019) found that the flow chart lead people to think that the economy started recovering seven months earlier than the stock chart. The estimations of the participants in the stock condition were more accurate. Thus, they concluded that stock/flow visual representation influences graph understanding. The biggest difference, however, was in the evaluation of Obama; participants who had seen the flow graph evaluated his impact on the economy positively (with 66% reporting he made it better and 8% reporting he made it worse). On the other hand, participants presented with the stock graph evaluated President Obama's impact on the economy negatively (with 60% reporting he made it worse and 24% reporting he made it better). Thus, Spiller et al. (2019) showed that the way in which the same data is presented in a graph (namely in a stock or a flow graph) can influence people's attitudes.

Besides visual representation in the form of stock or flow, another factor that, although not visual, might affect the way people process visual information and form attitudes, is topic relevance. Padilla et al. (2018) created an overview of different types of processing information. According to them, people can make both intuitive and strategic, reasoned choices, which results in two types of processing. Firstly, there is Type 1 processing, which is fast and without complex reasoning. The other way of processing, called Type 2, stands for making decisions slowly, taking the information into careful consideration. When engaging in Type 2 processing, people use their working memory intensely, whereas for Type 1 processing, this working memory is barely used and is used unconsciously. Because of this, Type 2 processing results in a more robust attitude. Padilla et al.'s types of processing are very similar to the ones used by Petty and Cacioppo (1986) in their Elaboration Likelihood Model. However, Petty and Cacioppo call Type 1 processing "peripheral processing" and Type 2 processing "central processing". Because the latter names provide more clarity as to which type involves what, these terms will be used throughout the current study.

According to the Elaboration Likelihood Model (Petty & Cacioppo, 1986), people's motivation to process information, whether textual or visual, is determined for a big part by the degree of personal relevance a topic has. McGuire (1985) distinguishes five reader characteristics that affect motivation and ability. Manipulating these reader characteristics could change motivation and ability, resulting in steering towards central processing and ultimately more robust attitudes. As out of these five characteristics, only outcome-relevant involvement (equal to topic relevance) is source-dependent (instead of person-dependent), this factor is the easiest to be manipulated by the author who wants to persuade their audience. The consumer will then be more likely to form robust attitudes. Robust attitudes are especially important in this pandemic because they affect not only people's own health, but the health and daily life of the whole population in general. When people consider the visual information carefully, they will be more likely to understand why certain measures are taken by the government and will be more likely to see the need for certain regulation and probably behave more carefully.

Previous research on the effect of topic relevance on understanding graphs and making decisions based on these graphs is very scarce. However, some studies investigated topic relevance, such as Peck et al. (2019). They asked participants to rank various graphs. The researchers found that the personal context of the participants played a big role in their attitude towards the graph, and hypothesized that personal relevance of visualized data can

alter the way people look at a graph from the first second. However, as this was a qualitative study, only few (42) people participated.

A more extensive study was carried out by Kennedy and Hill in 2018. They investigated the role of emotions in the processing of data and found that many different emotions interact with other aspects of visualisations through graphs. Based on this, they stated that the so-called "feeling of numbers" is also important when people process graphs. They carried out 9 focus groups in various communities. The participants were asked to keep a diary about their encounters with graphs and their initial responses to them. It turned out that the respondents experienced a wide range of emotions when confronted with these visualizations, which could have impacted their understanding of the graph and their attitude formation.

Finally, a quantitative study by Frewer et al. (1996) from longer back investigated the effect of topic relevance by providing participants with (textual) information about either food poisoning (high relevance) or excessive alcohol use (low relevance). The relevance was typed high or low based on people's estimations of the likeliness it would occur to them. When participants had to list words they associated with the article they had read, they wrote more words for food poisoning than for excessive alcohol use. This suggests that people considered the information that was more relevant to them more carefully, taking the central processing route (Petty & Cacioppo, 1986). As information regarding new COVID-19 cases over time is mostly provided with visual information however, the question is raised whether these results will be similar for graphs.

Considering the described literature, some questions are still open. First of all, stock and flow visualizations have not been studied in a health context yet. If the findings from previous studies can be generalized to graphs used to communicate about health, this would enable governments and media to optimize their graphs so that people understand them better and make decisions that are better for their own health and that of others. This is especially important in the ongoing COVID-19 pandemic, because people's choices also affect other people. This means that the way graphs are designed does not only affect personal health, but public health as well. When understanding of these visualizations increases, the population will likely be more inclined to adhere to regulations, resulting in less infections and a better personal and public health. The findings of this study can also be extended beyond the COVID-19 pandemic. To exemplify this, findings on understanding and decision-making could also be used for informative health communication flyers. This could potentially result

in a better understanding of this information and more contentment with health communication.

Secondly, there is a large research gap regarding the influence of topic relevance of visual instead of textual information. In addition to this, the usual "factual" approach to graphs (by manipulating a visual aspect of the graph) has not really been combined yet with a more sociological approach that takes outcome-relevant involvement into account. This is remarkable as all these factors can influence the extent to which people understand graphs and the decisions they make based on these graphs.

The present study presented participants with either a stock or a flow graph and manipulated topic relevance. The understanding of the graphs and the decisions participants made after seeing them were investigated with two ultimate goals. Firstly to broaden the scientific knowledge about effects of manipulations in data visualizations and the role outcome-relevant involvement plays in visual information processing; secondly to provide more insight into the optimal way data should be visualized to communicate health risks to people in today's society.

The above lead to the following research questions and hypotheses:

Main question: *What are the effects of visual representation and topic relevance on graph understanding and decision-making in COVID-19 health communication?*

Research questions and hypotheses:v

1. *How does visual representation, consisting of a stock or a flow graph, influence graph understanding?*
   Based on Booth Sweeney and Sterman (2000) and Sterman and Booth Sweeney (2007), the expectation for the effect of visual representation was a difference in understanding between the conditions. More specifically, it was predicted that the stock graph would be understood better by the participants than the flow graph.

2. *How does visual representation, consisting of a stock or a flow graph, influence decision-making?*
   Based on Spiller et al. (2019), the hypothesis for this question was that there would be differences in decision-making between the stock graph and the flow graph.

Because a stock graph with bars that rise ever higher would probably look more alarming than a flow graph, the viewers exposed to the stock condition would likely agree more with stricter regulations (in this case, prolonging the closing of non-essential stores) than the viewers exposed to the flow condition (in agreement with Romano et al. (2020)). This effect was likely to be reinforced by the particular look of the graph. Namely, during the last few days displayed in the graph, the infections were rising, but the speed of the rise was slowing down. This resulted in the last bar of the flow graph being lower than the one-to-last, which would have given the impression of the situation not being as bad as in the stock graph.

3. *How does topic relevance influence graph understanding?*

   As Petty and Cacioppo (1986) and Frewer et al. (1996) suggest that a high topic relevance leads people to process centrally instead peripherally, which means they consider the information more carefully, it was hypothesized that the graph understanding would be higher with a high topic relevance.

4. *How does topic relevance influence decision-making?*

   Because the existing literature does not really address a possible connection between topic relevance and decision-making, it was difficult to formulate expectations for this research question. However, as high topic relevance likely leads people to taking the central processing route and makes them more engaged with the graphs (Petty & Cacioppo, 1986 and Frewer et al., 1996), the people in this condition were expected to agree more on the seriousness of the situation and the need for regulations. Consequently, we expected them to decide on stricter regulations (prolonging the closing of non-essential stores) than the people who were presented with a graph of low relevance.

5. *How do visual representation and topic relevance combined affect graph understanding?*

   Because high topic relevance stimulates people to process centrally, thus considering the information more carefully (Padilla et al., 2019), their understanding in the flow condition was expected to increase despite usual reported difficulty (Booth Sweeney & Sterman, 2000). This would likely result in an interaction effect on graph understanding. It was hypothesized that topic relevance would mitigate the differences in graph understanding caused by the different visual conditions stock and flow. Additionally, participants who saw a graph of low relevance would probably be less inclined to pay

detailed attention, thus misinterpreting the flow graph more often, which would result in a significant difference between the flow graph with low relevance and the other versions.

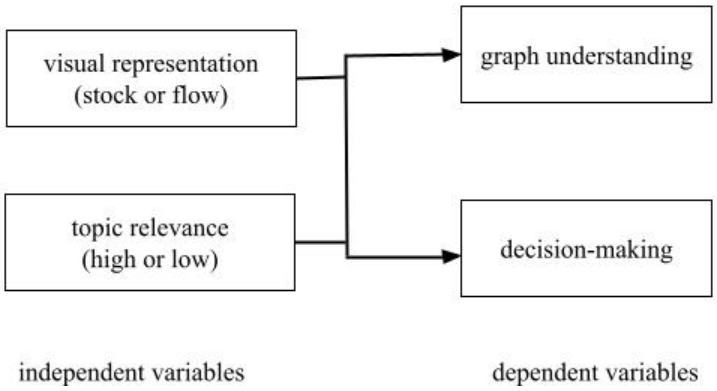
6. *How do visual representation and topic relevance combined affect decision-making?*
   For this question, the hypothesis was that there would be an interaction effect for visual representation and topic relevance. In research question 4, it was already hypothesized that high topic relevance would result in deciding on stricter regulations. As the stock graphs would look more alarming than flow graphs, the hypothesis was that stock graphs with high topic relevance would result in the highest degree of agreement, and that flow graphs with low topic relevance would lead to the lowest degree of agreement with regulations (Spiller et al., 2019 & Padilla et al., 2019).

Method

Design

The experiment had a 2x2 between-subjects design; each participant was assigned to one out of the four graph versions.

Analytical model



The independent variables were visual representation and topic relevance. Visual representation was a nominal variable with 2 levels: stock and flow. Topic relevance was also a nominal variable with 2 levels: high and low. The dependent variables were graph understanding and decision-making. Graph understanding was a ratio variable; the variable was computed by counting the correct answers to the understanding questions and dividing them by the total amount of questions, making it a proportion. Decision-making was measured on an interval scale.

Materials

Participants in the study were presented with one out of four different versions of a graph with the same underlying data. Two graphs were said to depict the amount of positive COVID-19 tests in the Netherlands, two graphs were said to show the amount of positive COVID-19 tests in Zambia. These countries were chosen, because the topic relevance was expected to differ greatly between them.

During the COVID-19 pandemic, measures taken by the government have affected almost every part of people's daily life, ranging from working from home to not being able to see family anymore. As a consequence, it was expected that outcome-relevant involvement for people living in the Netherlands would be very high for the amount of COVID-19 cases per day in the Netherlands, as the government usually bases its rules and recommendations on this information. On the other hand, the amount of COVID-19 cases per day in Zambia was not expected to be very relevant to people living in the Netherlands, as this country is far away and not important for the Dutch economy (Zambia is in the 138th place of export for the Netherlands (Rijksdienst voor Ondernemend Nederland [RVO], 2020), making it unlikely that the cases over there would affect the daily situation in the Netherlands.

For each country, one graph with stock representation of the data and one graph with flow representation of the data were created. Thus, there were four graphs version (which can all be seen in appendix 1): a stock graph with high topic relevance (figure 2), a stock graph with low topic relevance (for which only the name of the country was changed), a flow graph with high topic relevance (figure 3) and a flow graph with low topic relevance (for which again, only the name of the country was changed). In this study, the stock graph showed the total number of cases per day; the flow graph showed the change in number of cases when compared to the day before. All graphs were created with fictional, but realistic data. This was stressed in the introductory description provided to the participants, which can be fully seen in appendix 2.

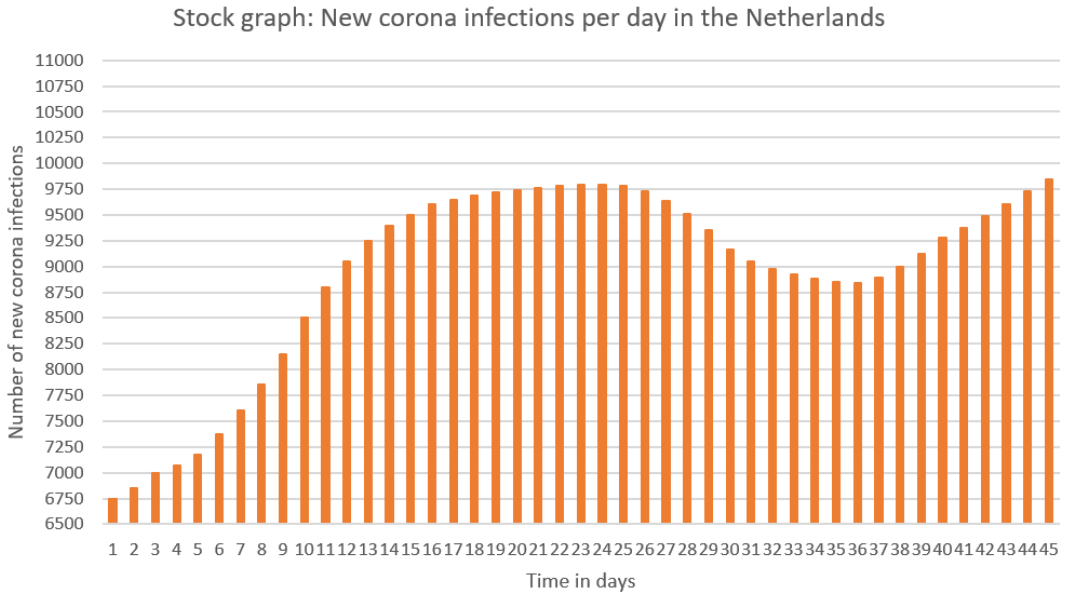


Figure 2: The stock graph for the Netherlands (high topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

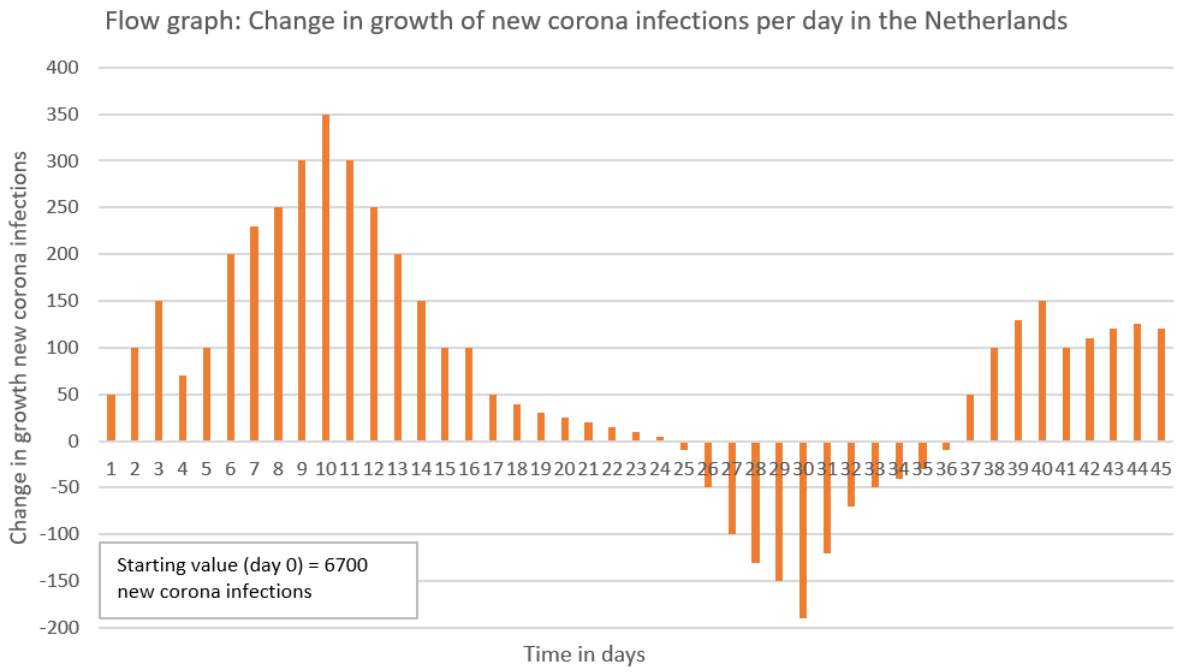


Figure 3: The flow graph for the Netherlands (high topic relevance), depicting the change in the (fictional) number of cases for each day (1 to 45) compared to the day before.

Participants

The survey was distributed via various channels, amongst which WhatsApp, LinkedIn and Instagram. A total amount of 162 inhabitants of the Netherlands participated in this study.[1] Only inhabitants of the Netherlands were allowed to take part in the study, because they could be expected to have a high topic relevance for the Dutch graph and a low topic relevance for the graph about Zambia. Additionally, people living in one country were chosen, because they could be expected to have been exposed to roughly the same COVID-19-communication throughout the pandemic.

The age of the participants ranged from 18 to 66 years (M = 27.21, SD = 12.99). However, by far most of the participants were in their early 20's. 100 participants were women (mean age 26.74, SD = 12.34), 57 were men (mean age 27.61, SD = 12.93), 3 chose the option "other" for gender (mean age 21.00, SD = 2.65) and 2 respondents indicated that they would rather not comment on their gender (mean age 28.00, SD = 11.31). 139 participants took the survey in Dutch, 23 took it in English. Of the group who completed the

[1] This study was part of a bigger research project. The total amount of participants in the survey was 246, but only 162 of them were used for this particular study.

questionnaire in Dutch, 52 were men, 84 were women, 2 chose the option "other" and 1 would rather not say anything about their gender. Their average age was 27.68 (*SD* = 13.13). Of the group who took the survey in English, 5 were men, 16 were women, 1 chose the option "other" and 1 would rather not say anything about their gender. Their average age was 22.57 (*SD* = 4.23). The age difference will likely have been due to the English speakers being mostly international students at Radboud University.

Instrumentation

Dependent variables

For decision-making, the participants were presented with the following scenario and asked to give advice whilst seeing a version of the graph (see appendix 1 for all graph versions).

- *On day 45, the authorities of Zambia/the Netherlands are supposed to make a decision about whether they should reopen the non-essential shops or whether they should prolong the closing of non-essential shops for another 14 days. Based on the graph you are seeing, what would your advice be?*

Answers to this question were measured on a 7-point Likert scale from "definitely stay closed" to "definitely reopen". The question was phrased like this, and not as a yes/no question, so an agreement bias (Kuru & Pasek, 2018) would be avoided. Participants were still able to see the graph on the same page to stimulate careful consideration of the infection numbers.

Subsequently, participants were shown the same graph they had seen before and were asked questions about the dependent variable graph understanding. The questions were inspired by the questions asked to measure understanding in Romano et al. (2020), but tailored to the specific visualization types of the present study. For the flow graph, the starting value was given in order to enable participants to answer question 1 and to give them a better idea of the situation.

1. *How many new Covid-19 cases were registered on day 3?* → Correct answer: 7000. Answers between 6800 and 7200 were counted as correct for the stock graph, because of impaired visibility (especially for participants who took the survey on their phone).
2. *Look at day 3 and day 4. Which day shows the biggest increase in new infections compared to the day before?* → Correct answer: day 3.

3. *Compare the period from day 1 to day 10 to the period from day 11 to day 20. Which period shows a stronger rise in infections?* → Correct answer: day 1 to day 10.
4. *What is the difference in the number of new infections between day 12 and day 13?* → Correct answer: 200. For the stock condition, answers between 160 and 240 were counted as correct because of impaired visibility (especially for participants who took the survey on their phone).
5. *On which day did the decrease of Covid-19 infections start to slow down?* → Correct answer: day 31. For the stock condition, day 30 and day 32 were also counted as correct due to impaired visibility (especially for participants who took the survey on their phone).

For each participant, a proportion of the right answers was computed that served as the variable graph understanding when conducting the statistical tests. To compute the proportion, the amount of correct answers was divided by the total amount of questions (5). Thus, all proportions were between 0 and 1.

Manipulation check

To assure the validity of the variable topic relevance, a manipulation check was conducted. Based on Frewer et al. (1997), all participants were asked the following questions to make sure that the graphs were indeed of different degrees of personal relevance:

- *The graph I saw is very relevant to me personally* -> Measured on a Likert-scale from 1 (disagree strongly) to 7 (agree strongly).
- *The positive COVID-19 tests in Zambia/the Netherlands are very relevant to me personally* -> Measured on a Likert-scale from 1 (disagree strongly) to 7 (agree strongly).
- *The COVID-19 regulations in Zambia/the Netherlands are very relevant to me personally* -> Measured on a Likert-scale from 1 (disagree strongly) to 7 (agree strongly).

The name of the country was adjusted depending on the version of the graph the participant had seen previously in the study. Because this manipulation check consisted of multiple questions, a Cronbach's alpha was computed. The reliability of the manipulation check for topic relevance, consisting of three items, was satisfactory: $\alpha = .78$.

Procedure

The experiment was conducted in the form of a questionnaire made in the online programme Qualtrics. Participants read the guidelines for conducting research at the Radboud University and gave permission for the use of data before they started the questionnaire. All participants were given the option to ask for more information on the project afterwards. The survey was originally created in English and subsequently translated to Dutch, because not all inhabitants of the Netherlands speak Dutch. Before starting the actual experiment, participants were asked which language they preferred to take the survey in.

The questionnaire started with a short informative description of the research project and an outlook on the survey. Then, participants were asked to click "agree" if they were at least 18 years old and wanted to participate. If not, they could click "I do not agree" and were led to the end of the survey.

The next question made sure the participant fell within the right group. To test this, the participant was asked in which country they lived. Only participants who indicated they lived in the Netherlands were permitted to take the survey. Participants who answered "other" were taken to the end of the questionnaire and thanked for their interest. After this, the remaining participants were asked some questions about the demographical characteristics age, gender and educational level.

The survey was divided in blocks (pages with questions). Every block consisted of one or multiple questions about the same topic (e.g. the 5 understanding questions). Whilst answering the decision-making and understanding questions, participants could see the corresponding graph. Participants were not able to go back to previous questions, nor were they allowed to skip questions. However, for the question on gender, they were given the option "I would rather not say". Participants were informed about the fictional nature of the data in the graphs, but it was emphasized that they should pretend the data were real when answering the questions. The completion time of the survey was around 10 minutes.

Because no reward was given for completion and because there was no supervision during the participation, it could have been the case that participants got bored or rushed through the survey. To limit the effects this might have had, the answers of participants with a completion time of under 4 minutes were screened. As a result, one participant who completed the survey with a response time of under 2 minutes was excluded from the

analysis, as a high number of answers did not even remotely make sense, including the very easy questions for graph literacy.[2]

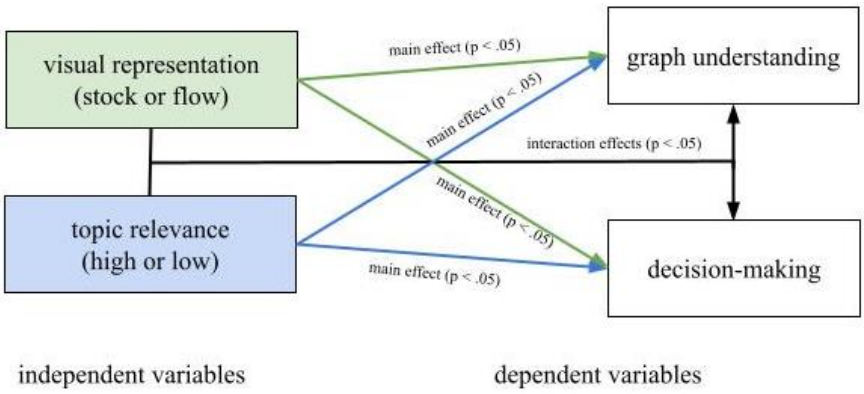
Statistical treatment

The manipulation for topic relevance was checked by conducting an independent samples t-test to see if there was indeed a difference in relevance between the Netherlands and Zambia.

The impact of visualization type (stock or flow) and topic relevance (high or low) on decision-making were measured by conducting a two-way ANOVA, with the independent variables visual representation and topic relevance and with the dependent variable decision-making. By conducting this ANOVA, a main effect for visualization type on decision-making (research question 2), a main effect for topic relevance on decision-making (research question 4) and an interaction effect of both visualization type and topic relevance on decision-making (research question 6) were researched.

Additionally, to research the impact of visualization type (stock or flow) and topic relevance (high or low) on understanding of the graph, another two-way ANOVA was conducted, again with the independent variables visual representation and topic relevance and this time with the dependent variable graph understanding. By conducting this ANOVA, a main effect for visualization type on understanding (research question 1), a main effect for topic relevance on understanding (research question 3) and an interaction effect of both visualization type and topic relevance on understanding (research question 5) were investigated.

Statistical model



[2] These questions were asked for a different researcher who used the same survey, as the survey was part of a bigger project group.

In accordance with the hypotheses, for visual representation, main effects on both graph understanding and decision-making were expected. Furthermore, main effects of topic relevance on graph understanding and decision-making were expected. In addition to this, interaction effects of visual representation and topic relevance on understanding as well as decision-making were hypothesized. All effects were considered statistically significant when $p < .05$ (two-tailed).

Results

Manipulation check

An independent samples t-test showed a significant difference between the participants who had seen the graph about Zambia (low topic relevance) and those who had seen the graph about the Netherlands (high topic relevance) (t (159) = 10.03, $p < .001$). Participants who saw the graph about the Netherlands (M = 4.24, SD = 1.36) felt like the graph itself and the topic of the graph were more relevant to them personally than the participants who had seen the graph about Zambia (M = 2.27, SD = 1.13).

Table 1. Topic relevance means and standard deviations (between brackets) for the different graph versions

	High: the Netherlands (n = 80)	Low: Zambia (n = 82)
	M (SD)	M (SD)
Topic relevance	4.24 (1.36)	2.27 (1.13)

Two-way ANOVA for decision-making

A two-way analysis of variance with graph type and topic relevance as factors showed a significant main effect of graph type on decision-making (F (1, 162) =10.94, p = .001, η^2 = .065). Participants in the stock condition (M = 2.17, SD = 1.57) were more likely to choose a prolonging of the closing of non-essential shops than participants in the flow condition (M = 2.99, SD = 1.47). However, the effect was very small and both groups were hesitant about reopening the stores, albeit not equally hesitant. Topic relevance was not found to have a significant main effect on decision-making (F (1, 162) = 1.09, p = .298). In addition to this, no interaction effect between graph type and topic relevance was found (F (1, 162) < 1, p = .479).

Table 2. Decision-making means and standard deviations (between brackets) for the different types of visualization and degrees of topic relevance (measured on a 7-point Likert-scale from definitely stay closed (1) to definitely reopen (7)).

	Topic relevance				total	
	high		low			
	M (SD)	*n*	*M (SD)*	*n*	*M (SD)*	*n*
Visualization type						
flow	3.03 (1.39)	40	2.94 (1.57)	36	2.99 (1.47)	76
stock	2.40 (1.67)	40	1.98 (1.47)	46	2.17 (1.57)	86
total	2.71 (1.56)	80	2.40 (1.58)	82		

Two-way ANOVA for understanding

Another two-way analysis of variance with graph type and topic relevance as factors showed a significant main effect of graph type on understanding (F (1, 162) = 59.93, $p < .001$, η^2 = .275). Participants in the stock condition (M = 0.77, SD = 0.22) understood the graph better than participants in the flow condition (M = 0.52, SD = 0.17). However, the effect was quite small. Topic relevance was not found to have a significant main effect on understanding (F (1, 162) = 1.01, p = .317). In addition to this, no interaction effect between graph type and topic relevance was found (F (1, 162) = 1.02, p = .314).

Table 3. Understanding proportions means and standard deviations (between brackets) for the different types of visualization and degrees of topic relevance (0 is none correct, 1 is all questions correct).

	Topic relevance				total	
	high		low			
	M (SD)	*n*	*M (SD)*	*n*	*M (SD)*	*n*
Visualization type						
flow	0.55 (0.18)	40	0.49 (0.16)	36	0.52 (0.17)	76
stock	0.77 (0.23)	40	0.77 (0.22)	46	0.77 (0.22)	86
total	0.66 (0.23)	80	0.64 (0.24)	82		

Discussion

In this study, a survey was conducted to investigate the effects of visual representation (stock or flow) and topic relevance on the extent to which people understand graphs and on their decision-making. In order to answer the main question "*What are the effects of visual representation and topic relevance on graph understanding and decision-making in COVID-19 health communication?*", 6 research questions were asked, of which the results will be weighed against the hypotheses here.

Regarding understanding, based on literature by Booth Sweeney and Sterman (2000), Sterman and Booth Sweeney (2007), the expectation was that participants would understand the stock graph better than the flow graph. This was reinforced by the results of the present experiment. For topic relevance, the hypothesis was that high topic relevance would lead people to process centrally instead of peripherally, resulting in a better graph understanding (based on Petty and Cacioppo, 1986, and Frewer et al., 1996). However, in contrast to this expectation, the data gathered in this study could not reinforce that high topic relevance leads to better understanding. No interaction effect of visualization type and topic relevance on understanding was found either. This was not in line with the hypothesis, which predicted that high topic relevance would increase understanding especially in the flow condition and that low topic relevance would worsen the understanding especially for the flow condition, which would create significant differences in understanding between the participants who had been exposed to different graph versions (based on Padilla et al., 2019, and Booth Sweeney and Sterman, 2000).

For decision-making, consideration of studies by Spiller et al. (2019) and Romano et al. (2020) resulted in the expectation of an effect of visual representation. Indeed, in line with the hypothesis, visual representation turned out to have an effect on decision-making. Namely, participants who had seen the stock graph were more likely to take stricter regulations (keeping the non-essential shops closed) than those who were in the flow condition. Regarding the effect of topic relevance on decision-making, although a hypothesis was formed, stating that high topic relevance would lead to stricter decision-making (keeping the non-essential stores closed), no effect of topic relevance on decision-making was found in this study. These findings were thus in contrast to Petty & Cacioppo (1986) and Frewer et al. (1996). Lastly, no interaction effect of visual representation and topic relevance on decision-making was found in this study. This was not in line with the hypothesis, which (based on

Spiller et al., 2019 and Padilla et al., 2019) had predicted that a combination of high topic relevance and a stock graph would result in the strictest adherence to regulations in decision-making (keeping the non-essential stores closed) and that a low topic relevance combined with a flow graph would result in the least strict decision-making.

In conclusion, only visual representation was found to have an effect. Namely, whether the graph was a stock or a flow visualization affected both understanding and decision-making of the participants. However, for topic relevance, no effects were found, nor were there any interaction effects. This could have had several causes, which will be discussed in this section.

Several points of critique on this study should be mentioned. First of all, a minor mistake was made in the design of the questionnaire. Namely, for the flow graph about the Netherlands in the English version, it was not mentioned that the decision they were supposed to make took place on day 45. This could have influenced their answers. However, as day 45 was the last day in the graph and thus "today", basing the decision on the situation in the last days was most logical. Therefore, it is expected that this deviation from the decision-making question in the other survey versions will not have had a noteworthy effect.

A complication regarding decision-making were pre-existing opinions that might have influenced people's answers instead of the graph they had seen. For example, a shop owner might have chosen to reopen the stores irrespective of the graph they had seen. As no manipulation check for this was conducted, it is unknown to what extent people's decision-making was based on the graphs they had seen or on their general, pre-existing opinions. Therefore, in future studies, it would be advisable to add a manipulation check. However, as the groups in all conditions made a decision in the direction of stricter regulations (keeping the non-essential stores closed) and as the standard deviations were not very high (all < 1.67), this complication will likely not have had a huge effect and likely does not explain the lack of interaction effect and lack of effect for topic relevance on this variable.

Regarding understanding, a complication was found when checking the distribution of age. Age was found to not be equally distributed over the graph types. An independent samples t-test revealed a significant difference in age between participants in the stock and the flow condition (t (151.89) = 2.19, p = .030). Participants in the stock condition (M = 28.90, SD = 14.08) were older than participants in the flow condition (M = 24.76, SD = 9.78). Because of the unequal distribution, an additional correlation test for a possible correlation

between age and decision-making and understanding was conducted. From this, it was concluded that there was a statistically significant correlation between age and decision-making (r (162) = -.174, p = .026). Older people were more likely to decide on stricter regulations (keeping the non-essential stores closed) than younger people. Thus, the effect of visual representation on decision-making could potentially have been partly due to the age difference and not solely to the stock/flow difference. However, as the effect was very small, this is not very likely. Nevertheless, a need for future studies on the effects of visual representation on decision-making still exists.

Unfortunately, for topic relevance, the null hypothesis could not be rejected based on the present study, even though the manipulation check showed that the relevance for the graph about Zambia was significantly lower than for the graph about the Netherlands. A possible explanation for the lack of effect on understanding could have been that participants might have overlooked that the graph was about a different country. This was also said by some (3) participants who were asked about the questionnaire afterwards. However, even if this was the cause of the lack of effect on understanding, this still does not explain why topic relevance did not influence decision-making. Namely, the country that the graph was about was mentioned explicitly in the decision-making question (*On day 45, the authorities of Zambia/the Netherlands*…). Additionally, as the decision-making question came before the understanding questions, the mentioned possible explanation becomes less likely, as attention had been drawn to the country of the graph already.

Regarding the implications of this research, the present study contributes to the academic work on communication through visualization by having shown that flow and stock visualizations have an influence on the understanding of health graphs. With this, Spiller et al. (2019)'s findings have been reinforced in another field of communication, namely health communication. The findings in this specific area of visualization type (stock versus flow) could be extended to other types of visualizations in health communication, such as linear visualizations that use stock and flow. Additionally, future studies could investigate the lack of influence from topic relevance further, as the expected effects were not found. They could e.g. use a different way to distinguish topic relevance levels and they could use (more) manipulation checks with the aim of optimizing the circumstances for detecting existing effects.

In the more practical sense, this study has shown that the type of graph that is usually used in Dutch COVID-19 communication (stock bar graphs) is appropriate to maximalise understanding and to promote strict decision-making. This would likely also hold true in other health contexts and could for example be used in preventive health communication. The findings of the present study could be used to tailor graphs in informative texts in such a way that they are easier to understand, which should stimulate (potential) patients to make healthier decisions and be more content with healthcare communication. However, for an optimate effect, further research on different graph versions would be required.

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Appendix 1: Graphs used in the questionnaire

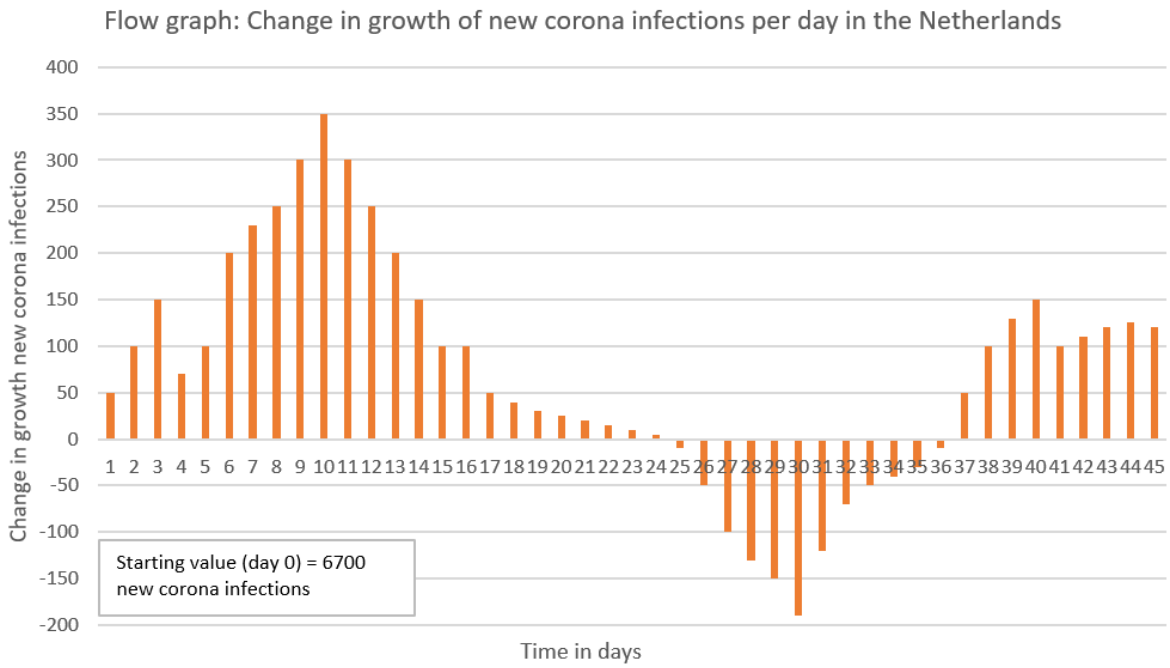

Figure 4. The English version of the flow graph for the Netherlands (high topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

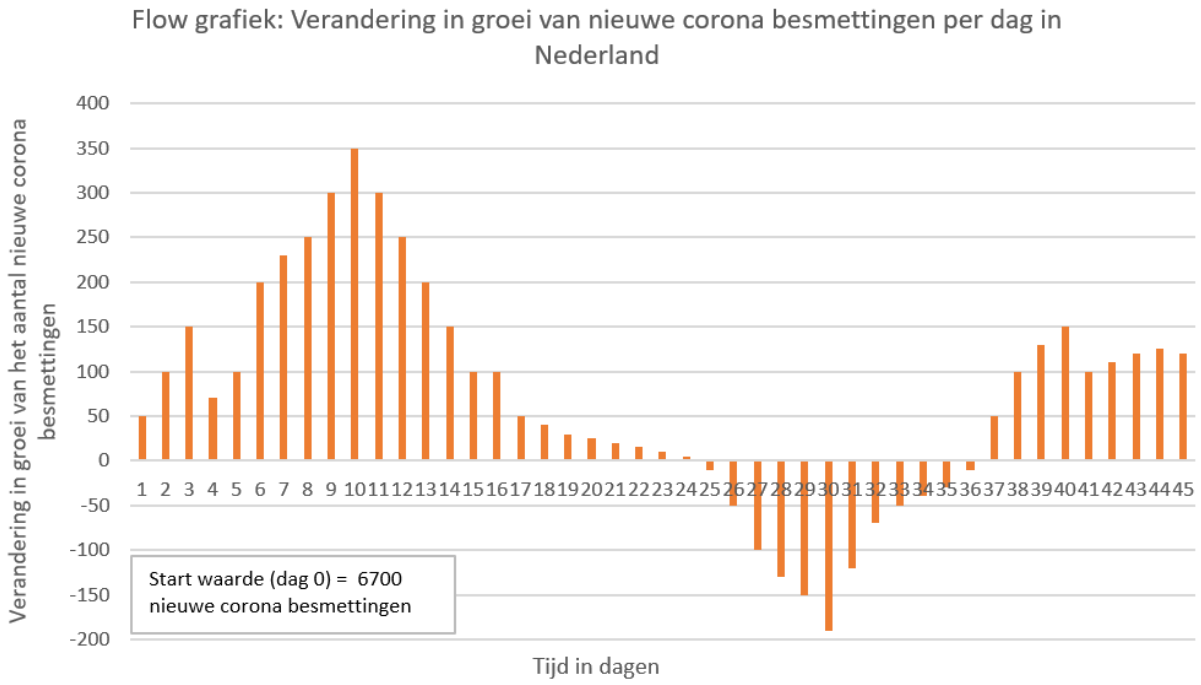

Figure 5: The Dutch version of the flow graph for the Netherlands (high topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

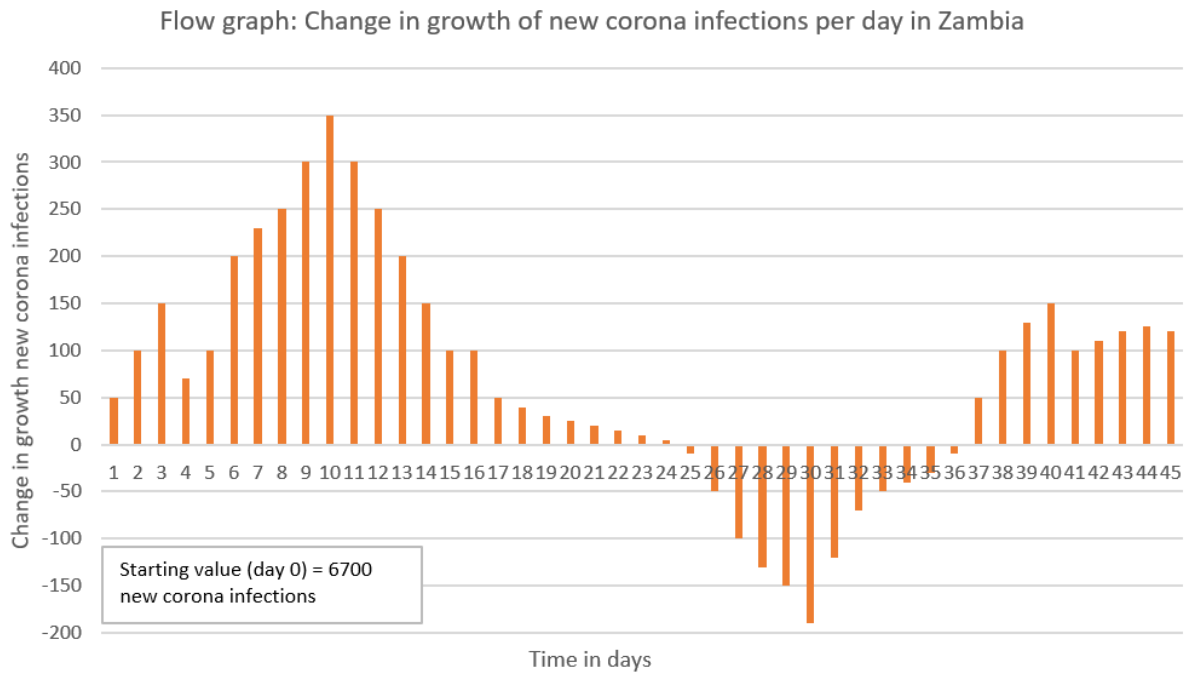

Figure 6: The English version of the flow graph for Zambia (low topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

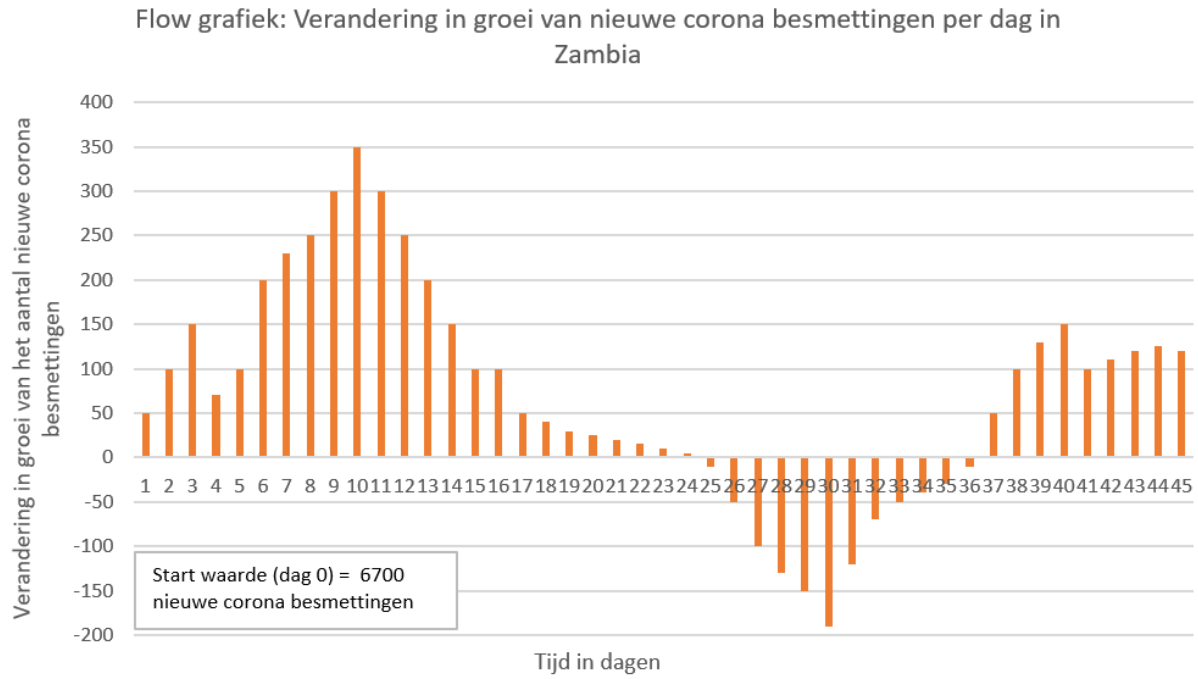

Figure 7: The Dutch version of the flow graph for Zambia (low topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

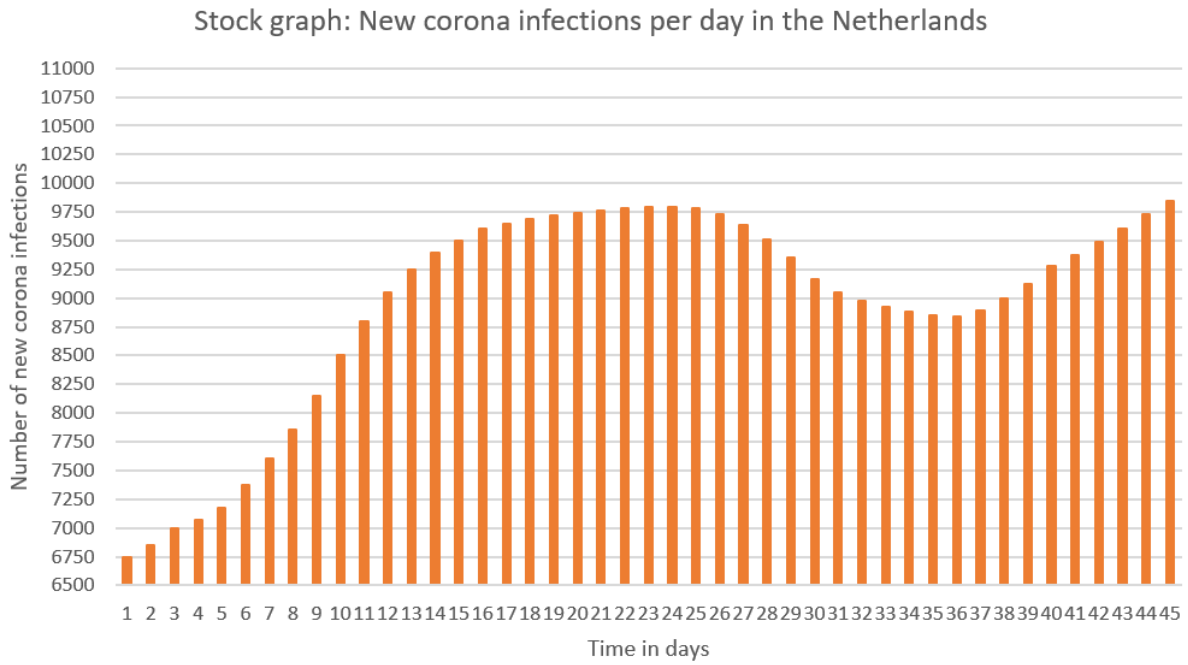

Figure 8: The English version of the stock graph for the Netherlands (high topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

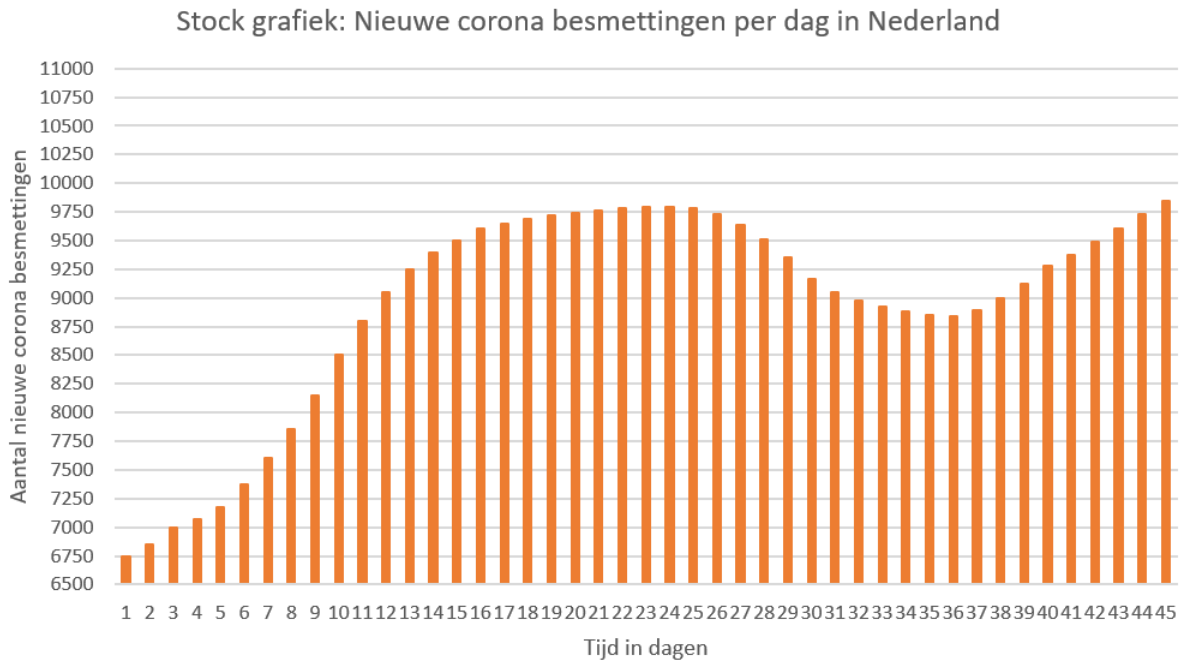

Figure 9: The Dutch version of the stock graph for the Netherlands (high topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

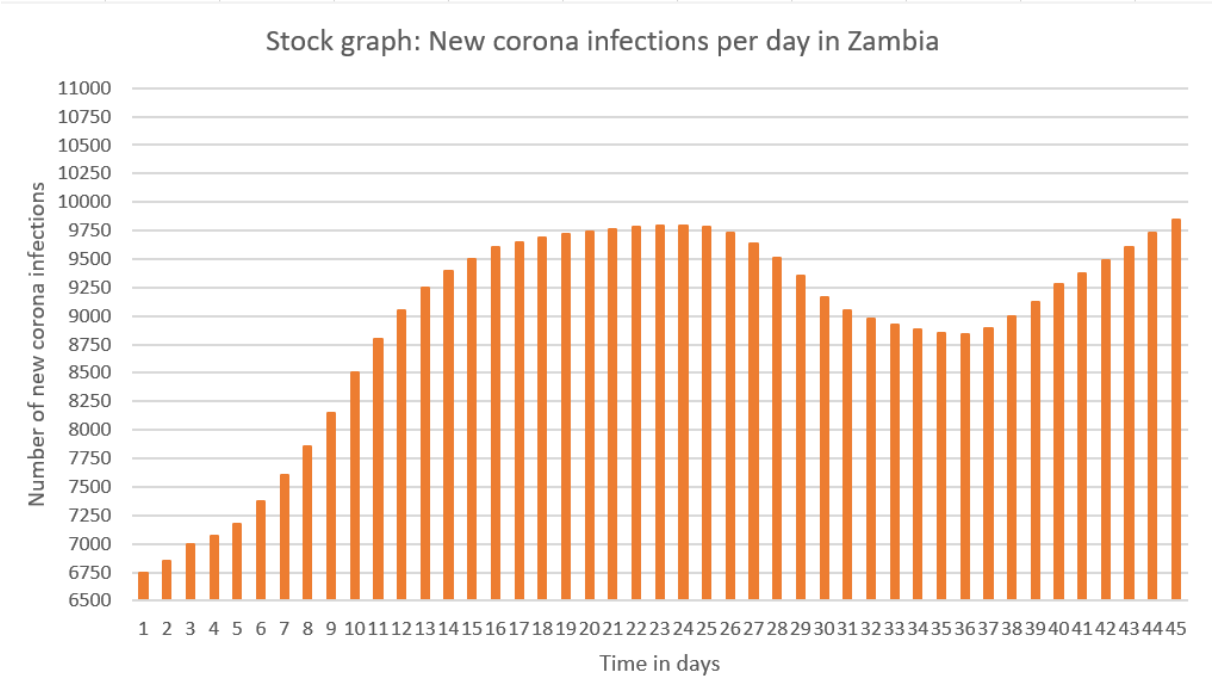

Figure 10: The English version of the stock graph for Zambia (low topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

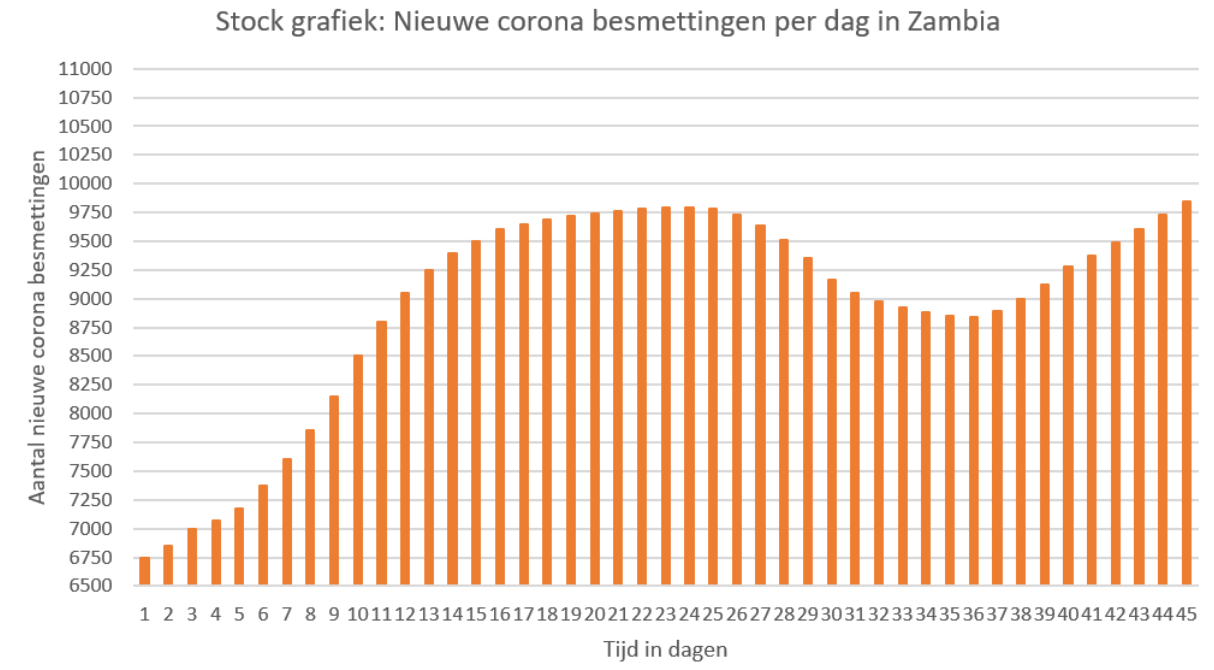

Figure 11: The Dutch of the stock graph for Zambia (low topic relevance), showing the (fictional) number of cases per day for day 1 to 45.

Appendix 2: The Qualtrics questionnaire

- **Standard: Language choice (1 Question)**
- **Branch: New Branch**
  - **If**
    - **If In welke taal wil je deze enquête zien? / In which language would you like to view this survey? Nederlands Is Selected**
      - **Group: Dutch**
        - **Block: Dutch consent and demographics (6 Questions)**
        - **BlockRandomizer: 1 - Evenly Present Elements**
          - **Group: Z Dutch stock**
            - **Standard: Z Dutch stock decision (4 Questions)**
            - **Standard: Z Dutch stock understanding (8 Questions)**
            - **Standard: Z Dutch manipulation check (4 Questions)**
          - **Group: Z Dutch flow**
            - **Standard: Z Dutch flow decision (4 Questions)**
            - **Standard: Z Dutch flow understanding (8 Questions)**
            - **Standard: Z Dutch manipulation check (4 Questions)**
          - **Group: NL Dutch stock**
            - **Standard: NL Dutch stock decision (4 Questions)**
            - **Standard: NL Dutch stock understanding (8 Questions)**
            - **Standard: NL Dutch manipulation check (4 Questions)**
          - **Group: NL Dutch flow**
            - **Standard: NL Dutch flow decision (4 Questions)**
            - **Standard: NL Dutch flow understanding (8 Questions)**
            - **Standard: NL Dutch manipulation check (4 Questions)**
        - **Block: Debriefing Dutch (1 Question)**
      - **EndSurvey:**

Standard: English consent and demographics (6 Questions)

BlockRandomizer: 1 - Evenly Present Elements

Group: Z English stock

Standard: Z English stock decision (4 Questions)

Standard: Z English stock understanding (8 Questions)

Standard: Z English manipulation check (4 Questions)

Group: Z English flow

Standard: Z English flow decision (4 Questions)

Standard: Z English flow understanding (8 Questions)

Standard: Z English manipulation check (4 Questions)

Group: NL English stock

Standard: NL English stock decision (4 Questions)

Standard: NL English stock understanding (8 Questions)

Standard: NL English manipulation check (4 Questions)

Group: NL English flow

Standard: NL English flow decision (4 Questions)

Standard: NL English flow understanding (8 Questions)

Standard: NL English manipulation check (4 Questions)

Standard: Debriefing English (1 Question)

Page Break

Start of Block: Language choice

In welke taal wil je deze enquête zien? / In which language would you like to view this survey?

- Nederlands
- English

Page Break

End of Block: Language choice

Start of Block: Dutch consent and demographics

INFORMATIE EN TOESTEMMING

Hallo! Wij zijn zes Bachelor International Business Communication studenten (Mara, Tom, Lucie, Tobias, Florian en Isabel) aan de Radboud Universiteit. Je wordt uitgenodigd om mee te doen aan een onderzoek waarin je een grafiek met fictieve data te zien krijgt gerelateerd aan gezondheidscommunicatie. Je zult verschillende vragen over deze grafiek gaan beantwoorden, met betrekking tot het begrijpen van de grafiek, besluitvorming en percepties over de grafiek. *Door het invullen van deze enquête help je ons erg bij het afronden van onze studie!* Wat wordt er van je verwacht?Meedoen aan het onderzoek houdt in dat je een online vragenlijst gaat invullen. De vragen hebben betrekking op informatie die je uit de grafiek kunt halen. Het invullen van de vragenlijst kost ongeveer **7-10** minuten.

Vrijwilligheid

Je doet vrijwillig mee aan dit onderzoek. Daarom kun je op elk moment tijdens het onderzoek je deelname stopzetten en je toestemming intrekken. Je hoeft niet aan te geven waarom je stopt. Wat gebeurt er met mijn gegevens? De onderzoeksgegevens die we in dit onderzoek verzamelen, zullen door wetenschappers gebruikt worden voor datasets, artikelen en presentaties. De anoniem gemaakte onderzoeksgegevens zijn tenminste 10 jaar beschikbaar voor andere wetenschappers. Als we gegevens met andere onderzoekers delen, kunnen deze dus niet tot jou herleid worden. We bewaren alle onderzoeksgegevens op beveiligde wijze volgens de richtlijnen van de Radboud Universiteit. Heb je vragen over het onderzoek?Als je meer informatie over het onderzoek wilt hebben, kun je contact opnemen met Peter de Swart (e-mail: p.deswart@let.ru.nl).

TOESTEMMING: Geef hieronder je keuze aan. Door te klikken op de knop ‘Ik wil meedoen’ geef je aan dat je:

● de bovenstaande informatie hebt gelezen

● vrijwillig meedoet aan het onderzoek

● 18 jaar of ouder bent

Als je niet mee wilt doen aan het onderzoek, kun je op de knop ‘Ik wil niet meedoen’ klikken.

○ Ik wil deelnemen aan het onderzoek

○ Ik wil niet deelnemen aan het onderzoek

Skip To: End of Survey If INFORMATIE EN TOESTEMMING Hallo! Wij zijn zes Bachelor International Business Communication stu... = Ik wil niet deelnemen aan het onderzoek

Page Break

X→ X→

In welk land woon je?

- [ ] Nederland
- [ ] Anders

Skip To: End of survey NL If In welk land woon je? = Anders

---

*

Wat is je leeftijd?

_____

Skip To: End of survey NL If Condition: Wat is je leeftijd? Is Less Than 18. Skip To: Helaas, je kunt niet mee doen aan dit....

X→ X→

Wat is je gender?

- ○ Man
- ○ Vrouw
- ○ Anders
- ○ Wil ik liever niet zeggen

Wat is je huidige of laatst afgeronde opleidingsniveau?

- ○ Basisschool
- ○ Middelbare school
- ○ MBO
- ○ HBO
- ○ WO Bachelor
- ○ WO Master
- ○ PhD

Page Break

Display This Question:

If If Wat is je leeftijd? Text Response Is Less Than 18

Or In welk land woon je? = Anders

Helaas, je kunt niet mee doen aan dit onderzoek. Hartelijk dank voor je interesse!

Skip To: End of Survey If Helaas, je kunt niet mee doen aan dit onderzoek. Hartelijk dank voor je interesse! Is Displayed

End of Block: Dutch consent and demographics

Start of Block: Z Dutch stock decision

De onderstaande grafiek toont **fictionele** (dus niet echte) data over het aantal *nieuwe* Coronabesmettingen per dag in Zambia. Voor deze enquête willen we je vragen om te doen alsof de data echt zijn.

Here, a version of the graph was shown to the participants.

Op dag 45 moeten de autoriteiten in Zambia een beslissing nemen of ze de niet-essentiële winkels heropenen of dat deze gesloten blijven voor nog 14 dagen.

X→ X→

Wat zou jouw advies zijn gebaseerd op de grafiek die je ziet?

- ○ Zeker gesloten houden (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Zeker heropenen (7)

Page Break

End of Block: Z Dutch stock decision

Start of Block: Z Dutch stock understanding

De onderstaande grafiek is dezelfde grafiek als die van de vorige pagina.

Here, a version of the graph was shown to the participants.

Lees de volgende 5 vragen zorgvuldig en gebruik de grafiek voor je antwoorden. Je kunt in- en uitzoomen op de grafiek.

*

Hoeveel nieuwe gevallen van COVID-19 waren er op **dag 3**?

_____

Kijk naar **dag 3** en **dag 4**. Welke dag laat de grootste stijging van nieuwe besmettingen zien ten opzichte van de dag ervoor?

- ○ Dag 3
- ○ Dag 4

Vergelijk de periode van dag 1 tot dag 10 met de periode van dag 11 tot dag 20. Welke periode laat een sterkere stijging in de besmettingen zien?

- ○ De periode van dag 1 tot dag 10
- ○ De periode van dag 11 tot dag 20

Wat is het verschil in het aantal nieuwe besmettingen tussen **dag 12** en **dag 13**?

_____

Op welke dag begon de snelheid van de daling in het aantal Covid-19 besmettingen af te nemen?

_____

Page Break

End of Block: Z Dutch stock understanding

Start of Block: Z Dutch manipulation check

Nu volgen nog een paar vragen waarin jouw mening over de grafiek en het onderwerp gevraagd wordt.

X→ X→

De grafiek die ik heb gezien is voor mij persoonlijk relevant.

- Helemaal niet mee eens (1)
- (2)
- (3)
- (4)
- (5)
- (6)
- Helemaal mee eens (7)

X→ X→

Het aantal positieve Coronatests in Zambia is persoonlijk relevant voor mij.

- ○ Helemaal niet mee eens (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Helemaal mee eens (7)

De COVID-19 regels in Zambia zijn erg belangrijk voor mij.

- ○ Helemaal niet mee eens (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Helemaal mee eens (7)

Page Break

End of Block: Z Dutch manipulation check

Start of Block: Z Dutch flow decision

De onderstaande grafiek toont **fictionele** (dus niet echte) data over de verandering in de groei van het aantal *nieuwe* Coronabesmettingen per dag vergeleken met de dag ervoor in *Zambia*. Voor deze enquête willen we je vragen om te doen alsof de data echt zijn.

Here, a version of the graph was shown to the participants.

Op dag 45 moeten de autoriteiten in Zambia een beslissing nemen of ze de niet-essentiële winkels heropenen of dat deze gesloten blijven voor nog 14 dagen.

Wat zou jouw advies zijn gebaseerd op de grafiek die je ziet?

- ○ Zeker gesloten houden (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Zeker heropenen (7)

End of Block: Z Dutch flow decision

Start of Block: Z Dutch flow understanding

De onderstaande grafiek is dezelfde grafiek als die van de vorige pagina.

Here, a version of the graph was shown to the participants.

Lees de volgende 5 vragen zorgvuldig en gebruik de grafiek voor je antwoorden. Je kunt in- en uitzoomen op de grafiek.

---

*

Hoeveel nieuwe gevallen van COVID-19 waren er op **dag 3**?

_____

X→ X→

Kijk naar dag 3 en dag 4. Welke dag laat de grootste stijging van nieuwe besmettingen zien ten opzichte van de dag ervoor?

- ○ Dag 3
- ○ Dag 4

X→ X→

Vergelijk de periode van dag 1 tot dag 10 met de periode van dag 11 tot dag 20. Welke periode laat een sterkere stijging in de besmettingen zien?

- ○ De periode van dag 1 tot dag 10
- ○ De periode van dag 11 tot dag 20

*

Wat is het verschil in het aantal nieuwe besmettingen tussen dag 12 en dag 13?

_____

Op welke dag begon de snelheid van de daling in het aantal Covid-19 besmettingen af te nemen?

_____

Page Break

End of Block: Z Dutch flow understanding

Start of Block: NL Dutch stock decision

De onderstaande grafiek toont **fictionele** (dus niet echte) data over het aantal *nieuwe* Coronabesmettingen per dag in Nederland. Voor deze enquête willen we je vragen om te doen alsof de data echt zijn.

Here, a version of the graph was shown to the participants.

Op dag 45 moeten de autoriteiten in Nederland een beslissing nemen of ze de niet-essentiële winkels heropenen of dat deze gesloten blijven voor nog 14 dagen.

Wat zou jouw advies zijn gebaseerd op de grafiek die je ziet?

- ○ Zeker gesloten houden (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Zeker heropenen (7)

Page Break

End of Block: NL Dutch stock decision

Start of Block: NL Dutch stock understanding

De onderstaande grafiek is dezelfde grafiek als die van de vorige pagina.

Here, a version of the graph was shown to the participants.

Lees de volgende 5 vragen zorgvuldig en gebruik de grafiek voor je antwoorden. Je kunt in- en uitzoomen op de grafiek.

---

*

Hoeveel nieuwe gevallen van COVID-19 waren er op **dag 3**?

_____

X→ X→

Kijk naar **dag 3** en **dag 4**. Welke dag laat de grootste stijging van nieuwe besmettingen zien ten opzichte van de dag ervoor?

- ○ Dag 3
- ○ Dag 4

Vergelijk de periode van dag 1 tot dag 10 met de periode van dag 11 tot dag 20. Welke periode laat een sterkere stijging in de besmettingen zien?

- ○ De periode van dag 1 tot dag 10
- ○ De periode van dag 11 tot dag 20

Wat is het verschil in het aantal nieuwe besmettingen tussen **dag 12** en **dag 13**?

_____

Op welke dag begon de snelheid van de daling in het aantal Covid-19 besmettingen af te nemen?

_____

Page Break

End of Block: NL Dutch stock understanding

Start of Block: NL Dutch manipulation check

Nu volgen nog een paar vragen waarin jouw mening over de grafiek en het onderwerp gevraagd wordt.

X→ X→

De grafiek die ik heb gezien is voor mij persoonlijk relevant.

- Helemaal niet mee eens (1)
- (2)
- (3)
- (4)
- (5)
- (6)
- Helemaal mee eens (7)

X→ X→

Het aantal positieve Coronatests in Nederland is persoonlijk relevant voor mij.

- ○ Helemaal niet mee eens (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Helemaal mee eens (7)

De COVID-19 regels in Nederland zijn erg belangrijk voor mij.

- ○ Helemaal niet mee eens (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Helemaal mee eens (7)

Page Break

End of Block: NL Dutch manipulation check

Start of Block: NL Dutch flow decision

De onderstaande grafiek toont **fictionele** (dus niet echte) data over de verandering in de groei van het aantal *nieuwe* Coronabesmettingen per dag vergeleken met de dag ervoor in Nederland. Voor deze enquête willen we je vragen om te doen alsof de data echt zijn.

Here, a version of the graph was shown to the participants.

Op dag 45 moeten de autoriteiten in Nederland een beslissing nemen of ze de niet-essentiële winkels heropenen of dat deze gesloten blijven voor nog 14 dagen.

Wat zou jouw advies zijn gebaseerd op de grafiek die je ziet?

- ○ Zeker gesloten houden (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Zeker heropenen (7)

End of Block: NL Dutch flow decision

Start of Block: NL Dutch flow understanding

De onderstaande grafiek is dezelfde grafiek als die van de vorige pagina.

Here, a version of the graph was shown to the participants.

Lees de volgende 5 vragen zorgvuldig en gebruik de grafiek voor je antwoorden. Je kunt in- en uitzoomen op de grafiek.

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*

Hoeveel nieuwe gevallen van COVID-19 waren er op **dag 3**?

_____

X→ X→

Kijk naar dag 3 en dag 4. Welke dag laat de grootste stijging van nieuwe besmettingen zien ten opzichte van de dag ervoor?

- ○ Dag 3
- ○ Dag 4

X→ X→

Vergelijk de periode van dag 1 tot dag 10 met de periode van dag 11 tot dag 20. Welke periode laat een sterkere stijging in de besmettingen zien?

- ○ De periode van dag 1 tot dag 10
- ○ De periode van dag 11 tot dag 20

*

Wat is het verschil in het aantal nieuwe besmettingen tussen dag 12 en dag 13?

_____

Op welke dag begon de snelheid van de daling in het aantal Covid-19 besmettingen af te nemen?

_____

Page Break

End of Block: NL Dutch flow understanding

Start of Block: Debriefing Dutch

Dit is het einde van het experiment. Hartelijk dank voor je deelname! Mocht je benieuwd zijn naar het doel van het onderzoek of nog verdere vragen hebben, dan kun je een berichtje sturen naar mara.hoogendoorn@student.ru.nl.

Vriendelijk verzoek om de inhoud van dit onderzoek niet te bespreken met mensen die (misschien) nog aan het onderzoek gaan meedoen. Voor het onderzoek is het van belang dat deelnemers van tevoren niet op de hoogte zijn van de onderzoeksvraag en onderzoeksmethode.

End of Block: Debriefing Dutch

Start of Block: English consent and demographics

X→ X→

INFORMATION AND CONSENT

Hello! We are six Bachelor students (Mara, Tom, Lucie, Tobias, Florian en Isabel) of the International Business Communication department at Radboud University. You are invited to participate in a research project in which you will be presented with a fictional graph about health communication. You will be asked several questions about this graph, ranging from graph understanding to decision-making and graph perception. *By participating in this survey, you are helping us a lot with the last part of our studies!*

What is going to happen to you?The procedure involves filling out an online survey. The questions concern information that can be taken from a graph. Filling out the survey will take approximately **7-10 minutes**.

Voluntary participation

Your participation in this research is voluntary. This means that you can withdraw your participation and consent at any time during the research, without giving a reason.

What will happen to my data? The research data we collect during this study will be used by scientists as part of data sets, articles and presentations. The anonymized research data is accessible to other

scientists for a period of at least 10 years. When we share data with other researchers, these data cannot be traced back to you.All research and personal data are safely stored following the Radboud University guidelines.
More information?Should you want more information on this research study, please contact Peter de Swart (e-mail: p.deswart@let.ru.nl).

CONSENT: Please select your choice below. Clicking on the "Agree" button below indicates that:

• you have read the above information

• you voluntarily agree to participate

• you are at least 18 years of age

If you do not wish to participate in the research study, please decline participation by clicking on the "I do not want to participate" button.

○ I want to participate

○ I do not want to participate

Skip To: End of Survey If INFORMATION AND CONSENT Hello! We are six Bachelor students (Mara, Tom, Lucie, Tobias, Florian en... = I do not want to participate

Page Break

In which country do you live?

- ○ The Netherlands
- ○ Other

Skip To: End of survey EN If In which country do you live? = Other

Page Break

*

What's your age?

_____

Skip To: End of survey EN If Condition: What's your age? Is Less Than 18. Skip To: Unfortunately, you cannot participate....

What's your gender?

- ○ Man
- ○ Woman
- ○ Other
- ○ I'd rather not say

What is your current / last completed educational level?

- ○ Primary school
- ○ High school
- ○ Trade school
- ○ University of Applied Sciences
- ○ Bachelor University
- ○ Master University
- ○ PhD

Page Break

Display This Question:

If In which country do you live? = Other

Or Or What's your age? Text Response Is Less Than 18

Unfortunately, you cannot participate in this research. Thank you for your interest.

Skip To: End of Survey If Unfortunately, you cannot participate in this research. Thank you for your interest. Is Displayed

End of Block: English consent and demographics

Start of Block: Z English stock decision

The following stock graph depicts fictional data (so not real!) about the number of new corona infections per day in Zambia. For this survey, we would like you to pretend the data are real.

Here, a version of the graph was shown to the participants.

On day 45, the authorities of Zambia are supposed to make a decision about whether they should reopen the non-essential shops or whether they should prolong the closing of non-essential shops for another 14 days.

X→ X→

Based on the graph you are seeing, what would your advice be?

- ○ Definitely stay closed (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Definitely reopen (7)

Page Break

End of Block: Z English stock decision

Start of Block: Z English stock understanding

The following graph is identical to the graph that you saw on the previous page.

Here, a version of the graph was shown to the participants.

Read the following five questions carefully and use the graph for your answer. You are able to zoom in and zoom out.

How many new covid cases were registered on day 3?

_____

Look at day 3 and day 4. Which day shows the biggest increase in new infections compared to the day before?

- ○ Day 3
- ○ Day 4

Compare the period from day 1 to day 10 to the period from day 11 to day 20. Which period shows a stronger rise in infections?

- ○ The period from day 1 to day 10
- ○ The period from day 11 to day 20

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*

What is the difference in the number of new infections between day 12 and day 13?

_____

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*

On which day did the decrease of covid-19 infections start to slow down?

_____

Page Break

End of Block: Z English stock understanding

Start of Block: Z English manipulation check

Here follow a few questions about your opinion on the graph and the topic of the survey.

Page Break

The graph I saw is very relevant to me personally.

- ○ Strongly disagree (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Strongly agree (7)

The positive COVID-19 tests in Zambia are very relevant to me personally.

- Strongly disagree (1)
- (2)
- (3)
- (4)
- (5)
- (6)
- Strongly agree (7)

The COVID-19 regulations in Zambia are very relevant to me personally.

- Strongly disagree (1)
- (2)
- (3)
- (4)
- (5)
- (6)
- Strongly agree (7)

End of Block: Z English manipulation check

Start of Block: Z English flow decision

The following flow graph depicts fictional data (so not real!) about the change in growth of new corona infections relative to the day before each day in Zambia. For this survey, we would like you to pretend the data are real.

Here, a version of the graph was shown to the participants.

On day 45, the authorities of Zambia are supposed to make a decision about whether they should reopen the non-essential shops or whether they should prolong the closing of non-essential shops for another 14 days.

Based on the graph you are seeing, what would your advice be?

- ○ Definitely stay closed (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Definitely reopen (7)

Page Break

End of Block: Z English flow decision

Start of Block: Z English flow understanding

The following graph is identical to the graph that you saw on the previous page.

Here, a version of the graph was shown to the participants.

Read the following five questions carefully and use the graph for your answer. You are able to zoom in and zoom out.

Page Break

How many new covid cases were registered on day 3?

_____

Look at day 3 and day 4. Which day shows the biggest increase in new infections compared to the day before?

- ○ Day 3
- ○ Day 4

Compare the period from day 1 to day 10 to the period from day 11 to day 20. Which period shows a stronger rise in infections?

- ○ The period from day 1 to day 10
- ○ The period from day 11 to day 20

What is the difference in the number of new infections between day 12 and day 13?

_____

*

On which day did the decrease of covid-19 infections start to slow down?

_____

Page Break

End of Block: Z English flow understanding

Start of Block: NL English stock decision

The following stock graph depicts fictional data about the number of new corona infections per day in the Netherlands.

Here, a version of the graph was shown to the participants.

The authorities of the Netherlands are supposed to make a decision about whether they should reopen the non-essential shops or whether they should prolong the closing of non-essential shops for another 14 days.

Based on the graph you are seeing, what would your advice be?

- ○ Definitely stay closed (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Definitely reopen (7)

Page Break

End of Block: NL English stock decision

Start of Block: NL English stock understanding

The following graph is identical to the graph that you saw on the previous page.

Here, a version of the graph was shown to the participants.

Read the following five questions carefully and use the graph for your answer. You are able to zoom in and zoom out.

*

How many new covid cases were registered on day 3?

_____

Look at day 3 and day 4. Which day shows the biggest increase in new infections compared to the day before?

- ○ Day 3
- ○ Day 4

Compare the period from day 1 to day 10 to the period from day 11 to day 20. Which period shows a stronger rise in infections?

- ○ The period from day 1 to day 10
- ○ The period from day 11 to day 20

What is the difference in the number of new infections between day 12 and day 13?

_____

On which day did the decrease of covid-19 infections start to slow down?

_____

Page Break

End of Block: NL English stock understanding

Start of Block: NL English manipulation check

Here follow a few questions about your opinion on the graph and the topic of the survey.

The graph I saw is very relevant to me personally.

- ○ Strongly disagree (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Strongly agree (7)

The positive COVID-19 tests in the Netherlands are very relevant to me personally.

- ○ Strongly disagree (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Strongly agree (7)

The COVID-19 regulations in the Netherlands are very relevant to me personally.

- ○ Strongly disagree (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Strongly agree (7)

End of Block: NL English manipulation check

Start of Block: NL English flow decision

The following flow graph depicts fictional data about the change in growth of new corona infections relative to the day before each day in the Netherlands.

Here, a version of the graph was shown to the participants.

The authorities of the Netherlands are supposed to make a decision about whether they should reopen the non-essential shops or whether they should prolong the closing of non-essential shops for another 14 days.

Based on the graph you are seeing, what would your advice be?

- ○ Definitely stay closed (1)
- ○ (2)
- ○ (3)
- ○ (4)
- ○ (5)
- ○ (6)
- ○ Definitely reopen (7)

Page Break

End of Block: NL English flow decision

Start of Block: NL English flow understanding

The following graph is identical to the graph that you saw on the previous page.

Here, a version of the graph was shown to the participants.

Read the following five questions carefully and use the graph for your answer. You are able to zoom in and zoom out.

---

*

How many new covid cases were registered on day 3?

_____

Look at day 3 and day 4. Which day shows the biggest increase in new infections compared to the day before?

- ○ Day 3
- ○ Day 4

Compare the period from day 1 to day 10 to the period from day 11 to day 20. Which period shows a stronger rise in infections?

- ○ The period from day 1 to day 10
- ○ The period from day 11 to day 20

What is the difference in the number of new infections between day 12 and day 13?

_____

On which day did the decrease of covid-19 infections start to slow down?

_____

Page Break

End of Block: NL English flow understanding

Start of Block: Debriefing English

This is the end of the experiment. Thank you so much for your participation! If you are curious about the purpose of this research or have any further questions, then you can send a message to mara.hoogendoorn@student.ru.nl.

We kindly ask you to not share the content of this research with people who (might) have not participated yet in this study but are planning to do so. For the purpose of this study, it is essential that participants are not aware of the research question and research method prior to the experiment.

End of Block: Debriefing English

Appendix 3: Statement of own work

Student name: Mara Hoogendoorn

Student number: 1025437

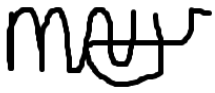
PLAGIARISM is the presentation by a student of an assignment or piece of work which has in fact been copied in whole or in part from another student's work, or from any other source (e.g. published books or periodicals or material from Internet sites), without due acknowledgement in the text.

DECLARATION:

a. I hereby declare that I am familiar with the faculty manual (https://www.ru.nl/facultyofarts/stip/rules-guidelines/rules/fraud-plagiarism/) and with Article 16 "Fraud and plagiarism" in the Education and Examination Regulations for the Bachelor's programme of Communication and Information Studies.

b. I also declare that I have only submitted text written in my own words

c. I certify that this thesis is my own work and that I have acknowledged all material and sources used in its preparation, whether they be books, articles, reports, lecture notes, and any other kind of document, electronic or personal communication.

Signature: 

Place and date: Apeldoorn, 6th of June 2021