



Neurometric and biometric measurement of the effectiveness of covid-19-related public service announcements

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Abstract

This research aims to examine the effects of public service advertisements on individuals in Turkey in order to ensure vaccine acceptance during the pandemic. For the relevant objective, a mixed methodology was utilized. In the first phase of the research, 25 public service announcements published during the pandemic were subjected to a classical rhetorical analysis to emphasize the discourse strategy that they reflect. Rhetorical analysis revealed that 46.16% of the examined PSAs feature logical discourse (logos), 29.5% feature emotional discourse (pathos), and 22.2% feature moral discourse (ethos). In the second phase of the research, neurometric (EEG) and biometric (GSR, Eye Tracking) measurement instruments were used to assess the impact of each persuasion strategy identified through rhetorical analysis on individuals. The results of an experiment with 69 participants showed that the emotional discourses (pathos) in PSAs have a greater impact on viewers' cognitive performance and attention. In particular, it was determined that the n400 potential was activated in the brains of the participants in response to PSAs which represent pathos rhetoric, and that their biometric responses based on eye movements and electrification on the skin differed in the 400–600 ms range. Consequently, it is anticipated that the current study will benefit from two aspects. First, within the scope of the examined literature, this study is the first to combine neurometric measurement with a rhetorically-based qualitative analysis. It is anticipated that the related mixed methodology will offer researchers an alternative viewpoint. Second, it is anticipated that the findings will contribute to the understanding of how society can be persuaded to adopt the appropriate behavior patterns in situations such as a global pandemic, as well as the impact of discourse strategies on individuals.

Keywords COVID-19 · Public service announcements (PSAs) · Persuasion strategies · Rhetorical analysis · Electroencephalography (EEG) · Eye tracking · Galvanic skin conductivity response (GSR)

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1 Introduction

Even though it's been four years since the COVID-19 epidemic first appeared in Wuhan on November 17, 2019, it quickly spread over the world and continues to have a devastating impact today. According to the most recent data from the World Health Organization (WHO), there have been 767,750.853 reported cases of COVID-19, including 6,941.095 fatalities, as of June 2023 (WHO, 2023). In this scenario, after India, Japan, and South Korea, Turkey is the Asian country with the highest number of COVID-related fatalities due to the COVID-19 pandemic (Worldometers, 2023). The COVID-19 pandemic has caused Turkey a total number of 17,232,066 confirmed cases with 102174 deaths up to June 2023 (Worldometers, 2023).

With the emergence of the first COVID-19 case in March 2020, the Turkish government launched the implementation of stringent, national anti-epidemic measures (Coşkun et al., 2021). In the past four years, the formation of the measures has occurred in four distinct phases: national lockdown, controlled social life (vaccination, mask use, distance regulations, covid monitoring system), new social life measures, and new normalization (Subaşı & Baycan 2022). Public service announcements (hereafter, PSAs) and information activities conducted by public and private institutions play an important role in society's acceptance of the practices adopted to fight the pandemic during each period.

Research has indicated that PSAs increase public awareness by explaining the causes, symptoms, and effects of COVID-19 (Ansell et al., 2021; Anttiroiko, 2021). According to Górska et al. (2022), in times of pandemic, communication with the public applying rhetorical strategies, which represent the art of persuasion, has a positive effect on the ability to change behavioral patterns.

In addition to this, if we discuss how rhetoric strategies affect public opinion in the context of an epidemic, the results reported by Cairney and Wellstead (2021) demonstrate that different rhetoric strategies provide trust and togetherness to decrease uncertainty and encourage people to follow the rules.

By means of rhetorical strategies, governments justify their operational and strategic choices about COVID policies and make them acceptable with a colorful blending of different rhetorics (Hoque et al., 2022).

Furthermore, the related research also indicates the effects of rhetorical strategies in the struggle against COVID-19, in different contexts such as Poland (Glowka, 2023), New Zealand (Bui et al., 2022), China (Cheng et al., 2022) and France (Opillard et al., 2020). Furthermore, the related research also indicates the effects of rhetorical strategies in the fight against COVID-19 in different contexts, such as Poland (Glowka, 2023), New Zealand (Bui et al., 2022), China (Cheng et al., 2022), and France (Opillard et al., 2020).

All this research about rhetorical strategies in the pandemic process has remarkably contributed to literature. However, these studies focus on particular points about rhetoric, such as which rhetoric is more dominant, and do not offer a comprehensive perspective to explain how rhetoric triggers behavioral change.

In order to fill this gap, the aim of the current study is to provide a neuroscientific viewpoint of rhetorical strategies and to examine the effect of rhetoric on neuromet-

ric and biometric outputs of behaviour in the scope of Turkish PSAs in the period of COVID-19.

This paper also contributes to our understanding of the effect of rhetoric under the conditions of a pandemic in several ways. First, we investigated rhetorical patterns in Turkish PSAs that emphasize the importance of vaccines. Studies of COVID-19 in Turkey have focused on economic systems (Açıköz & Günay, 2020), psychological effects (Aslan et al., 2020), vaccine hesitancy (İkişik et al., 2021), and outbreak control (Demirbilek et al., 2020). However, no prior research has directly explored the dominant rhetoric of PSAs, which represent Turkish persuasion policy about vaccination campaigns.

Second, using the mixed methodology, which includes rhetoric analysis and neurometric (EEG) - biometric (eye tracking, GSR) analysis tools, we examine the biometric and neurological arousal created by PSAs on individuals. To the best of our knowledge, this is the first study to combine the neuroscience perspective with the rhetorical lens.

2 Literature review

2.1 Public health communication and public service announcements

Public service announcements (PSAs) play a crucial role in marketing communications by promoting social causes, raising awareness, and driving positive behavior change among the public. These messages are typically sponsored by non-profit organizations, government agencies, or other socially responsible entities, aiming to educate and motivate individuals to take action for the betterment of society (Murry et al., 1996).

From a marketing communication perspective, PSAs employ various strategies to effectively deliver their messages and engage the target audience. First and foremost, PSAs focus on capturing attention (O'Keefe & Reid, 2020). They employ compelling visuals, emotional storytelling, or provocative statements to grab viewers' interest amidst the clutter of information. By using powerful imagery, relatable characters, or real-life scenarios, PSAs aim to evoke empathy, curiosity, or even shock to drive engagement (Lorch et al., 1994).

Another critical aspect of PSAs is crafting a clear and concise message. These announcements often tackle complex social issues, so it is essential to distill the information into a succinct and understandable format. PSAs use persuasive language (Selfe & Selfe, 2008), memorable slogans (Trichur, 2021), or catchy jingles to convey their message effectively. This approach ensures that viewers retain key information and are more likely to remember and act upon it. In addition to all these advantages offered by PSAs, conveying the message to a large audience and enabling them to take action requires good use of persuasive communication strategies. This situation reveals the importance of the messages and discourses developed.

2.2 Rhetorical strategies in persuasive public communication

There are numerous theories in the literature regarding the effect of persuasion, which consists of fundamental elements such as source, message, receiver, and objective, on altering individuals' attitudes. In this context, Aristotle focuses on the discourse of the source with its rhetorical emphasis (Larson, 1989). Yale influence theory emphasizes the reliability of the source, the characteristics of the recipient segment, and the attractiveness of the message (Curtis & Smith, 2008). Petty and Cacioppo (1986), on the other hand, emphasized the message in the persuasion process of the advertisement in the theory of elaboration probability, while the social judgment theory emphasized the perception by emphasizing the cognitive bases of the recipient against the message (Sherif et al., 1965).

While all these theories emphasize that the focus of informative messages and PSAs will increase their impact on society, rhetorical discourses from the source at this point show us the persuasion strategies used to change behavior patterns. (Rapp, 2002; Cope & Sandys, 2010). In this context, basic rhetorical strategies are divided into three: *ethos* (moral), *pathos* (emotional), and *logos* (logical). *Ethos* has an emphasis on moral, cultural, and social values in the discourse, *pathos* has an emphasis on the basic feelings of individuals such as love, fear, being rewarded, and the desire to belong, while *logos* has a logical emphasis on the discourse put forward by the source and triggers the process of social persuasion (Elden, 2005).

Prior research has identified the countries' communication strategies in the effort to combat COVID-19 (Everett et al., 2020; Heffner et al., 2021). It is seen that public service ads have a positive effect on many different measures, such as the acquisition of correct behavior patterns and social isolation (Utych and Fowler, 2020; Yang & Ren, 2020; Hou et al., 2020; Dhengre et al., 2022). In this context, research conducted by Everett et al. (2020) stated that the content of the messages and the demographic characteristics of the individuals caused differences in compliance with the measures for the crisis process. It was determined that messages with a utilitarian discourse are more effective at influencing public behavior than those without moral values, accuracy, or a moral stimulus (Everett et al., 2020). Heffner et al. (2021) examined how media-presented public service ads' discourse styles (fear-based and positive emotional discourse) affect Americans' COVID-19-related isolation. As a result of the study, it was determined that messages based on positive emotional discourse, as opposed to the fear-based stimulus discourse used in PSAs, allow individuals to independently implement the isolation strategy.

In China, Yang and Ren (2020) found that emphasizing moral responsibility in COVID-19 measures and leaders' utterances helped increase collective awareness. According to another study conducted on prominent social media channels in China, public service advertisements are effective at shaping social awareness and risk perception (Hou et al., 2020). One of the prominent results of the study is that unfounded rumors and misdirected message contents in the media channels affect the risk perception of the public negatively and trigger irrational behaviors such as stocking. On the other hand, Dhengre et al. (2022) discussed the negative impact of unsubstantiated health news and misinformation messages published on social media on public health and social resistance during COVID-19. The negative effects of misinforma-

tion and misleading media news during the epidemic also showed themselves in the social mobility related to vaccination. When the studies carried out in this context are examined, it has been determined that the news made without specifying the source and based on personal comments strengthens the anti-vaccine views (Marco-Franco et al., 2021; Jiménez-Sánchez et al., 2020; Garrett, 2020; Wang & Lund, 2020; Abdollahimajd et al., 2020).

When all the studies discussed above are evaluated together, it is seen that conducting the right communication campaigns in times of social crisis is of vital importance for public health. For this reason, it was considered important to determine which message attractiveness would be more effective in the context of the subject discussed, and the main hypothesis of the research was developed in this direction.

H_1 : Cognitive and biometric responses of participants to PSAs differ according to different types of rhetoric strategies.

2.3 Neuroscientific approach to rhetorics

Initiatives developed from the perspective of neuroscience on the examination of rhetorical concepts such as emotion, reason, or empathy promise to provide important insight to develop human cognition and communication strategies. Jack and Appelbaum (2010) defined this development as a multidisciplinary field and discussed it under the title of “Neurorhetorics”.

Similarly, Hogan (2017) reported that there is an important association between neuroscience and literary studies in the context of discourse in terms of monitoring emotions and reorganizing them accordingly. In light of the aforementioned premises, it is thought that neuroscience methods will offer new opportunities in order to strengthen the effect of discourse on communication purposes.

Knowing more about psychophysiological processes such as emotions (Baños-González et al., 2021) avoidance/approach (Hansen, 2005), memory (Fernández et al., 2023), learning (Cartocci et al., 2017), and empathy (Fabi & Leuthold, 2018), which are critical dynamics for communication and especially for PSAs that aim to develop a behavior at the social level, increases the effect of persuasive communication. Although the importance of this innovative initiative has been emphasized many times in theoretical studies, since experimental studies are still extremely limited, it was decided to evaluate discourse analysis according to the data obtained from neuroscience methods in this study and the following hypothesis were developed.

H_{1a} : Participants’ levels of electrification on the skin towards PSAs differ according to different rhetorical strategies.

H_{1b} : Participants’ visual attention towards PSAs differ according to different rhetorical strategies.

H_{1c} : Participants’ cognitive load towards PSAs differ according to different rhetorical strategies.

3 Method

We adopted a mixed-methods design, which incorporates quantitative and qualitative research techniques in a single study, and we combined rhetorical analysis with neuroscientific research methodology. Figure 1 illustrates the design of the study and its all phases.

3.1 Identification of public ads (stimulus selection) and rhetorical analysis

The first stage of the research includes determination of public Ads. In this process, we determined 54 public spots related to vaccination published by the Turkish Ministry of Health, Municipalities, Governorates, Turkish Medical Association, Chambers of Commerce, and Industry (June–November 2021). Then, the contents of 54 public service announcements were examined in terms of similarity, and it was tried to prevent the repetition error that may arise in the rhetorical analysis process (Gomaa & Fahmy, 2013).

The contents of the spots and the slogans they presented were examined by two researchers, and the data set was reduced to 39 slogans by removing the spots with the same slogan, although they presented different visuals.

The identification of public ads was followed by a rhetorical coding process. According to Smith (2007), Aristotle's rhetoric can be used to explain the construction of visual and verbal arguments that attempt to persuade various target populations. From this point, we based on classical rhetorical analysis (Wróbel, 2015). Especially, 39 slogans were classified based on emotional (pathos), cognitive (logos), and moral (ethos) persuasion emphasis. In the classification of slogans, basic rhetorical analysis steps in the literature were followed in determining which slogan empha-

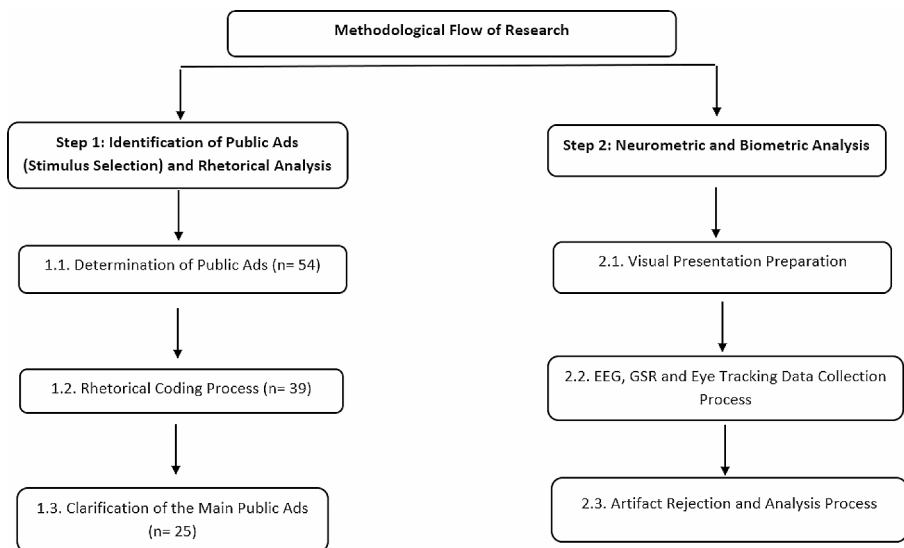


Fig. 1 The methodological flow of research

sizes emotional, cognitive, or moral emphasis (Green et al., 2008; Meyer, 2009). In this context, slogans that directly appeal to the emotions of individuals and highlight personal interests and emotions are coded as emotional, that is, pathos strategy. PSAs in which a social discourse is emphasized rather than the individual, the “I” subject is replaced by the “We” subject, and appeals to cultural and social values are based on moral (ethos) discourse (Meyer, 2009).

Moreover, messages in which various emphases such as the flag, Turkish society, Turkey, and togetherness stand out in the process, are positioned morally, while individual discourses based on singular pronouns such as I and you are positioned as emotional persuasion-oriented.

The last category considered in the rhetorical analysis process is related to cognitive discourses. The slogans that reference scientific data and statistics and emphasize objectivity were categorized as logos-rhetoric (Wróbel, 2015).

In all these steps, two researchers with expertise in qualitative research and rhetorical methodology separately codified each PSAs. The obtained analyzes were combined by an external coder and the reliability criteria for the information to be used as the main data set of the research were tried to be provided (Wyndet al., 2003). As a result of all the coding steps carried out, the final data set was determined as 25 PSAs (Table 1).

According to Table 1, the majority (48.16%) of the 25 PSAs emphasise vaccination through logical discourse (logos). Emotional discourse (pathos) accounts for 29.62% and moral discourse (logos)accounts for 22.22%.

3.2 Neurometric and biometric analysis

While preparing the experiment presentation, first of all, each of the 25 public service announcements with different backgrounds and environmental stimuli was placed on a common ground. By removing the images in the background of the original slogans, it was tried to prevent the stimuli that the research did not focus on in the data collection process from affecting the data results (Plong et al., 2012).

After the preparation of the visuals related to the public service ads, the experimental presentations used in obtaining the EEG, eye tracking and GSR data were prepared with the Paradigm Experiment Software.

Particularly, each block in the experiment flow starts with the 400 ms presentation of the “+” sign, which allows the participants to focus. Then, the presentation of the 300–500 ms waiting screen (empty gray screen) was performed in order to eliminate the event-related potentials that may arise from the +sign. In the last step, the contents of the public service ads based on the three discourse strategies (emotional, cognitive, and moral) obtained as a result of the rhetorical analysis were shown for 1000–1500 ms.

In the end, the contents of three stimulus groups were presented 50 times in the experimental presentation, which consisted of a total of 10 blocks; each presentation block was repeated twice within itself; and the average duration of the entire experiment was determined to be 13.29 min.

The selection of participants is a factor that must be considered during the research procedure. The study population is comprised of every citizen in Eskisehir/Turkey.

Table 1 PSAs used in the study and associated rhetorical strategies

PSAs related to the COVID-19 vaccine	Rhetorical strategies
Get vaccinated for a healthy tomorrow, a healthy society	Moral Discourse (Ethos)
We roll up our sleeves for our health	Moral Discourse (Ethos)
Let's get vaccinated... Let's make the risk map of our city blue	Moral Discourse (Ethos)
Being vaccinated is a person's responsibility to himself and to society	Moral Discourse (Ethos)
Vaccination is a social responsibility	Moral Discourse (Ethos)
To gain community immunity and return to our normal lives, Turkey, let's vaccinate	Moral Discourse (Ethos)
Get vaccinated, and protect your loved ones	Emotional Discourse (Pathos)
Vaccination is freedom. We have no choice but to get rid of the mask and other restrictions	Emotional Discourse (Pathos)
Don't be nervous, get vaccinated	Emotional Discourse (Pathos)
Let's roll up our sleeves... Let's protect our lives and our loved ones	Emotional Discourse (Pathos)
Get vaccinated and protect yourself and your loved ones	Emotional Discourse (Pathos)
For our health... Let's get vaccinated	Emotional Discourse (Pathos)
We are vaccinating for your health and your loved ones	Emotional Discourse (Pathos)
Covid-19 vaccines reduce the risk of contracting the disease, the risk of severe illness, the rate of hospitalization, and the death rate	Logical Discourse (Logos)
Let's follow the precautions and get vaccinated to minimize the risk of spreading COVID-19	Logical Discourse (Logos)
Vaccination is the best method of prevention in the fight against epidemics	Logical Discourse (Logos)
The most effective, safest and easiest way to protect against COVID-19 is to be vaccinated	Logical Discourse (Logos)
Covid-19 vaccines have been developed through standard quality, safety and efficacy studies	Logical Discourse (Logos)
It has been proven in clinical studies that Covid-19 vaccines provide high protection	Logical Discourse (Logos)
Covid-19 vaccines provide high protection and are safe	Logical Discourse (Logos)
The safety of Covid-19 vaccines has been proven by clinical studies	Logical Discourse (Logos)
Scientific researches show that vaccination does not increase the risk of miscarriage in pregnant women	Logical Discourse (Logos)
Vaccination is the most effective way to control epidemics	Logical Discourse (Logos)
Did you know that 83% of active Covid-19 cases in Turkey consist of people who have never been vaccinated or who have not completed their vaccinations?	Logical Discourse (Logos)
Studies show that people who get vaccinated are 63% less likely to transmit disease than those who do not	Logical Discourse (Logos)

However, the vastness of the universe and the challenges posed by data collection under pandemic conditions, a simple random sampling method with a 95% confidence interval, an effect size of 0.5, and a power of 0.80 was utilized (Faul et al., 2009; Lakens, 2013).

Participants volunteered to take part in the study. In particular, researchers shared a post on social media platforms, and those who agreed to participate were invited to

the laboratory via email. During the participants selection process, for a healthy EEG recording to be made, participants must be mostly right-handed, not have psychiatric, neurological, or visual problems, and not be getting treatment for these problems. (Luck, 2014). In order to achieve this objective, the hand use scale (Oldfield, 1971) and questions regarding the history of neurological disorders were included in the preliminary information questionnaire disseminated to volunteers.

Another limitation of participant selection is related to eye tracking methodology. For the calibration of the eye tracker, the participants must not have any eye defects (Krafka et al., 2016). In order to overcome this limitation, the pre-questionnaire form was augmented with a question regarding the existence of an eye disorder. In addition, each individual who was invited to participate in the experiment provided with a consent form and the experimental protocol was shared.

3.3 EEG, GSR and eye tracking data collection process

EEG, GSR, and eye tracking systems have been used to evaluate the neurometric and biometric effects of diverse discourse strategies in PSAs. The details of each measurement method are presented below.

EEG recordings were recorded unipolar from 32 active channels according to the 10/20 system via the G.Tec Nautilus EEG. EEG recording was performed with a sampling rate of 256 Hz and both mastoid electrodes were used as a reference during recording (Luck, 2014). To detail the EEG data collection process specifically, the participants were initially seated in a comfortable, non-moving chair 100 cm away from the LCD monitor. Then, the main filtering process of the EEG was carried out via gRecorder software. During EEG setup, the input range was 375 mV (44.70 nV), the bandpass was between 0.5 and 30 Hz, and the notch selection was between 48 and 52 Hz (Luck, 2014). Participants completed a 4-minute demo experiment with similar patterns to the original experiment to prevent application issues (Woodman, 2010).

Eye Tribe wireless 150 Hz eye tracker was used to record the eye movements of the participants. The first step in the eye tracking system is the calibration process (Krafka et al., 2016). In this procedure, the participant was first informed about the calibration process, then the researcher calibrated the participant's eye movements, and then the data recording procedure started.

Skin conductivity (Shimmer Sensing 3 GSR) was employed to measure the the participant's level of arousal. Preparing the device for use was carried out after the EEG and eye tracking setups were completed. After a researcher established the GSR device's basic filtering parameters in Matlab, stimulus bands were placed on the participant's index and middle fingers and started data collection.

3.4 Artifact rejection and analysis process

After the completion of the experimental phase, the raw data obtained from each measuring device was first subjected to the separation of artifacts. Each measuring device's data was cleaned using a distinct software application. Specifically, the brain waves obtained through the EEG device were cleared of artifacts and unrecorded data

via the EEGLAB 14.1.0 software run based on the Matlab program. A 30 Hz low pass filter was applied in the process (Luck, 2014). The data were then segmented based on stimulus (200 ms before stimulus onset and 1100 ms after stimulus encounter).

EEG also include biometric responses of the human body. At this point, artifacts caused by eye movement, blinking and heartbeat were removed by Independent Component Analysis (ICA) (Westerfield et al., 2001). Then, the artifact rejection was completed and digitized via Matlab and transferred to the SPSS environment.

The cleaning process of the data obtained by the eye tracking system were performed with Gazepoint software, and color and blink-induced distortions were excluded from the analysis process (Krafka et al., 2016).

In the analysis process, the last data cleaning and digitization step was carried out for the GSR data. For GSR measurements, the data should be organized individually. The activity of sweating glands varies among individuals. To ensure that GSR peaks constitute stimulus feedback, the tonic level (neutral state) was calculated at the individual level, and the valence of the phasic level (probe) was debated over the deviations (Shi et al., 2007). After cleansing, artifact-free biometric and biometric data were analyzed with the SPSS 21 package program.

4 Findings

In the measurement of the galvanic skin conductivity response, the difference between the phasic and tonic levels of the individuals was accepted as arousal (Bari, 2020), and these differences in the Microsiemens (μS) level were evaluated as the “excitation potential” of the 82 participants in the study. The averages of these psychophysiological responses to a total of 25 different stimuli in 3 rhetoric strategy as pathos, logos and ethos which constitute the experimental set of the participants, were analyzed by SPSS. Kolmogorov Smirnov ($n > 30$) test was applied to determine whether the GSR data fit the normal distribution conditions and it was seen that the data were not normally distributed ($p = 0.00 < 0.05$). For this reason, non-parametric tests were preferred in the analysis of the data. According to the results of descriptive statistical analysis, the lowest arousal level was 2583 μS , and the highest arousal level was 8,323,084 μS . Kruskal Wallis test was used to determine the distribution of data according to message types, and the difference between the averages was found to be statistically significant ($H(2) = 13.43, p = 0.001$) (Table 2).

Mann Whitney-U test, which is one of the complementary comparison techniques, was applied in order to determine which message group caused the significant dif-

Table 2 Distribution of arousal potential averages between different rhetorical strategies

	N	Mean rank	Chi-Square	df	p
Arousal potential averages					
Pathos	7	83.70	13.432	2	0.001**
Ethos	6	59.05			
Logos	12	56.75			
Total	25				

**Significant at the 0.01 level

Table 3 Differences in arousal potential mean between different rhetorical strategies

			Mean rank	U	Z	p
Arousal potential averages	Pathos	7	83.70	616.00	-11,395	0.003*
	Ethos	6	59.05			
	Pathos	7	83.70	563.00	-10,596	0.001**
	Logos	12	56.75			
	Logos	12	56.75	944.00	-2.1933	0.084
	Ethos	6	59.05			

*Significant at the 0.05 level; **Significant at the 0.01 level

Table 4 Variance analysis results regarding average gaze duration between different rhetorical strategies

Mean gaze time	SS	df	Mean square	F	p
Between groups	1615532.70	2	807766.35	17.28	0.00**
Within groups	10284335.85	22	46747.08		
Total	2643968.56	24			

**Significant at the 0.01 level

ference. As a result of the analysis, a significant difference was found between the arousal potentials arising from pathos and ethos oriented PSAs ($U=0.03 < 0.05$).

Similarly, the responses to pathos rethoric and logos rethoric PSAs differ statistically ($U=0.01 < 0.05$). However, no statistically significant difference was found between the arousal potentials for the logical and moral message groups ($U=0.84 < 0.05$) (Table 3).

The data obtained through the GSR show that the level of arousal for PSAs with pathos rethoric is higher than those with ethos and logos. It was determined that the participants felt a greater excitement/stress in the face of emotional PSAs when interpreted in the context of experimental design. These findings indicated that H1a was supported significantly in this study ($p < 0.05$).

Another biometric measurement method of the study is eye tracking systems. Eye tracking studies are accepted as important instruments to detect the conscious attention that individuals develop towards visual stimuli (Shagass et al., 1976; Armstrong & Olatunji, 2012; Wang et al., 2021). Through this system, participants' attention to stimuli was measured via gaze time, revisits and fixations. Eye movements of 82 participants for messages with emotional, moral, and logical contents were detected at millisecond levels and subjected to SPSS analysis. As a result of the Kolmogorov Smirnov ($n > 30$) test, the mean gaze durations of all three rethoric groups (pathos, logos, ethos) were found to be normally distributed $p=0.20 > 0.05$). For this reason, the One Way ANOVA test was conducted to determine whether the average viewing times for the relevant message groups differed. The results show a statistically significant difference between the groups ($F(2,22)=17.28, p=0.00 < 0.05$) (Table 4).

As a result of Levene's test, (Levene: 0.41; $p=0.66 > 0.05$), it was concluded that the variances were homogeneously distributed. According to the Tukey test results, which were preferred in this direction, the average viewing time for messages with pathos strategy ($M=1178.14, SD=237.43$) had both ethos ($\bar{x}=597.33, SD: 199.42, p=0.00 < 0.05$) and logos strategies significantly different than the messages with ($\bar{x}=$

Table 5 Variance analysis results for the average fixation between different rhetorical strategies

Average fixation	SS	df	Mean square	F	p
Between groups	3.50	2	1.75	0.51	0.60
Within groups	74.50	22	3.39		
Total	78.00	24			

Table 6 Variance analysis results for average revisits between different rhetorical strategies

		N	Mean rank	Chi-Square	df	p
Average revisits	Pathos	7	7.36	7.92	2	0.019*
	Ethos	6	6.58			
	Logos	12	8.88			
	Total	25				

*Significant at the 0.05 level

Table 7 Revisit averages between different rhetorical strategies

		N	Mean rank	U	Z	p
Average revisits	Pathos	7	7.36	18.50	-1.38	0.001**
	Ethos	6	6.58			
	Pathos	7	7.36	13.50	-2,51	0.003*
	Logos	12	8.88			
	Logos	12	8.88	15.00	-2.055	0.053
	Ethos	6	6.58			

*Significant at the 0.05 level; **Significant at the 0.01 level

619.83, $SD=211.34$, $p=0.00 < 0.05$). No significant difference was found in terms of messages with ethos and logos rethoric ($p=0.97 > 0.05$).

As a result of the Kolmogorov Smirnov ($n > 30$) test, it was observed that the average number of fixations for the three message groups was normally distributed ($p=0.20 > 0.05$). For this reason, the One Way ANOVA test was carried out to determine whether the average number of focusing on the relevant groups differed. The results show that there is no statistically significant difference between the groups ($F(2,22)=0.51$, $p=0.60 > 0.05$) (Table 5).

Finally, as a result of the Kolmogorov Smirnov ($n > 30$) test performed on the number of revisits for all three message groups, it was observed that the data were not normally distributed ($p=0.01 < 0.05$). For this reason, Kruskal Wallis test was applied to the data. As a result of the test, it was determined that revisit rates are differed due to the message types ($H(2)=7.92$, $p=0.02$) (Table 6).

Mann Whitney-U test, which is one of the complementary comparison techniques, was applied in order to determine from which group the significant difference was determined. The revisit rate to the messages with pathos oriented PSAs was found different from ethos ($U=0.001 < 0.05$) and logos oriented PSAs messages ($U=0.003 < 0.05$) (Table 7).

In sum, it is observed that the average gaze duration and the average number of revisits are more intense in emotional messages (pathos). Thus, our hypothesis H1b is supported in scope of gaze duration and revisit movement of eye. Although

Table 8 Analysis of variance regarding parietal region (N400 potential) between different rhetorical strategies

Parietal region (N400)	SS	df	Mean square	F	p
Intercept	531.60	1	531.59	82.30	0.00**
Error	523.16	81	6.45		

**Significant at the 0.01 level

Table 9 Analysis of variance regarding frontal region (N400 potential) between different rhetorical strategies

Frontal region (N400)	SS	df	Mean square	F	p
Intercept	237.17	1	237.17	39.14	0.00**
Error	490.86	81	6.06		

**Significant at the 0.01 level

no significant difference was found at the level of all groups in terms of fixations ($p=0.84 > 0.05$), it was noteworthy that messages with emotional content were prominent in the specified attention levels.

As part of the EEG analysis, which is the third measurement method used in the study, the researchers collected data on N400 potentials. The N400 potential is an event-related potential that occurs between 400 and 500 ms after a stimulus and offers insights into the verbal processing ability of the brain (Zhou & Wan, 2018). Moreover, N400 has been identified as a potential associated with semantic expectation in numerous research studies (Rolke et al., 2001; Lau et al., 2008). In the analysis process, the cognitive response to the N400 potential for three message groups (pathos, ethos and logos) in three brain regions (parietal, central and frontal) was measured with the EEG tool. The EEG waves were then digitised using MATLAB and the results were analysed using SPSS. In a repeated measures ANOVA, the sphericity assumption was met only for the N400 potential in the parietal [(Wilks' Lambda=0.999, $F(2, 80)=0.044$, $p=0.096$)] and frontal [(Wilks' Lambda=0.926, $F(2, 80)=3$, $p=0.047$)] regions. Thus, our hypothesis H1c is supported. Specifically, the N400 potential amplitude in the parietal region was found to differ depending on the type of rhetorical discourse reflected by the PSAs (ethos $\bar{x} = -1.50$, pathos $\bar{x} = -1.48$, logos $\bar{x} = -1.43$) (Table 8).

Table 9 shows the differentiation of the amplitude values of the N400 potential in the frontal region based on the three rhetorical types. This differentiation in the frontal region, which is responsible for the cognitive processing of the brain, shows that messages constructed with pathos rhetoric ($\bar{x} = 1.23$) are more effective than other types of discourse (ethos $\bar{x} = 1.02$, logos $\bar{x} = 0.69$).

5 Discussion and conclusions

In order to create, change or reinforce an attitude on a social scale, a strategic communication language must be designed and implemented within a certain systematic framework. This persuasion process to develop a social behavior includes many stages of communication, starting with the effort to raise awareness and making the behavior permanent. This cognitive process, which the individuals who make up

the target audience experience when they are faced with such mass communication efforts, is of utmost importance for the development of the next steps and the shaping of the behavior, which is the final target. Many different message strategies are used in the development of a persuasive communication message. One of them is the communication strategy, which is based on rhetoric of Aristotle and uses logical, emotional and moral components, which are the elements of message appeal (Wróbel, 2015). Considering the fact that the values, current attitudes and behaviors, emotions and cognitive processing capacities of the individuals who make up the society can be quite different from each other, it can be thought that it is a very difficult process to design a successful persuasion communication for the whole society. This study was carried out in order to understand what kind of communication message triggers what kind of cognitive process in the stage of establishing communication on issues covering the whole society. In this way, it is foreseen that it will be possible to make an inference about which of the persuasion messages used have a greater impact at the individual level, and as a result, it will allow a faster adaptation in society.

The focus for the example of social communication is COVID-19, which was on the agenda of the whole world as of 2019 and was accepted as a pandemic in a short time. In 2021, the use of vaccines formulated to prevent the spread of the epidemic was authorized, and vaccination campaigns launched simultaneously in numerous nations. Concerns about this virus and vaccines/vaccine candidates that societies faced for the first time necessitated the development of different persuasion strategies at the country level (Syed Alwi et al., 2021; Panda et al., 2021). Many vaccination campaigns were organized in Turkey, including by non-governmental organizations, especially the Turkish Ministry of Health, and in this way, awareness, information and incentives were tried to be provided for COVID-19 vaccines. In this study, the public service advertisements developed by the Turkish Ministry of Health and applied on the axis of public communication were examined. In this context, 25 different public service announcements were identified and their contents were subjected to rhetorical analysis, and the discourses were classified based on emotional, logical, and moral rhetoric.

In order to determine how the messages are perceived at the cognitive level by the target audience, 3 different neuroscientific methods were integrated and used. As a result of the analyses made using electroencephalography, eye tracking, and galvanic skin conductivity response, it was determined that the psychophysiological responses of the participants who were exposed to these public spots differed according to the message content. The data collected with the GSR reveals that the message type in which 82 participants experienced the most arousal was messages with pathos strategy. Similarly, eye tracking data show that the average gaze duration and the average number of revisits differ and increase in emotional discourse. These results indicate that the conscious attention levels of the participants improved towards emotional (pathos) discourse. Finally, the neural responses of the participants to the stimuli were examined with EEG, and when the event-related potentials were evaluated with the N400, it was seen that messages with emotional rhetoric stood out compared to other types of rhetoric.

The results show that pathos discourse stands out in the development of cognitive and physiological responses of individuals compared to logos and ethos rhetoric strategies in mass communication (and in particular for COVID-19 vaccine PSAs).

5.1 Theoretical contributions

To the best of our knowledge, our study is the first to examine the rhetorical persuasion strategies used in PSAs by integrating Biometric (eye Tracking and GSR) and cognitive (EEG) methodology. The method offers a mixed methodological approach by analysing the prominent discourse strategies in public service announcements through rhetorical analysis and simultaneously analysing the biometric responses of individuals and the mechanisms of cognitive processing of information through neuroscience techniques.

This method, which can be easily transferred to different research fields such as communication, management and even politics, contributes to strengthening communication strategies in the social marketing literature and triggering positive behaviour change.

5.2 Managerial implications

The study aims to examine the three persuasion strategies (ethos, logos, pathos) employed in PSAs during health-related situations and their impact on an individual's cognition and biometric reactions such as eye movement, eye fixation and arousal level. The findings reveal that PSAs which reflect acceptance of COVID-19 vaccination primarily rely on the logos strategy, which represents an intellectual form of persuasion. Despite the prevalence of using a logos strategy in discourse, emotional discourse strategies (pathos) have been discovered to be more effective than other types of discourse in supporting the individual's cognitive focus and physical response when looking at the impact of the preferred discourse (logos and ethos) on the individual. Based on this finding, it is predicted that in the process of creating public service announcements, both public institutions, administrations and marketing communication experts should focus on messages that activate the emotional functioning mechanisms of individuals, which will be beneficial in establishing positive behavioural patterns and increasing message effectiveness.

5.3 Limitations and future research lines

Although this study offers useful findings, it has its limitations, as with any scientific research. Firstly, the sampling capacity consisting mainly of individuals between the ages of 18 and 30 can lead to different outcomes in terms of the reproducibility of the results of the study. At this point, the re-implementation of research, taking into account different age groups, will contribute to a deeper understanding of the cognitive and biometric impact of persuasive strategies. Secondly, our research focuses on PSAs regarding the acceptance of COVID-19 vaccines in Turkey, potentially limiting their applicability to other populations due to cultural and linguistic differences. In

future research, examining public service announcements used in different countries will contribute to avoiding relevant cultural and language-based limitations.

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Declarations

Conflict of interest The authors would like to state that there is no potential conflict of interest.

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