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Optimizing weblinks embedded within digital vaccination invitations to increase trust and booking intention: Experimental Evidence.

Claire M. Oakley, Hazel Sayer, Dawn Liu Holford, Wändi Bruine de Bruin, Gaëlle Vallée-Tourangeau, Tim Chadborn, Miroslav Sirota, Marie Juanchich

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Abstract

Background: People are encouraged to respond swiftly to digital health invitations like vaccination prompts, but they are also encouraged to question the legitimacy of digital communications. This research focuses on an overlooked aspect of digital communication that can be leveraged to foster trust and user engagement: embedded weblinks.

Objective: Drawing from digital communication theory and psychological science, we posited that fluent weblinks that are easy to read and transparently identify the healthcare provider will improve trust and user engagement.

Methods: In three experiments (total N = 3,183), participants read a hypothetical email from the UK's National Health Service (NHS) inviting them to book their COVID-19 vaccination by clicking a weblink. The control invitation included the weblink initially used by the UK's national COVID vaccination services. The control weblink is compared to a clear weblink (easy to read and easy to identify host) (Experiment 1 and 3) or to concealed weblinks: a text-embedded weblink and a shortened weblink (Experiment 2 and 3). Participants reported their trust in the invitation, their perceived readability of the weblink, who they thought the website host was, and their intention to book an appointment by clicking on the weblink.

Results: Clear weblinks and text-embedded weblinks increased the identification of the host organization and were perceived as easier to read, which was associated with increased trust perception and booking intention. Shortened weblinks aided host identification but had a detrimental impact on perceived readability and did not increase trust perception or booking intention.

Conclusions: Health-related digital communications should include readable weblinks with an identifiable host to foster trust and engagement. Where changing the weblink is impractical, concealing it via a text-embedded weblink is an effective alternative.

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Keywords: Digital communication**;** health communication; weblinks; URL; trust; fluency; phishing; vaccination uptake

Introduction

In recent years, healthcare providers in the United Kingdom (UK) and elsewhere have expanded their communication channels—such as using social media platforms and direct electronic messaging— to improve patient engagement in preventative medicine and routine check-ups [1, 2]. Short message service (SMS) text and email reminders have proven to be simple, cost-effective means to reduce missed appointments and boost vaccination rates, thus increasing healthcare efficiency and quality of care, of which preventative medicine is a core component [3, 4]. The UK COVID-19 vaccination rollouts built on the previous success of digital invitations and sent millions of invitations to book their COVID-19 vaccine online via a dedicated NHS weblinks or URLs (Unique Resource Locators - a reference or address to access internet resources) [1]. However, some people might have doubted the authenticity of the invitation and refused to use it for fear that it would be a phishing attempt (an attempt to steal private information). In fact, COVID saw an explosion of phishing attempts with cybercriminals impersonating reputable health organizations to steal private information [5]. What genuine and nefarious messages have in common is that they both have a weblink – one leading to a much-needed vaccination booking website and the other to an attempt to steal personal information or money [6, 7]. The present research focuses on the nature of weblinks embedded within health invitation messages and how these links shape (dis)trust and booking intention.

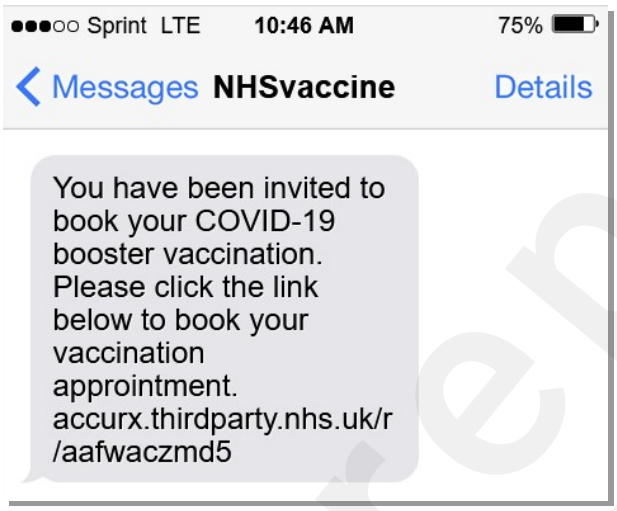
The public may be particularly wary when receiving communications from health providers

following the increase in COVID-19 related phishing attempts and national broadcasting and media reporting of these [8]. During the pandemic, scammers chose to impersonate health institutions to exploit people's desire to protect themselves from COVID-19 in many countries, such as the UK [9], Australia [10], and France [11]. In 2022, 61% of all cyberfraud reported in England was related to COVID-19, with fraudsters impersonating the NHS and inviting victims to get tested or vaccinated [12]. In 2020, Google reported that scammers were sending 18 million hoax emails related to COVID —including 100 million phishing attempts—every day [5]. For example, Figure 1 shows a digital scam message that appeared to be sent by the NHS and invited recipients to click on a weblink to book their COVID-19 vaccination [8]. These incidents potentially undermined public trust in using weblinks to book vaccine appointments and increase the importance of recognizing whether the message is authentic.

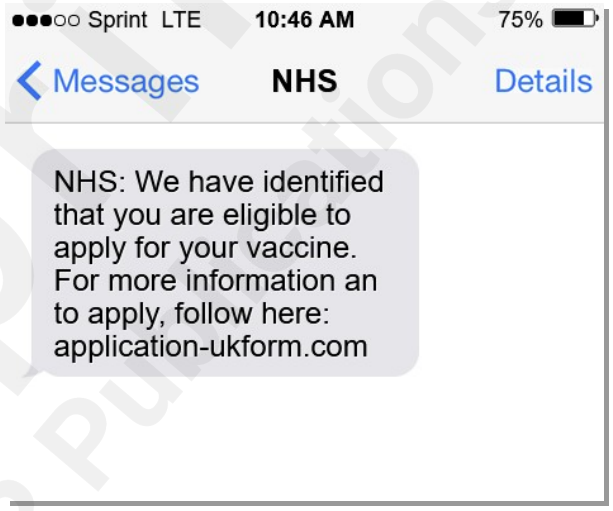
Figure 1.

Example of a real vaccination invitation text message sent by the National Health Services (NHS) in the UK and a phishing attempt impersonating the NHS vaccine services. Note that the weblink in the real message is longer and harder to read than the link in the scam message

(a) Real NHS vaccination invitation



(b) Scam vaccination invitation



Much research has focused on the content of invitations and reminders to improve appointment uptake [e.g., 2, 13, 14], but were primarily focused on what information might increase or decrease vaccination intention. For example, how mentioning risk might lower vaccination intention [15] or how to present the benefits of vaccines [16, 17]. There is also research on the features of a message that characterize a scam. For example, the presence of typos in the message [18] or a short deadline to meet before losing an opportunity [19] are both warning signs that the message might be a phishing attempt. However, there is little research on the design of weblinks embedded within (health) messages and how those weblinks may encourage or discourage recipients to click-through [see 20 for an exception].

It is notoriously difficult to decide whether a link leads to a fraudulent or legitimate website [20]. More advanced technology can be used to design weblinks that are safer by using specific protocols (e.g., https – instead of http) or by using official protected domains (e.g., .gov for government webpages). However, beyond the technical features of the weblinks, we posit that their wording matters too. We identified two features of a weblink that could be used to improve recipients' trust perception and intention to use the link. One way is to enhance the weblink's wording, to make it easier to identify the host of the website through reading the weblink's text. Making the website's host clearer to the reader echoes advice given to the public to question whether the website host is known and trusted [21]. For example, public e-health services are only trusted if

the public can identify the service provider and trust them [22]. Therefore, a weblink must clearly communicate the website's host (e.g., the UK's NHS) to foster trust and booking intention. Vaccination booking links often include the name of a trusted organization within the link, which is expected to elicit trust [23]. However, recipients might be unable to identify the organization as they could be confused by the presence of other words and nonsensical characters and the absence of spaces between words, making it difficult to parse the correct information.

A second feature of the wording of weblinks that could shape recipients' trust is how easy or difficult weblinks are to read - a phenomenon called fluency in cognitive psychology. According to the fluency theory, reading ease shapes people's perception beyond what is described literally [24]. For example, people were more willing to invest in stocks with fluent names like "Barnings" than in stocks with names that are hard to process, like "Ightsbry" [25]. Furthermore, drugs or food additives that had disfluent names, such as "Cytrigmcmium", were perceived as more dangerous than drugs with fluent names, such as Fastinorbine [26, 27]. Fluency was also directly associated with trust perception in economics games. People with fluent names were entrusted more money in a trust game than people with difficult to read names [28]. Based on fluency theory [24], we could expect that weblinks that contain words that are easy to read and understand will feel more trustworthy and trigger greater user engagement, than weblinks that include a nonsensical string of letters and numbers. In practice, some live links used in vaccination invitation communications during the pandemic did *not* identify a familiar host or use easy to read words. For example, the weblink used by the NHS was quite difficult to read, which may have hindered recipients' trust and willingness to book their appointment via the link: https://accurx.thirdparty.nhs.uk/r/aafwaczmd.

An alternative strategy to using easier to read weblinks that clearly identify a website host is to "hide" links by embedding them in descriptive anchor text, or by embedding them in weblink shortened URLs such as bit.ly or Tiny URL [29]. Anchor text is the clickable text of a hyperlink, which can be tailored to be concise and easy to read, for example by using a text-embedded weblink: "Book your vaccine here." Alternatively, due to character / space constraints in SMS messages, URL shortening services are often used. For example, this shortened version of the NHS link: https://bit.ly/3GtTL0c, was used by some GP practices during the COVID-19 pandemic, and similar links remain in use today. Hidden links are advantageous. They are either more fluent and meaningful, or shorter, so pertinent where space is limited. However, hidden links might not directly help to identify the website hosting the URL. Hiding the link might also be perceived as a convenient mask or disguise used to obscure the true website host [29]. To verify the authenticity of hidden links, recipients must rely on other information to identify the source, such as the sender information from the message or email they have received.

We conducted three experiments using hypothetical but realistic digital vaccination booking invitations to examine how manipulating the embedded weblink alters recipients' intentions to use the link to book a vaccination appointment. The invitations were modelled on the layout, style, design, and sender information from notification emails sent from the NHS and other UK Government bodies during the COVID-19 pandemic. Building on research showing the importance of a trusted host [23] and reading ease [24], we hypothesized that relative to a control weblink where the host is embedded within random letters and nonsensical words, a weblink that includes a clear host and that is easier to read would lead to greater trust and booking intention (H1). We also expected that hiding the link by embedding it into text or using a shortened weblink would also make it easier to read and identify the host, leading to greater trust and booking intention (H2). In experiments 1 and 2, we tested how different weblink design strategies may improve trust and booking intention and then replicated these findings in a larger and more ethnically diverse sample in experiment 3. The three experiments were preregistered (reference #84106, 84816, and 86763, respectively). The preregistration protocols and materials are available on the Open Science Framework (see Data Availability statement for details). The studies received ethical approval through the Ethics Committee of the University of Essex (ETH 2122-0265).

Experiment 1

Method

Participants

We invited 600 UK[1] respondents via the Prolific platform to complete the study, aiming for a 50% gender quota goal, and received 614 responses. Of this initial sample, 13 did not include any data for the present study (three did not give consent to proceed with the survey and 10 did not finish the experiment). We excluded 32 cases where participants failed at least one of two pre-registered attention check questions, designed to confirm that participants were reading the questions. A minimum survey completion time of five minutes was set to filter out speeders. The resulting sample of 569 participants was sufficient to detect a small to medium effect of the link manipulation relative to the control on trust perception in an analysis of variance, f = 0.15 (assuming α = .05, power = .95)[2].

Participants' ages ranged from 18 to 88 years, M = 41.25 years (SD = 14.61). Our sample comprised 49% women, 50% men, and 1% non-binary, with an ethnic composition of 86% White, 7% Asian, 4% Black, 3% Mixed/Multiple ethnicities, and 1% Other. The study took place in the UK in January 2022, when the first COVID-19 vaccine had become available to all adults. The booster vaccine was also available to adults who had received their first COVID-19 vaccination over three months before [30]. Most (89%) of the participants had received their first COVID-19 vaccination, and 72% of those who were eligible had received their booster vaccination. See Supplementary Materials section A for a more detailed sample description.

Design

This study used a between-subjects experimental design with two conditions: a control and an experimental condition. Participants were randomly assigned to read one of two versions of a COVID-19 vaccination invitation email. The control group read a vaccination invitation email with the control weblink that was in use by the NHS in text message vaccination invitations in 2021 and 2022 ("accurx.thirdparty.nhs.uk/r/aafwaczmd5"), while the experimental group read the same email, but the control weblink was replaced with a 'clear' weblink that was easy to read and had an easily identifiable website host ("https://vaccine-booking.nhs.uk").

Materials and Procedure

Participants recruited through the Prolific platform were directed to the study on Qualtrics and received £2.50 for taking part based (median completion 15.5 min, equivalent to £9.68/hour). The study took place during the COVID-19 pandemic in early January 2022, when the Omicron variant—more infectious, but less severe COVID variant — caused a substantial increase in COVID-19 [31]. Despite a decrease in severity, the size of the epidemic wave caused an increase in death and hospitalization [31].

After obtaining informed consent at the beginning of the survey, participants were asked if they had received their first dose of the COVID-19 vaccine. The study started with questions about vaccination attitudes for a separate study (e.g., vaccine risk perception, vaccine effectiveness, subjective social norm). Participants were then presented with a hypothetical vaccination invitation email containing either the control or the experimental 'clear' weblink (see Figure 2). Random assignment to conditions was implemented using Qualtrics' built-in randomizer. The control group viewed a vaccination invitation email with the control weblink that was in use by the NHS in text message vaccination invitations in 2021 and 2022 ("accurx.thirdparty.nhs.uk/r/aafwaczmd5"). The

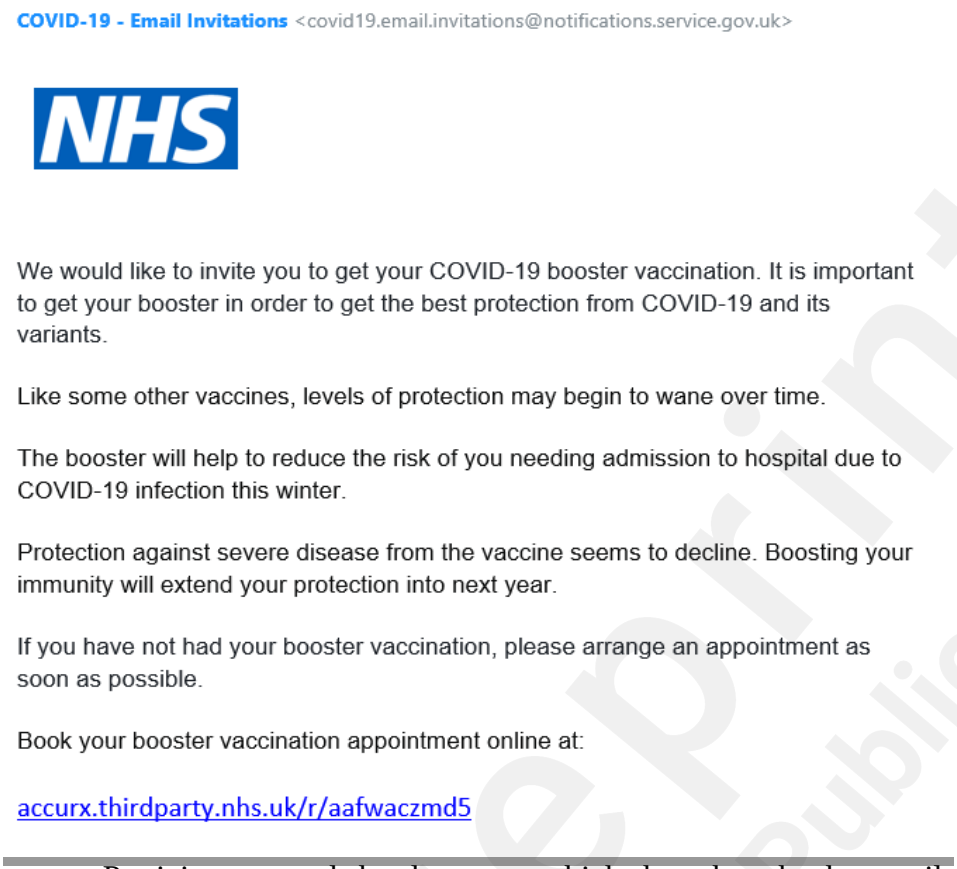
[1] We replicated this study, experiment 2, and 3 in a US sample with the same weblink manipulation but using a fictitious host (since in the US, vaccination invitations were not centralized). In this manuscript we only concentrate on the UK context, for which our study materials are most representative of participants' vaccination invitation experience - the NHS was the institution that invited the whole population to be vaccinated. Results for the American participants are summarized and reported separately on the OSF.

[22] We replicated the analyses without the preregistered data exclusion. We found similar results (see SM section D).

experimental group viewed the same email, but with a weblink that was easy to read and had an easily identifiable website host ("https://vaccine-booking.nhs.uk").

Figure 2

Email invitation used in Experiment 1-3 with the control weblink used by the National Health Service (NHS) in the UK for the 2021-2022 COVID-19 vaccination invitations.



Participants rated the degree to which they thought the email appeared to be suspicious or trustworthy on a 5-point Likert scale (1: *Very suspicious* – 5: *Very trustworthy)*, how likely they were to click on the weblink to book an appointment (1: *Very unlikely* – 5: *Very likely*), and the perceived readability of the link by evaluating how easy to read the weblink was (1: *Very difficult* – 5: *Very easy*).

Finally, participants answered who they thought was hosting the weblink out of four responses: "The NHS", "Pharmacy US", "A third party" or "Not sure", which were recoded as correct (NHS = 1) or incorrect (any other answer = 0). Participants then completed sociodemographic questions, indicating their age, ethnicity, gender, and education level.

The distribution of the variables and zero-order correlation between variables is available in SM section C. Data transformation, variance analyses, and chi-square tests were performed using SPSS version 28[3]. Path analyses were implemented using the lavaan package v. 0.6 – 11 with RStudio version 2022.01.07 and R version 4.0.4.

Results

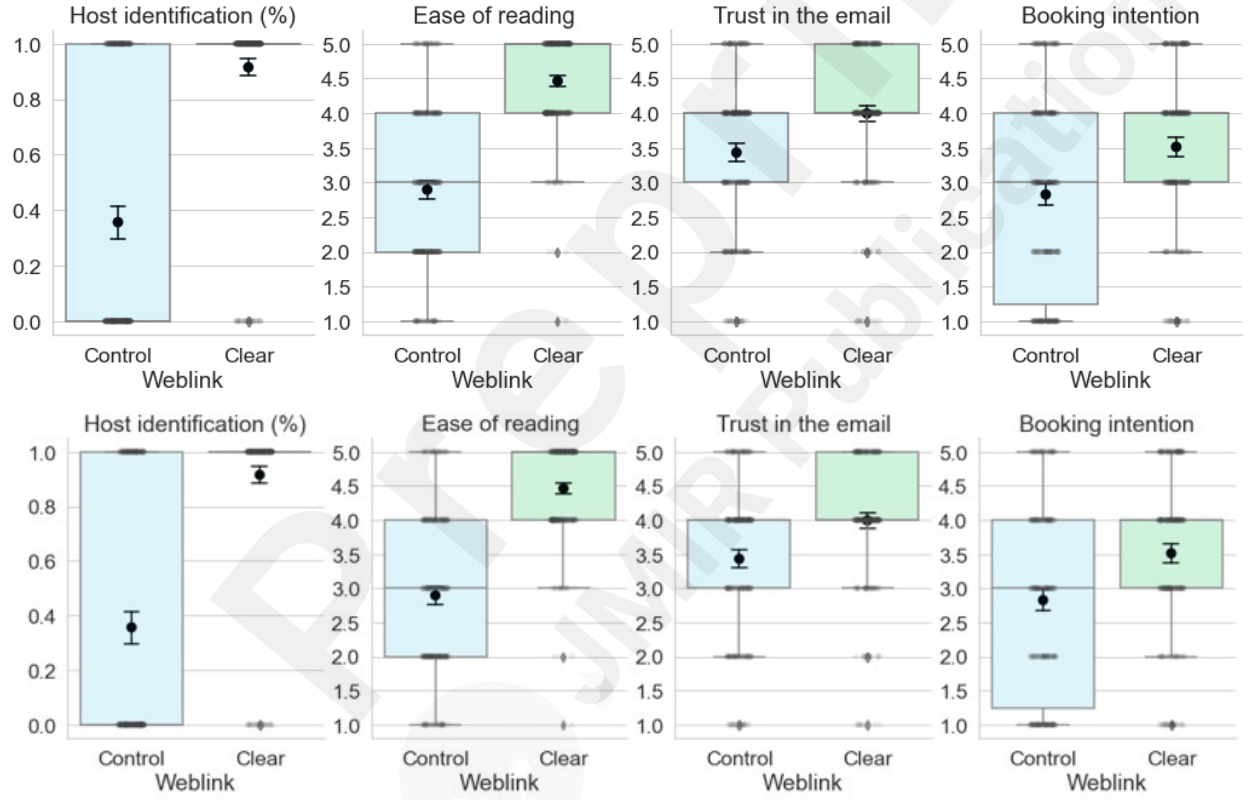
Most participants (64%) who received the email containing the control link were unable to correctly identify the NHS as the weblink's host and judged the weblink as slightly hard to read. As hypothesized, the clear weblink resulted in improved host identification compared to the control link,

[3] We preregistered variance analyses to assess the effect of the weblink condition on perceived readability, trust and booking intention for Experiment 1-3. In Experiment 2, we also preregistered a mediation analysis. To provide consistent analyses of the direct and indirect effects across studies, we conducted both analyses for the three experiments. The results converge. We report the results of the mediation results here and those of the variance analyses in SM section B.

was judged easier to read, led to greater perceived trust in the email, and fostered higher booking intentions (Figure 3). Of those participants who received the email with the control weblink, 43% of the respondents were skeptical about the trustworthiness of the email (responding either very suspicious/quite suspicious/not sure), and 63% were not keen to use the control link (responding either very unlikely/unlikely/unsure). The path analysis (Figure 4) revealed that the positive effect of the clear weblink (compared to the control link) on trust and booking intentions was partly explained by the improved identification of the website host (see the b coefficient of the indirect effect). Perceived readability (indirect effect a) did not explain the effect of the link on trust. The path between perceived readability and trust was not statistically significant, indicating that readability and host identification competed when predicting trust perception in the email[4]. The clear weblink's positive effect on trust, compared to the control link, was robust after adding covariates of gender, age, education, and ethnic minority status in a regression analysis (SM section E).

Figure 3.

Relative to the control weblink (in blue), the clear weblink (in green) helped participants recognize the website host correctly, was judged easier to read, and the email in which the weblink appeared was found more trustworthy, while participants reported greater intention to book their vaccination appointment via the weblink (Experiment 1, N = 569)

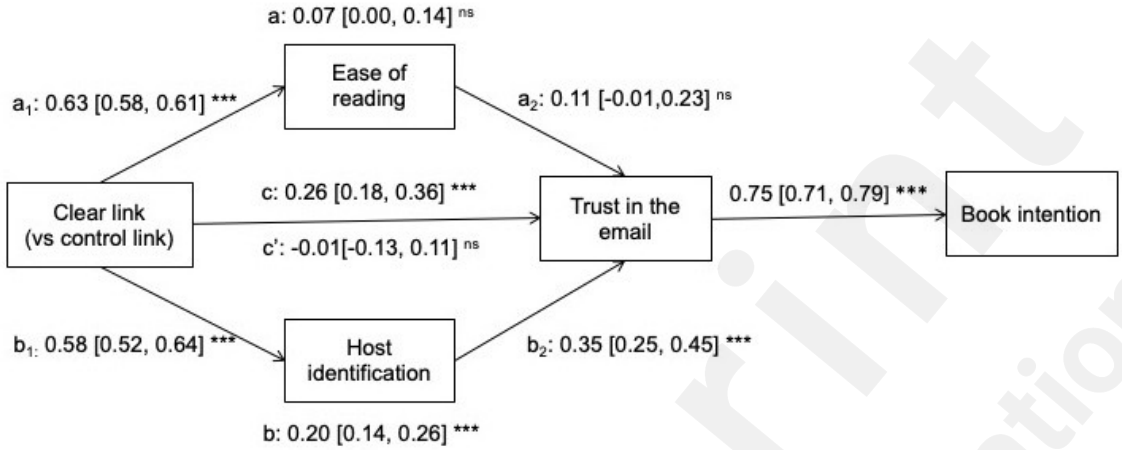


[4] The analyses conducted on the full sample (without the preregistered data exclusions) also showed a significant mediation effect of fluency. The path model is reported in SM section D.

Note: The means are shown in black circles with 95% CI. The box represents the interquartile range, the line the median, the error bars show the minimal and maximal values without outliers, with the outliers indicated by diamond-shaped points. The host identification panel shows the proportion of correct interpretations. The control link was the NHS original vaccination invitation link "accurx.thirdparty.nhs.uk/r/aafwaczmd5" and the clear link was "https://vaccine-booking.nhs.uk".

Figure 4

Effect of the clear weblink (vs. control) on correct identification of the host, readability, trust and booking intention. The effect of the weblink on trust was explained by improved correct host identification. The model shows β regression coefficients.



Note: *** $P < 0.001$, ns: not significant. Indirect effects - a: subjective fluency of the link, b: correct host identification. Values are standardized, path analysis β coefficients, with bias-corrected bootstrap 95% confidence intervals from 5000 samples.

Experiment 1 evidences how minor changes to a weblink embedded in an email changes people's perception of that email. The results show that using a weblink that helps to identify the host and is easy to read increased trust and booking intention.

Experiment 2

In Experiment 1, we found that improving the weblink improved trust in the vaccination invitation email and booking intention relative to a control link that was previously used nationally by the NHS. However, it is only sometimes possible, or practical, to change the weblink of a website. In this follow-up experiment, we examined an alternative strategy that sidesteps the need to modify the link: concealing it —a strategy used by UK GP practices (based on the UK authors' experience). We compared the control weblink to a text-embedded weblink (the "book here" weblink) and a shortened weblink using URL shortener services ("https://bit.ly/3GtTL0c").

Based on the negative associations between fluency and trust [28], we expected that concealing the weblink would reduce the negative effect of the weblink disfluency on trust in the message and booking intention, compared to the control weblink and the bit.ly weblink. Furthermore, we expected that compared to seeing the control weblink (to an unclear website host), hiding it would encourage participants to rely on the message's sender to correctly identify the host, thereby increasing trust and booking intention.

Method

Participants

We used Qualtrics as a panel provider to set quotas on gender, age, and ethnicity to match the UK population. They delivered data meeting our quality requirements: participants who did not speed through the study (>5 min completion time) and who correctly answered the two attention

check questions included in the study. The 596 participants were all UK residents, 18 to 88 years of age (M = 44.74, SD = 16.67). The sample comprised 51% women, 49% men, and 1% non-binary, with an ethnic composition of 86% White, 7% Asian, 4% Black, 3% Mixed/Multiple ethnicities, and 1% Other. The sample was sufficient to detect a small to medium effect when comparing the three weblinks regarding trust perception in a variance analysis, f = 0.17 (assuming α = .05, power = .95). See Supplementary Materials section F for a more detailed sample description.

Design

Replicating the between-subjects design of Experiment 1, participants were randomly assigned by an automatic Qualtrics randomizer to one of three conditions: viewing a hypothetical COVID-19 vaccine invitation featuring either the control link (shown in Figure 2) or one of two concealed link conditions: a text-embedded weblink (the "book here" weblink) or the shortened weblink created using Bit.ly services ("https://bit.ly/3GtTL0c").

Materials and Procedure

This study followed the same procedure and analyses as Experiment 1, with the materials only altered to reflect the two new experimental weblinks being tested.

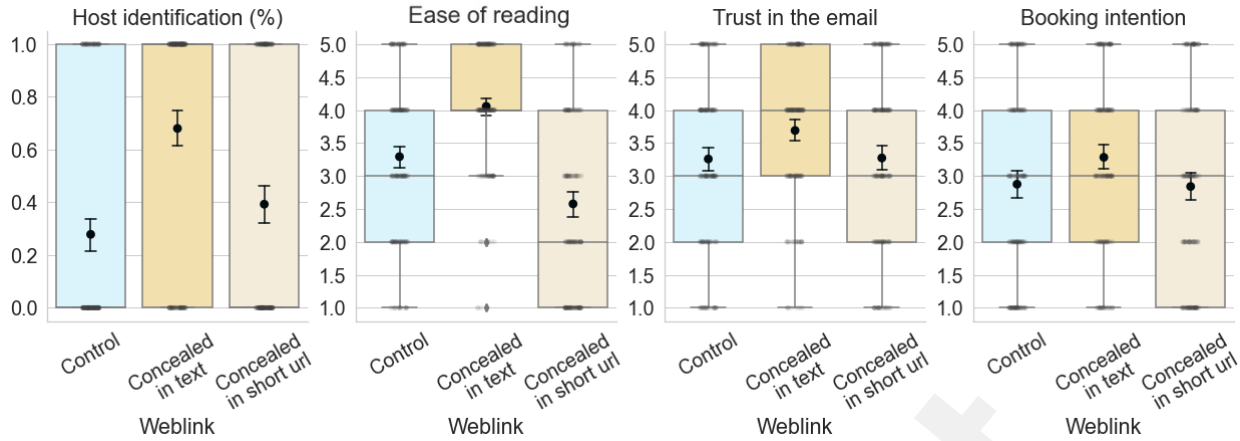
Results

Experiment 2 replicated the finding of Experiment 1, as shown in Figure 5, that the control link was perceived more negatively, resulting in the lower website host identification, perceived readability, trust, and booking intention. When the email included the text-embedded weblink, participants were better able to identify the website host (+40%), the link was also perceived to be easier to read, and participants reported greater trust in the email and booking intention. The shortened weblink also led to an increased identification of the website host compared to the control link (+11%), but the shortened link was perceived to be *less* fluent and did not yield a greater level of trust and booking intention (see Figure 5). The path analysis effects are reported in Figure 6[5], showing regression coefficients.

Figure 5.

Relative to the control weblink (in blue), concealing the weblink in text (in orange) or in a shortened weblink (in beige) helped participants recognize the website host correctly, but only the text-embedded weblink was considered more fluent, and had an overall positive effect on email trust and booking intention (Experiment 2, N = 596)

[5] We report the results of the mediation results here and those of the variance analyses in SM section H.



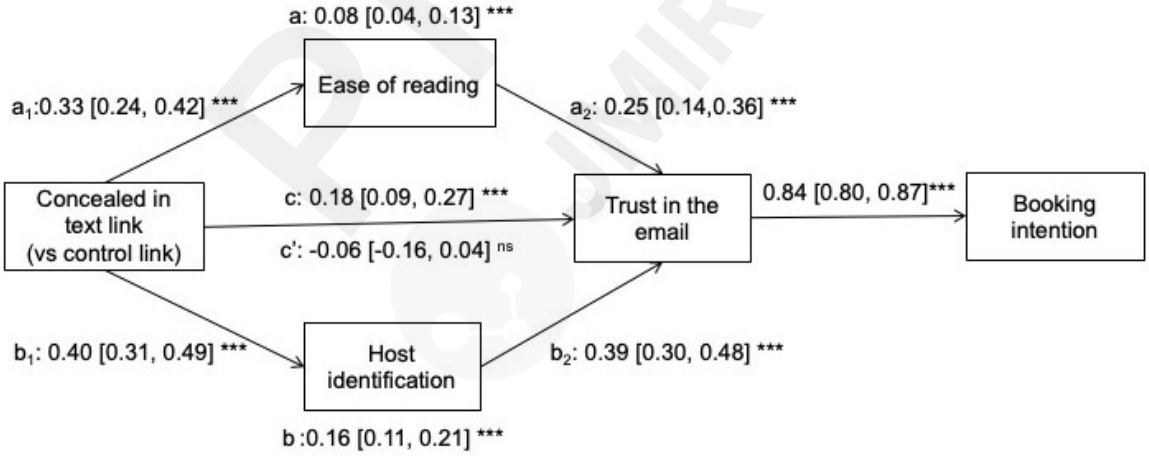
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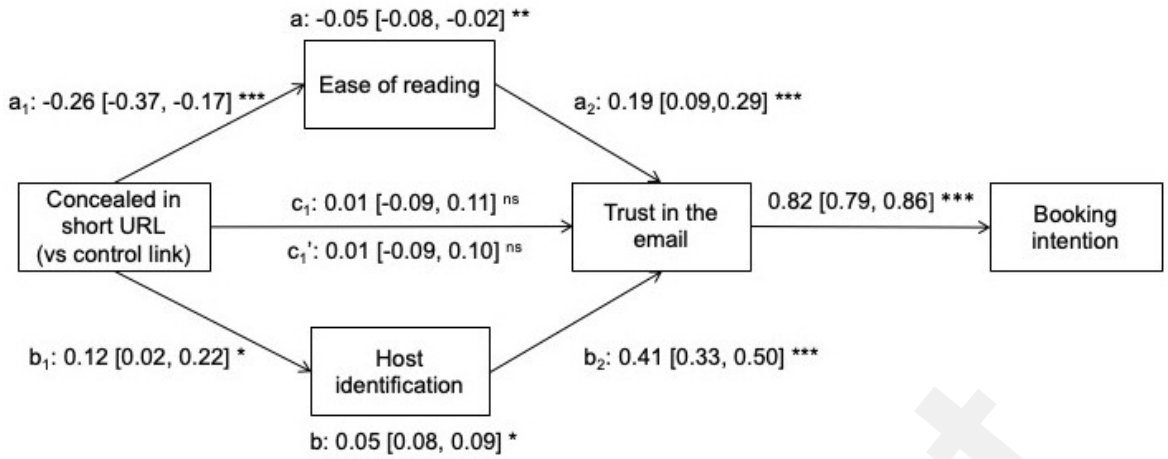
The path model shown in the upper panel of Figure 6 indicates that the effect of the text-embedded weblink on trust was statistically explained by both the heightened correct host identification and reading ease. The model shown in the lower panel indicates that the bit.ly weblink had the expected positive effect on trust via improved host identification. However, this effect was cancelled out by the *negative* effect that the link had on trust because of its lower fluency. Therefore, the bit.ly weblink did not improve trust perception compared to the control weblink.

The effect of the weblink on trust was similar after adding gender, age, education and ethnic minority status as covariates in a regression analysis (SM section E).

Figure 6

The text-embedded weblink and the bit.ly link had an effect on trust and booking intention (vs. control link) via the correct identification of the host and link fluency. The models show β regression coefficients.





Note. *** $P < 0.001$, ** $P < .01$, * $P < .05$, ns: not significant. Indirect effects: a: via subjective fluency of the link, b: via correct host identification. Values are standardized, path analysis β coefficients, with bias-corrected bootstrap 95% confidence intervals from 5000 samples.

Experiment 2 evidenced that concealing a weblink in a vaccination invitation email can be a good strategy to improve trust—but the effectiveness depends on how the link is hidden. Our results show that although both the shortened bit.ly and the text-embedded links omitted the source in the URL, this did not prevent participants from identifying the NHS as the host. Most of the participants used visual cues such as the NHS logo in the email letterhead, to determine the website host. However, the two concealed weblinks varied in terms of fluency. The shortened bit.ly weblink led to worse perceived readability and overall did not improve trust and booking intention. In contrast, concealing the weblink by embedding it in a word, led to both improved fluency (in addition to better host identification), which led to higher levels of trust in the overall email and booking intention. The results emphasize the additive role of host identification and fluency.

Experiment 3

Experiments 1 and 2 show that a clear weblink and a concealed, text-embedded weblink are effective strategies to facilitate host identification, improve link fluency, foster trust in the email, and increase booking intention. In Experiment 3, we compare the benefits of improving the weblink's readability and including a clear host with concealing the weblink by embedding it in text, relative to the control link in a larger and more ethnically diverse sample. In the UK, people from ethnic

minority groups tend to trust health institutions less [32], which might undermine the benefits of recognizing a well-known health institution. This lower level of institutional trust is one of the factors that explains why vaccination uptake is lower among ethnic minority communities in the UK [33-35] despite these groups being more likely than the white majority to experience severe illness and death from COVID-19 [36].

Method

Participants

The study was carried out in February-March 2022 via Qualtrics. Of 2,019 respondents who passed the attention check, one was excluded for completing the study too quickly (a preregistered minimum time to complete the study of 5 min). The sample of 2,018 participants was sufficient to detect a small effect of the link manipulation relative to the control condition on trust perception in a variance analysis where three groups were compared, f = 0.09 (assuming α = .05, power = .95). Participants' ages ranged from 18 to 89 years (M = 45.51, SD = 16.59). We used quota samples on age and gender to reach representative proportions but aimed to sample more participants from ethnic minority groups (up to 50%). The sample comprised 51% women, 49% men, 0.1% non-binary, and <0.1% other gender identification, with an ethnic composition of 52% White, 23% Asian, 13% Black, 9% Mixed/Multiple ethnicity and 3% Other. See Supplementary Materials section I for a more detailed sample description.

Design

Using a between-subjects design, participants were randomly allocated to one of three experimental conditions using the Qualtrics randomizer: participants viewed a hypothetical COVID-19 vaccination invitation email using either the control link ("accurx.thirdparty.nhs.uk/r/aafwaczmd5"), the clear weblink ("https://vaccine-booking.nhs.uk"), or the text-embedded weblink ("book here").

Materials and Procedure

This study followed the same procedure and analyses as Experiments 1 and 2, re-using the materials from Experiment 1 and the email containing the text-embedded weblink from Experiment 2.

Results

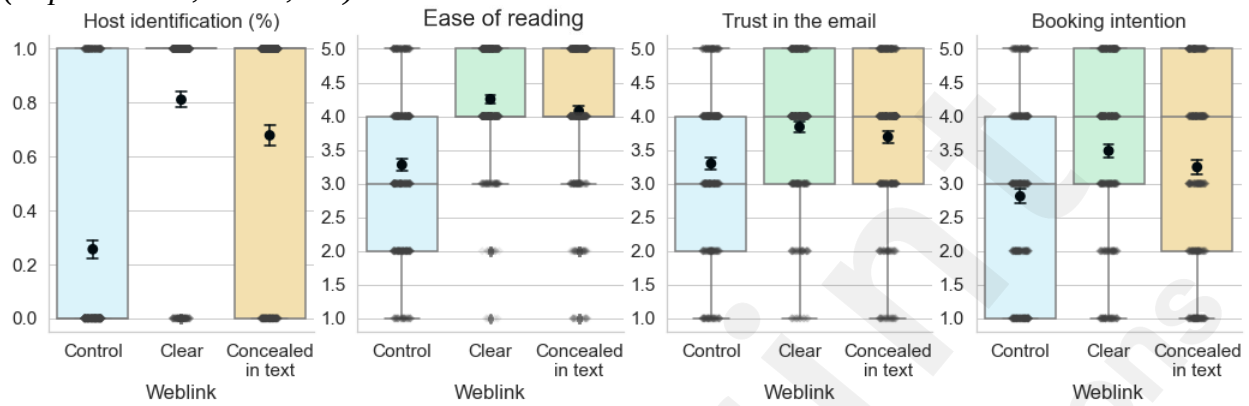
Both the clear link and the text-embedded weblink improved host identification (+58% and +45%, respectively), perceived readability, trust and booking intention relative to the control condition, as shown in Figure 7. The improved host identification and perceived readability mediated the positive effect of the clear and text-embedded weblinks on trust (Figure 8)[6]. The comparison of the two experimental conditions showed that the clear weblink increased correct host identification and generated more trust in the email, along with higher booking intention than the text-embedded weblink (see descriptively in Figure 7 and analyses in SM section L). The effect of each weblink on trust, compared with the control link, was similar after adding gender, age, education and ethnic minority status as covariates in a regression analysis (SM section E), in this larger, more ethnically diverse sample (47% minority groups).

[6] We report the results of the mediation results here and those of the variance analyses in SM section J.

We tested the effect of the weblinks on ethnic minority participants separately and found consistent effects. The clear weblink and the text-embedded weblink increased correct host identification and perceived readability, which increased trust and booking intention (SM section K).

Figure 7

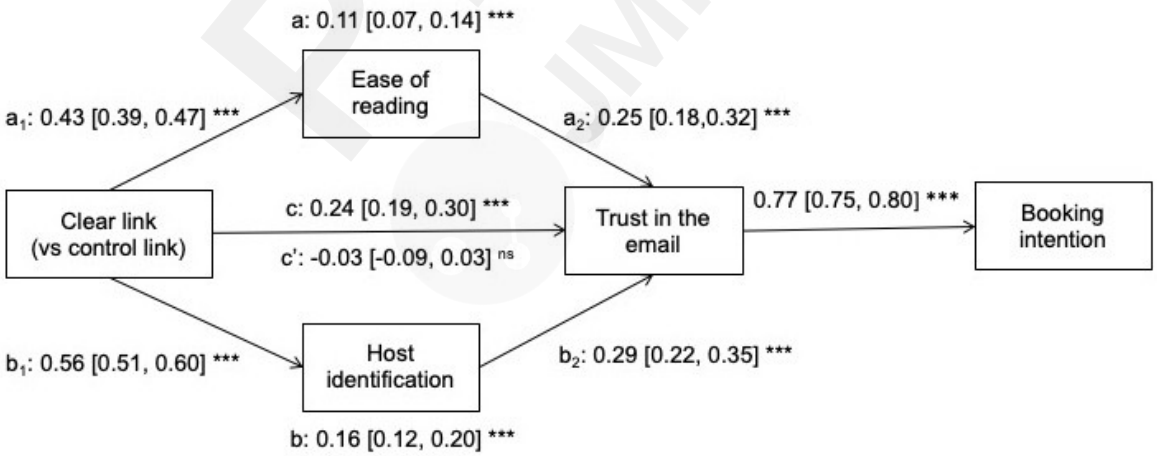
Relative to the control link (in blue), the clear weblink (in green) and the link concealed via text embedding (in orange) helped participants recognize the website host correctly, were perceived as more fluent, and had an overall positive effect on email trust perception and booking intention (Experiment 3, N = 2,018)

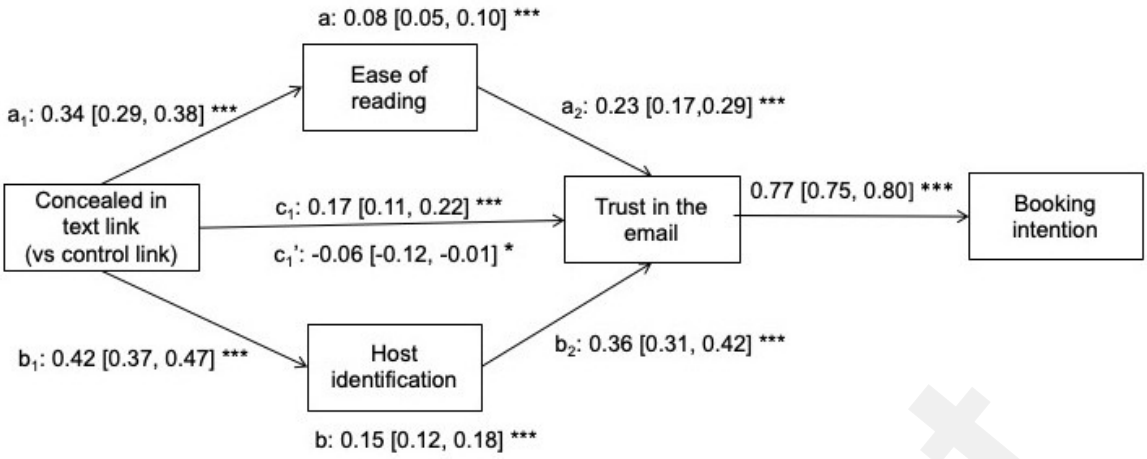


Note. The means are shown in black circles with 95% CI. The box represents the interquartile range, the line the median, the error bars show the minimal and maximal values without outliers and the outliers are shown as diamonds error. The host identification panel shows the proportion of correct interpretations. The control link was the NHS original vaccination invitation link "accurx.thirdparty.nhs.uk/r/aafwaczmd5", the clear link was "https://vaccine-booking.nhs.uk" and the concealed text-embedded weblink was "book here".

Figure 8

The clear weblink and text-embedded weblink improved trust and booking intention (vs control) and these effects were explained by the correct host identification and perceived readability. The model shows β regression coefficients.





Note.*** P < 0.001, ** P < .01, * P < .05, ns: not significant. Indirect effects: a: subjective fluency of the link, b: correct host identification. Values are standardized, path analysis β coefficients, with bias-corrected bootstrap 95% confidence intervals from 5000 samples.

Results of Experiment 3 confirm the pivotal role of weblinks in vaccination invitation email. We found that the design of the link shaped participants' trust in the email and their intention to book their vaccination appointment via the weblink. The study also found that the improvements to the control weblink was effective for participants from ethnic minority groups, who tend to report lower levels of trust in health institutions and lower vaccination engagement [33-35].

Discussion

In a context where real vaccination invitations must battle against scam messages to garner the recipient's trust, our findings show that the design of weblinks can shape overall trust in the communication. We identify two weblink characteristics that enhance both trust and engagement. Across three studies, we found that easy to read weblinks with clear host organizations improved trust in the vaccination invitation emails and vaccination booking intention. This work complements research on how best to frame information about vaccine effectiveness [2, 13, 14, 37], bringing attention to an overlooked element of digital communications: embedded weblinks. Consistent with information scent theory [38] and previous research on weblinks [21], we found that the features of weblinks shape their use. We found that difficult to read links harmed people's perception of the message in which the weblink appears, making the vaccination invitation emails look untrustworthy and reducing recipients' willingness to use the link.

The COVID-19 pandemic required people nationwide to change their behaviors to protect themselves and their communities. Timely vaccination uptake is facilitated by using digital invitation messages and reminders [3, 4, 39]. However, people are understandably skeptical when they receive a text message inviting them to click on a link. Scammers exploited people's eagerness to be vaccinated and sent fake vaccination invitations, aiming to steal private information [40, 41]. Our work complements research focusing on developing trustworthy digital (health) communication and on strategies that make people more likely to fall for phishing attempts (e.g., time pressure, the threat of losing out on an opportunity) [20, 21].

Weblinks should clearly identify the website host (e.g., NHS) and be easy to read to appear trustworthy. Our control link was the weblink used by the NHS in 2021 and 2022 in the COVID-19 vaccine rollout. The control link mentioned the name of the host, but the host information was lost to recipients because this crucial information was crowded between a reference to a third party ("accurx.thirdparty") and a string of letters and numbers ("r/aafwaczmd"). The overall link is ambiguous, disfluent, seemingly untrustworthy, and unlikely to trigger user engagement. Despite the link being an actual NHS link that people in the UK had already received, and that it appeared within an email that was very similar to standard NHS emails, less than half of the participants in our experiments (total N = 3,183) believed that clicking on the link would direct them to an NHS webpage. The disfluent link may have undermined the participants' confidence despite the presence of other cues that would make the email appear legitimate.

A weblink with a clear reference to the NHS as website host helped more recipients identify the host organization, improving participants' trust and user engagement with the weblink, when compared with the disfluent control link. When the provided weblink is fluent and appears to be trustworthy, the participants may then be influenced by their positive perceptions of the host organization. Results might differ for organizations that are less well known or that are not trusted. In fact, even for organizations that are globally trusted like the NHS [42], some segments of the population might report some levels of distrust, potentially reducing the positive effect of identifying the NHS as the website host. However, we replicated the benefits of host identification in a diverse sample, including ethnic minority groups who tend to trust health institutions less than the white majority group [e.g., 33]. Yet, using website hosts that people do not recognize would have a null effect, and hosts recognized as untrustworthy would return negative outcomes [22, 43]. It remains possible that facilitating the identification of the host might show null effects for unknown hosts or even backfire for hosts with a negative reputation.

A weblink should also be easy to read and understand. How easy to read people find text —known as fluency —is a meta-cognitive perception: a higher level perception of cognitive processing [24]. When the NHS sent a vaccination invitation, the fluency of the weblink had a role over and above whether participants recognized the website host. Easy to read links increased trust in the email and user engagement with the link itself, adding evidence of the effect of fluency on people's judgments and decisions [e.g., Fastinorbine; 25, 26, 27, 28].

Changing weblinks is not always possible; in those cases, concealing the links in text is a good option to increase trust and user engagement with invitation emails. Concealing links in embedded text increases fluency perception but also reduces the information people can get from links —not being able to draw from them who the host is and what the website function is. This may not be an issue in the context of an email where the email clearly features a host (e.g., the email is sent from the NHS or includes the NHS logo). We found that 'hiding' links in embedded text helped participants identify the website host and improved fluency perception, trust in the message, and intention to use the link.

Shortening weblinks via private websites also facilitated host identification (e.g., https://bit.ly/3GtTL0c); however, despite being more concise (one way to operationalize fluency [28]), they felt less fluent, reducing trust and user engagement. Shortened links are senseless strings of numbers and mixed case letters, making them difficult to read. Hiding weblinks in text instead of in a shortened URL elicited more trust but less so than a clear link, possibly because of the lack of transparency of the URL—participants could not identify where the link would lead them and had to guess based on who sent the email.

In our studies, even hidden links - that did not feature the host organisation - improved host identification and user engagement but this was due to the presence of other cues in the email that could be used to identify the host or sender of the invitation. Hidden links may be particularly suboptimal in the context of SMS, as these additional cues about the host are not readily available to the reader.

Limitations

Our studies were conducted via hypothetical invitations to which participants reported hypothetical intentions, which may not truly reflect how people respond to a real-life email. Additional factors may influence their decisions, such as their pre-existing level of trust in the health organization [43], whether they are a regular internet user, and whether the invitation is perceived as being useful [22]. Other aspects of weblinks also signal their trustworthiness, such as recognized internet domains (e.g., .gov) and website security (e.g., https) [19], although understanding this requires some information technology knowledge. Further research on the psychological effects of weblinks should be conducted to inform their optimization.

An important ethical consideration is that while these findings can help optimize public health messaging, they may also be misused by cybercriminals in scams and phishing attempts. For example, cybercriminals could mimic the link characteristics shown to enhance trust—such as clear weblinks and text-embedded weblinks links—to deceive recipients. This underscores the importance of pairing communication design improvements with strong public education around digital vigilance. Users should be regularly reminded to verify message sources, check for secure and official URLs, and report suspicious content. Public campaigns should aim not only to improve the effectiveness of health communications but also to raise awareness about the evolving tactics used by cybercriminals.

Recommendations for future health communications

Hidden links allow fluency issues to be sidestepped but they are known to carry risk, because they lack transparency. They can be easily used by cybercriminals to redirect users in phishing attacks, and hence clear links might be a better option overall. Therefore, we recommend that future public health messaging consider the readability and format of weblinks in addition to the message or email content and ensure that recipients can easily verify the sender of the email or text message to achieve optimal engagement in future health campaigns.

Conclusion

Digital health communication designers face an uphill battle to secure users' trust in a context where scams proliferate. Scams often include very convincing links, using features that maximize trust, which places less well-designed – but official - links at a disadvantage. Digital communication and psychological research can inform how to design improved weblinks that increase user trust and engagement. Here, we provide tools for institutions to foster trust and engagement in their digital communications.

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Conflicts of Interest

None declared.

Data Availability

The data are available on the Open Science Framework: https://osf.io/7ze84/?view_only=553dc8477c58401bbee59d989e5a634a.

Abbreviations

COVID-19 – Coronavirus Disease of 2019.

NHS – National Health Service, UK.

URL – Universal Resource Locator.

SMS – Short Message Service.

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Multimedia Appendixes

Supplementary Materials (SM).
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