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USING BAYESIAN STATISTICS TO INVESTIGATE THE RELATIONSHIPS AMONG L2 WRITING ATTITUDE, WRITING SELF-EFFICACY AND WRITING ANXIETY

İKİNCİ DİLDE YAZMA TUTUMU, YAZMA ÖZYETERLİĞİ VE YAZMA KAYGISININ İNCELENMESİ İÇİN BAYES İSTATİSTİĞİ KULLANIMI

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Abstract

The role of relevant psychological variables in L2 writing is very well documented in the literature and writing attitude, writing self-efficacy and writing anxiety are no exception. However, it is seen in the literature that the majority of the studies with respect to L2 writing-related psychological variables utilize frequentist or classical statistics to make inferences and come to conclusions. In this respect, the present study aimed to fill a gap in the literature by proposing an alternative interpretation of the possible relationships among L2 writing attitude, writing self-efficacy and writing anxiety by means of Bayesian statistics, as they have advantages over their frequentist counterparts in educational research in terms of estimating more complex models, making estimations based on prior models and being more informative in general. The study had a cross-sectional and descriptive design. 152 pre- service teachers of English participated in the study and completed writing attitude, writing self-efficacy and writing anxiety scales voluntarily. The data collected was subjected to analyses to check for normality. Following the tests of normality, Bayesian correlation analyses were used to check potential relationships among the aforementioned psychological variables. The findings confirmed the previously identified positive correlation between L2 writing attitude and writing self-efficacy as well as the negative correlation of L2 writing anxiety with writing attitude and writing self-efficacy with a Bayesian approach, indicating extreme evidence for all relationships.

Key Words: Bayesian statistics, writing anxiety, writing attitude, writing self-efficacy.

Özet

İkinci dilde yazma becerisiyle ilgili psikolojik değişkenlerin rolü çok kez incelenmiş ve yazma tutumu, öz yeterlik yazma ve yazma kaygısı da bu incelemelere dahil edilmiştir. Ancak, ikinci dilde yazma ile ilişkili psikolojik değişkenlerle ilgili çalışmaların çoğunun, sonuçlara ulaşmak için klasik istatistik yöntemleri kullandığı görülmektedir. Bu bağlamda çalışma, klasik istatistiğe göre daha karmaşık modeller oluşturabilen, önceki modelleri yeni modeller ile birlikte kullanabilen ve genel olarak daha fazla bilgi verme kapasitesine sahip olan Bayes istatistiği yöntemlerini kullanarak ikinci dile yazma tutumu, yazma özyeterliği ve yazma kaygısı arasındaki olası ilişkilere alternatif bir yorum getirmeyi amaçlamaktadır. Çalışma kesitsel ve betimsel bir tasarıma sahiptir. 152 İngilizce Öğretmeni adayı gönüllü olarak çalışmaya katılmıştır. Toplanan veriler öncelikle normallik analizlerine tabi tutulmuş, bunun ardından, yukarıda belirtilen psikolojik değişkenler arasındaki potansiyel ilişkileri sınamak için Bayes korelasyon analizleri kullanılmıştır. Bulgular daha önce ikinci yazma tutumu ile yazma özyeterliği arasındaki pozitif korelasyon ile yazma kaygısı ile yazma tutumu arasındaki negatif korelasyonu doğrulamış ve tüm ilişkiler için en uç düzeyde kanıt bulunduğunu göstermiştir.

Anahtar Kelimeler: Bayes istatistiği, yazma kaygısı, yazma tutumu, yazma özyeterliği

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1. Introduction

Psychological variables are undeniably effective in second/foreign language achievement (Brown, 2007) and L2 writing skills are no exception to this, being influenced by the levels of certain variables such as writing attitude, writing self-efficacy and writing anxiety. However, it is seen in the relevant literature that most studies focus on the interactions regarding L2 writing-specific psychological variables in frequentist terms, depriving relevant findings of the additional or alternative information which could be provided by possible choices other than frequentist statistics. In this respect, even though how certain psychological variables interact with each other and writing skills can already be found in numerous studies in the literature relevant to language teaching and learning, the fact that almost all of them are limited to frequentist findings necessitates the re-visiting of those variables by means of alternative statistical models, such as Bayesian statistics, to extend or confirm the current body of related knowledge.

In order to have an understanding of how Bayesian statistics provide an alternative to frequentist statistics, a comparison of two approaches may prove useful. According to a frequentist point of view, probability only belongs to events that can be repeated, which deems the analysis of probability an investigation of a particular limiting frequency over repeated runs of the same test (O'Hagan, 2004). However, Wagenmakers (2007) argue that a researcher is typically interested in the probability of confirming a hypothesis in a given set of data and the traditional p value does not provide the researcher with this particular piece of information. On the other hand, the Bayesian notion of probability acknowledges the uncertainty as a result of both random variability and a lack of knowledge and thus, it treats the concept of probability as the degree of belief in the findings obtained (O'Hagan, 2014).

The interpretation of results also differs according to the approach one adopts as frequentist or Bayesian in statistics. With respect to interpretation, the frequentist view argues that a null hypothesis can be falsely rejected only in 5% of n repetitions of the same analysis with new data each time and this puts repetitions in the centre of statistical inference. Contrasting the frequentist viewpoint, the Bayesian approach posits that a 95% interval precisely means that the probability of a parameter being within that interval is 95% (O'Hagan, 2004; Wagenmakers, Lee, Lodewyckx, & Iverson, 2008).

In their series of publications regarding the use of Bayesian statistics in psychology research, Wagenmakers et al. (2018) make a list of the strengths of Bayesian statistics over their frequentist counterparts based on the relevant literature and find that unlike frequentist statistics, Bayesian statistics allow for the consolidation of current findings with prior ones (Cumming, 2014), resulting in the use of what is already known on a given topic (Jaynes, 2003) and making findings more coherent (Lindley, 2000). Furthermore, as also stated in the comparison of frequentist and Bayesian approaches, the latter makes the quantification of confidence that a specific interval which also includes the true mean possible while confidence intervals in the former approach is based on repetitions (Pratt, Raiffa, & Schlaifer, 1995).

According to Pratte and Rouder (2012) as cited in Wagenmakers et al. (2018), these features of Bayesian statistics allows for the extension of simpler models to more complex models naturally. In addition, Bayesian statistics are not severely biased against the null hypothesis (Sellke, Bayarri, & Berger, 2001) or dependant on sampling schemes that are unspecified (Lindley, 1993). Lastly, the superiority of Bayesian statistics over frequentist statistics also stems from the ability to monitor the strength of evidence as new data comes into the model (Rouder, 2014) and quantify its strength (Jeffreys, 1935) in favour of both the null and the alternative hypotheses (Wagenmakers, 2007).

In the recent literature, Bayesian statistics have been reported to bear advantages both in terms of educational science and L2 research. According to König and van de Schoot (2018), adopting a Bayesian approach to hypothesis testing in educational science makes it possible to work with more complex models and to make use of former models, making the findings obtained more informative in general than findings obtained through frequentist analyses. Within the particular domain of L2 research, Norouzian, Miranda and Plonsky (2018) suggest that thanks to Bayesian statistics, theory development and its criticism can improve, prior findings can gain importance and the focus of research can shift towards the computation of parameters that are worthy of investigation. In this regard, it can be stated that Bayesian statistics have potential to add value to educational research and L2 research.

As the present study aims to confirm/re-establish the relationships among writing attitude, writing self-efficacy and writing anxiety in the English as a Foreign Language context, it is necessary to review the previous findings with respect to the issue, too. In the relevant literature, it is seen that Yavuz-Erkan and İflazoğlu-Saban (2011) find that writing attitude has a moderate and positive relationship with writing self-efficacy but moderate and negative relationship with writing anxiety in an undergraduate context. Similarly, writing self-efficacy and writing anxiety have been shown to have a moderate and negative relationship in primary school (Pajares & Valiante, 1997), upper-secondary (Blasco, 2016) and graduate (Ho, 2016) contexts. In brief, the relevant literature shows that L2 writing attitude and writing self-efficacy are positively correlated but both constructs are negatively correlated with L2 writing anxiety.

Considering the advantages of Bayesian statistics over frequentist statistics and the fact that the literature indicates a gap with respect to the Bayesian interpretations of the possible relationships among L2 writing attitude, writing self-efficacy and writing anxiety, the present study aims to find out if the frequentist relationships proposed among the aforementioned constructs can be confirmed by means of a Bayesian approach.

Aim of the Study

Taking into account the relevant literature on the strengths of Bayesian statistics, this study aimed to find out if there were relationships among L2 writing attitude, writing self-efficacy and writing anxiety from a Bayesian viewpoint. For this reason, the following research questions were developed:

1.   What are the L2 writing attitude, writing self-efficacy and writing anxiety levels of pre-service English teachers in Edirne?

2.   Are there relationships among L2 writing attitude, writing self-efficacy and writing anxiety within a group of pre-service English teachers in Edirne?

2. Methodology

The study adopted a cross-sectional correlational design and quantitative research methodology. According to Mckey and Gass (2005), correlational designs are typically used in survey-based quantitative studies in order to test potential relationships among variables or to see if one variable can be predicted using another variable. Since this study aimed to identify potential relationships among three psychological constructs and their sub-constructs, a correlational design was chosen to meet the aims of the study.

2.1. Participants and Context of the Study

The participants of the study were 152 undergraduate students of English Language Teaching in a public university in Turkey, who all volunteered to participate in the study. The mean age of the participants was 21.79 (SD = 2.19) with a minimum of 19 and a maximum of 32. Among them, 47 (30.9%) were male and 105 (69.1%) were female. 81 (53.3%) of the

participants were second year, 41 (27%) of the participants were third year and 30 (19.7%) of the participants were fourth year students.

2.2. Instruments

To measure the levels of writing attitude (WA) among the participants Writing Attitude Scale (WAS) (Erdoğan, 2013) was used. WAS is an 18-item five-point and single-factor Likert scale in which statements are responded to as completely agree, agree, undecided, disagree and completely disagree. According to its developer, WAS is a valid and reliable scale producing an α of .92. In the present study, the Cronbach's Alpha coefficient was found to be .94, indicating excellent reliability.

Writing self-efficacy (WSE) was measured by means of the Self-Efficacy in Writing Inventory (SEWI), developed by Yavuz-Erkan (2004). SEWI is a 21-item and four-point rating scale in which test-takers respond to statements as 'I cannot do it at all', 'I can't do it well', 'I can do it' and 'I can do it very well'. The scale is comprised of five subscales as Content (Statements 6, 9, 12, 17, 21), Design (Statements 2, 5, 8, 11, 16), Unity (Statements 3, 4, 10, 13, 19), Accuracy (Statements 1, 7, 14, 18) and Punctuation (Statements 15, 20). Deemed both valid and reliable by its developer (Yavuz-Erkan, 2004), the reliability coefficients (α) for SEWI were initially reported to be .88 for Content, .80 for Design, .77 for Unity, .74 for Accuracy and .50 for Punctuation. In the present study, the Cronbach's Alpha coefficient was computed to be .93 for the whole scale, .87 for Content, .83 for Design, .79 for Unity, .73 for Accuracy and .72 for Punctuation, indicating reliability levels from good to excellent.

In order to measure writing anxiety (WAN), Second Language Writing Anxiety Inventory (SLWAI), developed and validated by Cheng (2004) was used. SLWAI is a 22-item five-point Likert scale whose statements are responded to as 'Strongly Disagree', 'Disagree', 'No Strong Feelings Either Way', 'Agree' and 'Strongly Agree' and seven of the statements (1, 4, 7, 17, 18, 21, 22) are reversely scored due to negative wording. SLWAI consists of three subscales, namely Avoidance Behaviour (Statements 4, 5, 10, 12, 16, 18, 22), Somatic Anxiety (Statements 2, 6, 8, 11, 13, 15, 19) and Cognitive Anxiety (Statements 1, 3, 7, 9, 14, 17, 20, 21). The scale is considered both valid and reliable with reliability coefficients of .91 for the whole scale, .88 for Avoidance Behaviour, .88 for Somatic Anxiety and .83 for Cognitive Anxiety. In this study, reliability coefficients were calculated to be .89 for the whole scale, .73 for Avoidance Behaviour, .86 for Somatic Anxiety and .73 for Cognitive Anxiety.

In order to see if running parametric tests on the data was possible, skewness and kurtosis values of the constructs were investigated initially as proposed by Oppong and Agbedra (2016).

Table 1

Skewness and Kurtosis Values for each Construct

Construct	Skewness	Kurtosis
Writing Attitude	-.312	-.513
Writing Self-Efficacy	.029	-.513
Writing Anxiety	.122	-.646

According to Tabachnick and Fidell (2014), skewness and kurtosis values within a range of ±1.5 indicate that the data being analysed is normally distributed. Taking this suggestion into account, it was seen that the data for all the constructs were normally distributed as all the skewness and kurtosis values were seen to fall between ±1. For this reason, means and standard deviations for each construct were computed and relationships among constructs were sought for by means of Bayesian Pearson Correlation analyses. However, to make better use of

Bayesian statistics by also reporting the results of sequential analysis which include the strength of evidence for a given hypothesis and the comparison of the null hypothesis with the alternative hypothesis, correlation analyses were performed in pairs (WA – WSE, WA – WAN, WSE – WAN) by using JASP software (JASP Team, 2018). As indicated in the relevant literature, a positive correlation was sought for between WA and WSE (Yavuz-Erkan & İflazoğlu-Saban, 2011). However, negative correlations were checked for in the WA – WAN and WSE – WAN pairs as suggested in the relevant literature (Pajares & Valiante, 1997).

3. Findings

The first research question aimed to find out the WA, WSE and WAN levels of the participants. The findings were tabulated and presented below in Table 2.

Table 2

Means and Standard Deviations for each Construct

Construct	*M*	*SD*	*Min*	*Max*
Writing Attitude	3.52	0.77	1.44	4.89
Writing Self-Efficacy	2.90	0.49	1.62	3.90
Writing Anxiety	2.67	0.66	1.38	4.19

The second research question aimed to find out if WA, WSE and WAN were related constructs. As mentioned in the methodology section, the analyses for the second question were made in pairs to be able to report the strength levels of the evidence obtained for each correlation pair. The findings related to the first correlation pair, WA – WSE, are presented below.

The Bayesian correlation analysis of the WA – WSE pair revealed a Pearson's r of .50 and a Bayes Factor (BF10) of 3.500e+8 (95% CI = .37 - .61) in favour of a moderate and positive correlation, explaining 25% of the variance. The results of the sequential analysis to compare the likelihood of the presence or absence of a correlation between WA and WSE were presented below in Figure 1.
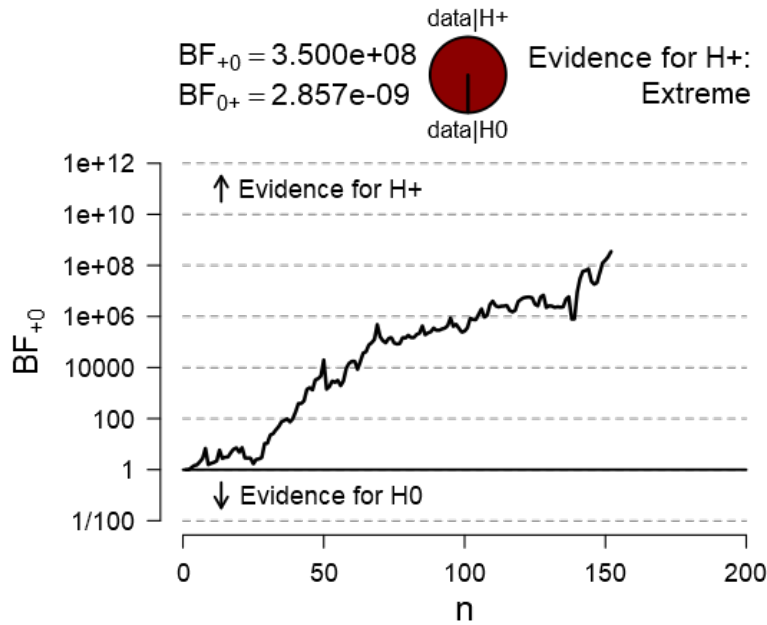
Figure 1. Sequential Analysis of the WA - WSE Pair

As seen in Figure 1, the likelihood of the presence of a correlation (H+) between WA and WSE in comparison to the absence of it (H0) (BF0+ = 2.857e-09) was slightly over 1e+08 times, indicating extreme evidence for the presence of a correlation. The analysis also showed that the likelihood of H+ increased as new data was added, being approximately 10000 with the addition of the data that belonged to the 50th participant, 1e+06 with the addition of the data of the 100th participant and exceeding 1e+08 after the addition of the data of the 150th participant.

The WA – WAN pair was also subjected to Bayesian correlation analysis to see if there was a negative relationship between two constructs. The results indicated a moderate and negative relationship with a Pearson's r of -.62, explaining 38% of the variance. The Bayes Factor (BF10) for this finding was computed to be 7.151e+14 (95% CI = -.705 - -.506). Since JASP produced an error that could not be troubleshot at the time of the research, sequential analysis could not be performed for the WA – WAN pair. However, the Bayes Factor for the null hypothesis (BF01), which argued for the absence of a negative correlation between WA and WAN, was calculated to be 1.398e-15 and with this BF value, the likelihood for the absence of a negative correlation between WA and WAN was computed to be close to 1/1e+16. On the other hand, the likelihood for the presence of a negative correlation was calculated to be approximately 1e+16, which indicated extreme evidence.

The results of the Bayesian correlation analysis to see if there was a relationship between WSE and WA indicated a Pearson's r of -.49, indicating a moderate and negative relationship which explained 24% of the variance. The Bayes Factor (BF10) for this analysis was found to be 6.988e+7 (95% CI = -.59 - -.36). Sequential analysis results were given below in Figure 3.
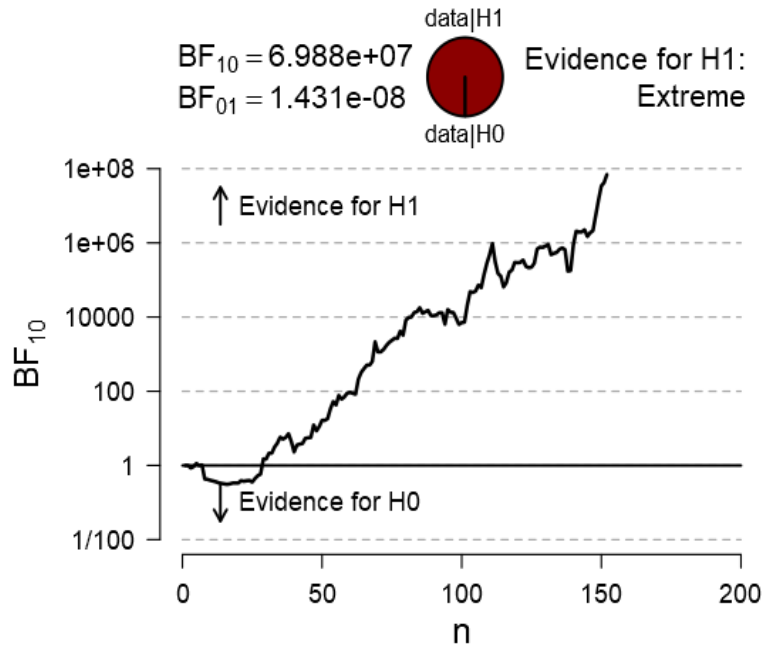
Figure 2. Sequential Analysis of the WSE - WAN Pair

As can be seen in Figure 3, the likelihood of the presence of a negative correlation (H1) between WSE and WAN was approximately 1e+08 times more than the likelihood of its absence (BF01 = 1.431e-08), indicating extreme evidence for a negative correlation between WSE and WAN. It was also seen in the results that, even though the first few data points favoured the absence of a negative correlation, the likelihood of its presence dramatically increased towards the data of the 50th participant, making it 10000 times more probable than its absence towards the addition of the data of the 100th participant and approximately 1e+08 times more probable after the addition of the data of the 150th participant.

4. Conclusion

The This study aimed to find out if relationships among L2 writing attitude, writing self-efficacy and writing anxiety could be detected using Bayesian statistics within a data set obtained from 152 undergraduate students of English Language Teaching studying in a public university in Turkey. The results indicated a moderate and positive relationship between writing attitude and writing self-efficacy. Moreover, moderate and negative relationships were detected in the writing attitude – writing anxiety and writing self-efficacy – writing anxiety pairs. Thanks to the results obtainable by Bayesian correlation analysis, it was also seen that the presence of the mentioned correlations was approximately 100 million (1e+08) times more probable for the writing attitude – writing self-efficacy and writing attitude – writing anxiety pairs than their absence. In addition, the probability of their presence increased even further with the addition of new data, indicating extreme evidence for all three analyses. The probability was even higher for the presence of the correlation identified above, being 10 quadrillion (1e+16) times more probable than its absence, also indicating extreme evidence and an increasing strength of evidence with the addition of new data.

The findings that writing attitude was positively correlated with writing self-efficacy and writing anxiety was negatively correlated with both writing attitude and writing anxiety

were seen to be in line with those of Yavuz-Erkan and İflazoğlu-Saban (2011), Pajares and Valiante (1997), Blasco (2016) and Ho (2016) in that they also achieved similar correlation strengths and the same directions in their studies. Even though all their findings were obtained by means of frequentist analyses, no difference was observed when the same variables were subjected to Bayesian correlation analyses. In this respect, it could be stated that the positive correlation between writing attitude and writing self-efficacy as well as the negative correlation of writing anxiety with both writing attitude and writing self-efficacy were confirmed both in frequentist and Bayesian approaches to data analysis.

Apart from confirming the already-proposed correlations among the variables of the study in an alternative statistical model, the findings obtained in the present study also confirmed the strengths of the Bayesian approach in L2 research over the classical approach. As suggested by Cumming (2014), Norouzian et al. (2018) and Jaynes (2003), adopting a Bayesian approach to look for correlations allowed the researcher to make use of what is already known about the variables of interest by making it possible to look for 'positive' or 'negative' correlations in particular. In addition, the ability to track how the analyses performed upon adding new data allowed the researcher to see which data points pushed the results towards the null hypothesis and which ones pushed them towards the alternative hypothesis. Lastly, as argued by Rouder (2014), Bayesian correlation analyses allowed the researcher to identify the strength of evidence present in the data in favour of a given hypothesis, making all the models more informative than their frequentist counterparts (König & van de Schoot, 2018). In sum, utilizing the Bayesian approach to statistics to detect correlations appeared to make it possible to use prior findings to reach L2-related conclusions, allowing the findings to provide more detailed information than a frequentist correlation analysis would.

The implication that can be drawn from the findings obtained in this study is that Bayesian statistics provide a strong alternative to their frequentist counterparts as the former provides a larger repertoire of knowledge such as how probable the hypotheses of a given study are and how the findings change, if they do, as new data is added to a given statistical model. Also allowing for using what is already known on a particular topic, Bayesian statistics, in deed, serve knowledge to accumulate as new findings emerge and L2-related knowledge appears to be no exception to this. In this regard, Bayesian statistics seem to provide a strong alternative to frequentist statistics in L2 research.

In pedagogical terms, the findings confirm that the psychological constructs related to L2 writing are interrelated and although no causation among their relationships is implied in this study, it can be concluded that psychological improvements among L2 learners, such as increased levels of writing attitude and self-efficacy or a decreased level of writing anxiety, may indicate positive changes in other psychological constructs and such a change may have a positive effect on L2 writing performance.

Even though the degree of belief reached through the findings of the study is rather high and it seems to be a viable option to use Bayesian statistics instead of frequentist statistics, it should be noted that the available Bayesian analyses in JASP (v0.9.2.0) are limited to parametric ones, so the assumptions for parametric statistics should be tested before working with JASP for Bayesian purposes. In the case of the violation of a parametric assumption, data transformation options can be considered. In further studies, the sequential analysis results can be scrutinized to investigate the reasons behind the fluctuations in the strength of evidence as new data comes into a given model and more explanatory findings can be obtained.

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