

But spell checker always corrects witch words eye misspelled

Spell checker use among good and poor spellers

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The present study examined spell checker software for both spelling recognition and production among college students. Sixty-four participants identified and corrected spelling in a prewritten story and produced spelling by writing a story. Both were completed with or without spell checker access. Results demonstrated differences between the performance of good and poor spellers (as defined using a baseline spelling test). When compared to good spellers, poor spellers corrected a greater percentage of spelling errors with spell checker than without. Spell checker helped all participants produce fewer spelling errors, but not fewer homophone errors. Additionally, more often than good spellers, poor spellers reported placing less effort into spelling words correctly when using spell checker. These findings suggest that poor spellers may have a greater need for spell checker than good spellers, and may be at a greater risk for relying on the software as the only step in the proofreading process.

Keywords: spelling, spell checker, spelling ability, spelling recognition, spelling production

Since the creation of spell checkers in the late 1970s, and more widespread availability in the subsequent years, students have been able to use this tool part of the writing process. Its purpose has been to assist writers in finding spelling errors and to look for correct spellings of various words. However despite the availability of this software, there are a growing number of college students who are not correctly spelling words at the level that is expected of them, and who may be at risk for being unsuccessful in their ability to complete college coursework (Russell, 2009). Poor spelling skills among students has raised some concerns among researchers and teachers that spell checker may be negatively influencing students to depend too much on the software to correctly spell words (Anderson-Inman &

Knox-Quinn, 1996; Galletta, Durcikova, Everard, & Brian, 2005). Inconsistencies in spelling-to-sound correspondences in the English orthography could only exacerbate this problem, where spellers may know the rule for spelling a particular sound, but not its exceptions. Without this knowledge, one may rely on outside sources, like spell checker.

Despite its good intentions, research indicates that a spell checker is not without flaws and sometimes makes errors such as marking correct words as incorrect, flagging proper nouns, and offering incorrect or inappropriate suggestions for words too far from the accurate spelling (e.g., Anderson-Inman & Knox-Quinn, 1996; Bosman, van Huygevoort, Bakker, & Verhoeven, 2007; Galletta et al., 2005; Gupta, 1998; MacArthur, Graham, Haynes, & DeLaPaz, 1996). Spell checkers have an accuracy rate of 94%, but will not flag errors if the misspelled word is a homophone error (e.g., *there* instead of *their*) or typographical error that forms the correct spelling of another word (e.g., *veil* instead of *evil*; Dobrin, 1990).

One study investigated the accuracy of spell checker's detection of spelling errors from a series of short stories and topic essays composed by students with learning disabilities (MacArthur, et al., 1996). Two unique raters read and marked students' in-class compositions for different types of spelling errors, including one classification for homophone errors (i.e., using *there* instead of *their*) and another grouping for other types of spelling errors. Results indicated that correct spelling suggestions were only provided for 55% of the 555 uniquely misspelled words produced by these students. McArthur et al. (1996) explains that while the spell checker is a helpful tool, the software cannot be relied upon to identify all errors with 100% accuracy.

Another study examined students' overconfidence in spell checker's ability to identify homophone and spelling errors, and asked participants to correct misspelled words embedded in a business letter (Galletta et al., 2005). As predicted, participants with higher verbal ability (as measured by SAT and GMAT standardized tests) performed better than participants expected to be poor spellers in identifying a significantly greater number of spelling and homophone errors without using spell checker. Based on these results, it would seem that good spellers should have also identified significantly more homophone and spelling errors than poor spellers when given spell checker access as well. However, good and poor spellers did not significantly differ in their accurate identification of homophone errors when having access to spell checker. Since a spell checker does not detect homophone errors as accurately as other spelling errors, good spellers identified fewer homophone errors with the spell checker because they may not have thoroughly proofread the letter and were relying on spell checker to correct all misspellings. These results suggest that students of all skill levels may not be using spell checker

as an editing tool to help their proofreading, but as the only step when reviewing their work (Galletta et al., 2005).

According to the arguments of writing critics, spell checkers could weaken spelling ability if students assume spell checkers can and should do all the work (e.g., Bangert-Drowns, 1993). With repeated use of spell checker in this manner, the students may forget how to spell words they have previously learned and/or never learn how to spell a word in the first place. A possible explanation for this phenomenon lies in nodal network theories (e.g., Harm & Seidenberg, 1999; MacKay, 1987; Plaut, McClelland, Seidenberg, & Patterson, 1996; Van Orden, Pennington, & Stone, 1990). Generally speaking, these theories suggest that words and their orthography are connected through a nodal network. In order to retrieve a word's spelling from memory, the associated nodes must be activated, and the strength of the connection dictates how quickly or easily activation can spread from a word to its orthography. Specifically, Transmission Deficit Hypothesis (TDH), a corollary of Node Structure Theory predicts that word retrieval difficulty is the result of weakened connections between a word and its phonology or orthography (e.g., Burke, MacKay, Worthley, & Wade, 1991; MacKay & Burke, 1990). While node connections can strengthen with repeated practice, if node connections are not activated over time, they may become weakened, resulting in difficulty retrieving information about a word or concept (MacKay & Burke, 1990). In regards to spelling, poor spelling or inability to spell a word can be explained in terms of a weakened connection between the word and its orthography.

How do weakened connections between words and their orthography relate to students and their use of spell checker? A weakened connection limits students' access to the orthography of a word. If students type an essay with the expectation that the spell checker will identify all of their errors, they may not put as much effort into trying to spell all words correctly (Galletta et al., 2005) than if the spell checker was not available or if the students did not have those expectations. According to nodal networks, infrequently accessing or using the orthography of a word would, in the long term, weaken the connections between a word and its orthography to weaken from lack of practice. Even good spellers may consequently weaken spelling connections if they repeatedly use spell checker and do not actively work to fix their own spelling errors and keep the connections strong. Furthermore, poor spellers who rely too much on spell checker and don't attempt to correctly spell on their own may never learn how to spell particular words, resulting in node connections that never properly form (MacKay & Burke, 1990).

Students who become dependent on a spell checker are at a greater risk of submitting documents to teachers or potential employers that contain spelling errors. Furthermore, when students only use the spell checker for editing without reading through their work, they are also at a greater risk of submitting documents with

errors that spell checker did not detect (e.g., homophone errors). This poses as a potential problem in educational and employment settings because students with poor spelling skills may be at risk of being perceived as having poor writing ability (e.g., Figueredo & Varnhagen, 2005) or of being somehow intellectually inferior (e.g., Kreiner, Schnakenberg, Green, Costello, & McClin, 2002).

However, this is not meant to paint a pessimistic view of spell checkers. Despite the limitations in its ability to detect homophone errors and the potential consequences of becoming dependent on spell checkers, the software does have advantages. Research indicates that spell checkers have improved the writing quality of various groups of individuals. For example, research shows improvement for students with learning disabilities (e.g., MacArthur et al., 1996), students learning English as a second language (Gupta, 1998), and second graders learning how to spell (Bosman et al., 2007). Other research suggests that these computer software programs have even made the writing process more manageable for some patients diagnosed with aphasia (Behrns, Hartelius, & Wengelin, 2009).

The benefits of spell checkers have also been investigated among a group of typical college students. In a study conducted by Hult (1985), the effects of word processing programs on writing correctness was assessed in order to determine if there were any benefits of using word processors to help improve writing mechanics (i.e., grammar, proper word usage, spelling). Here, writing correctness was defined as compositions that do not contain sentence fragments, run on sentences, faulty subject verb agreements, contradictory modifications, incorrect use of possessives, improper punctuation, wrong words, or spelling errors. Results of this study showed that word processing programs were beneficial in decreasing the number of spelling errors in student papers. Hult concluded that while word processing programs do not necessarily produce better written papers, the use of a spell checker results in a significantly greater percentage of correctly spelled words.

The purpose of the present experiment was not only to provide an update to the literature exploring spell checker, given the changes that have taken place over the last 20 years, but also to determine how access to spell checker software may impact spelling performance of good and poor spellers during the editing process. Currently, the majority of the existing research primarily focuses on students with learning disabilities (e.g., MacArthur et al., 1996) or students learning how to write (Bosman et al., 2007; Gupta, 1998). There is very limited research regarding the effects spell checker has on typical college students, and how the software is being used as an editing tool. While Hult's (1985) study included college students with no learning or language difficulties, the results may not be representative of how current college students use spell checker. More recent research (Galletta et al., 2005) investigated how college students perceive spell checker credibility. However, Galletta et al. (2005) did not explore the production of writing, and only

asked participants to recognize misspellings and correct them. Furthermore, the use of a self-report measure that assesses how participants use spell checker during the revision process would be useful in providing further insight into the proofreading practices of college students. No research, to date, has examined this aspect of students' perception of spell checker.

The present study attempted to bridge these gaps by asking college aged students to complete a series of tasks aimed at asking participants to use (or not use) spell checker to recognize and produce the spelling of words. Participants also completed a baseline spelling test which classified participants as good or poor spellers. A questionnaire regarding proofreading practices and the use of spell checker as an editing tool was also administered for further information regarding their perception of the usefulness and their expectations of this tool.

Researchers' predictions for good and poor spellers compared homophone errors to spelling errors in general. While many types of spelling errors exist, the present research compared homophone errors to other types of spelling errors in general. No other delineation among types of errors were made primarily because this allowed the researchers to compare errors that spell checker software would catch to errors that it wouldn't. Similar to results presented in Galletta et al. (2005), the researchers predicted that good spellers would identify and correctly fix more spelling and homophone errors without spell checker during the recognition activity when compared to poor spellers. However with spell checker, good and poor spellers were not expected to differentially identify or correctly fix spelling and homophone errors. Based on the delineation demonstrated between high and low verbal individuals in Galletta et al. (2005) and the weakened connections predicted by nodal network theories, it was also expected that when writing a short story poor spellers, when compared to good spellers, would produce more homophone and spelling errors without spell checker than with spell checker. However, with spell checker, poor and good spellers would not differ in the percentage of spelling and homophone errors produced.

Method

Participants

Sixty-four college students (39 females, 25 males) were recruited from five introductory psychology courses at a comprehensive regional college in western New York to participate in this study. There were a total of 36 first-year, 16 second-year, 7 third-year, and 5 fourth-year students. The mean age of participants was 19 years ($SD = 1.5$, Range = 18–27). All participants were native speakers of American

English with normal, or corrected-to-normal, vision and hearing and no documented learning disabilities.

32 participants were classified as poor spellers, and 32 participants were classified as good spellers, similar to the distinction made by Margolin & Abrams (2007), based on a median split of scores on the Baseline Spelling Test (see below). A median split of the scores was used in order to maximize inclusion of participants. The median spelling test score of all participants was 37% ($M = 36\%$, $SD = 16\%$, Range = 3%–75%). Participants with spelling test scores above 37% were considered good spellers (compared to the group that was sampled) whereas participants below the median were classified as poor.

Materials

Baseline Spelling Test

Participants completed an auditorily administered Baseline Spelling Test which consisted of 40 words that were commonly misspelled 20–80% of the time in previous studies of spelling (e.g., Margolin & Abrams, 2007). These selected words were also low in written frequency ($M = 3.4$, $SD = 2.8$, Range = 0–9; Francis & Kucera, 1982), and were between six and 11 letters long (e.g., *brilliance*, *massacre*, and *broccoli*).

Questionnaire

An 11 item questionnaire was created. Questions asked about gender, age, major, year in college, and whether or not they have been diagnosed with a learning disability for purposes of exclusion. Additional questions pertained to participants' use of spell checker and their perceptions of spelling ability. For example, one question asked participants to *describe the process [you] take when editing/proof-reading essays/and or papers for spelling and grammatical errors*. Another asked participants to rate on a Likert scale (5 = excellent, 4 = very good, 3 = fair, 2 = bad, 1 = very bad) how good of a speller they think they are and how often they *put less effort into spelling words the best [they] can while typing an essay/paper because spell checker will correct the mistakes* (5 = always, 4 = very often, 3 = sometimes, 2 = rarely, 1 = never).

Pre-written short story (Recognition activity)

The recognition activity used a 454 word short story that was typed, double spaced in 12 point Times New Roman font containing 25 spelling errors and 25 homophone errors. Homophone errors were defined as words that are pronounced the same way, but have different meanings and spelling (i.e., *sore* vs. *soar*). In the story, the sentence "My back is soar," contains a homophone error because the word

soar is the wrong version of the homophone. A spelling error refers to words that are misspelled, and the misspelling does not form an existing word (couch vs. cowch). The story was written by the experimenter, and was about a person waking up confused in a room filled with strange objects and strange noises behind a door. After experiencing heightened feelings of anxiety, the protagonist wakes up and realizes it was a dream. The pre-determined spelling errors in the story were also selected from Margolin & Abrams's (2007) word list of frequently misspelled words (e.g., *ceremony* spelled as *ceramony*, *plausible* spelled as *plausable*, and *occurrence* spelled as *occurance*) and ranged from being misspelled 2% to 77% of the time. Importantly, the words selected for this story were different from the words selected for the baseline spelling test.

Picture prompt (Production activity)

A picture prompt was selected for the production activity. The prompt was a photo of a young girl looking to the side with her arms folded over a car tire and a man kneeled down in the background fixing a car. The photo was created by Stockbyte/Getty Images and was retrieved from fictionwriting.about.com, and was printed on a color printer and presented to participants on an 8 ½" x 11" sheet of paper.

Design

The recognition activity used a $2 \times 2 \times 2$ factorial design, with type of speller (good and poor), type of error (homophone and spelling error), and presentation (with spell checker and without spell checker) as factors. Type of speller and mode of presentation were between subjects factors whereas type of error was a within subjects factor. The dependent variables were accuracy of error recognition and accuracy of error correction, where accuracy of error recognition referred to participants receiving credit for correctly identifying a word that is misspelled even if they did not provide the correct spelling, and accuracy of error correction referred to participants providing the correct new spelling of a word. In other words, the percentage of homophone (out of 25) and spelling errors (out of 25) that each participant accurately recognized and accurately corrected was recorded.

The production activity used a $2 \times 2 \times 2$ factorial design, with type of speller (good and poor), type of error (homophone and spelling error), and presentation (with spell checker and without spell checker) as factors. Type of error and mode of presentation were within subjects factors, and type of speller was a between subjects factor. The dependent variables were the proportion of homophone and spellings errors produced. In order to counterbalance this design, one half (32) of the participants started with the recognition activity and the other half started with the production activity. Within the production activity, all participants

completed one half of the session using spell checker and one half of the session without spell checker, with the order counterbalanced here as well.

General procedure

An appointment log with different dates and time slots was posted so that participant volunteers could sign up for a session with the experimenter. Each participant was seen individually, and participant numbers were assigned on a first come- first serve basis. Prior to starting each session, the experimenter provided an informed consent form for participants to sign and instructions on the tasks they were to complete.

For the recognition task, participants read the pre-written short story on Microsoft Word 2010 on a desktop Dell OPTIPLEX 380 personal computer equipped with an Intel Core 2 Duo 2.93GHz processor and a 17-in. monitor. One half of the participants read the short story with spell checker activated, while the other half of the participants read the story with spell checker deactivated. Participants were instructed to identify and correct all of the misspellings without knowledge of how many errors or what types of errors would be present in the story. Participants italicized misspelled words to indicate that a spelling error was identified, and then corrected these misspelled words by changing each word to the correct spelling. The participants had unlimited time to complete this activity. Upon completion, participants informed the experimenter when finished and the percentage of homophone (out of 25) and spelling errors (out of 25) that each participant accurately recognized and accurately corrected was recorded.

For the production activity, participants were shown the picture prompt and were then instructed to write a one page, double spaced short story in Microsoft Word 2010, using 12pt. Times New Roman font using the photo as a prompt. Depending upon which condition each participant was randomly assigned, participants were instructed to type the first half (one half the page, demarcated by the ruler tool in Microsoft Word) of the story with the spell checker function enabled or disabled. Upon completion of typing the first half, participants notified the experimenter. Participants were then told to briefly step out of the room, while the experimenter opened a new Microsoft Word document and either enabled or disabled the spell checker function (depending on how they had written the first half). Similar to the recognition activity, there was no pre-determined time limit to complete the task. However, the maximum amount of time to completion did not exceed 30 minutes.

After participants completed the recognition and production activities, the baseline spelling test was administered and was followed by the questionnaire. For the baseline spelling test, each word was read aloud to the participant and

was repeated if the participant wished to hear the word again. Participants wrote down their spelling of each word on a preprinted answer sheet. Participants were thanked for their participation, debriefed, and given credit for their psychology course requirement for their participation.

Results

Self-report of spelling behavior

Participants were asked to give self-report of several spelling behaviors. Means and standard deviations are presented in Table 1. Good and poor spellers were asked to rate their own spelling ability on a Likert scale from 1 to 5, where 1 indicates very poor spelling ability and 5 indicates excellent spelling ability. An independent-samples t test comparing the mean ratings of good and poor spellers found a significant difference between the two groups, $t(62) = 5.28, p < .001$, where poor spellers rated themselves lower in spelling ability ($M = 2.75, SD = .76$) than good spellers ($M = 3.66, SD = .60$). Good and poor spellers were also asked how often they put less effort into spelling words the best they can while typing an essay based on the belief that spell checker will correct spelling mistakes. Responses were also rated on a Likert scale from 1 to 5, where 1 indicates never and 5 indicates always. The results showed a significant difference in putting less effort into spelling words between poor ($M = 3.31, SD = 1.15$) and good spellers ($M = 2.5, SD = 1.11$) indicating that poor spellers place less effort into spelling words correctly more often, $t(62) = 2.77, p = .008$. However, no significant differences were found between good ($M = 4.03, SD = 1.06$) and poor spellers ($M = 4.32, SD = .93$) on how often they use spell checker to find and correct spelling errors after writing an essay, $t(62) = 1.26, p = .25$, and how often good ($M = 1.97, SD = .82$) and poor ($M = 2.13, SD = 1.04$) spellers use spell checker without re-reading their work, $t(62) = .67, p = .50$. There were also no significant differences between good ($M = 4.09, SD = .73$) and poor spellers ($M = 4.06, SD = 1.05$) on how often they use spell checker and read through their work, $t(62) = .14, p = .89$.

In addition to the above ratings, all participants were asked in an open-ended manner to *describe the process you take when editing/proofreading your essays and/or papers for spelling and grammatical errors*. Participant responses were tallied, such that responses identifying the same behavior were grouped together, and a total of seven different proofreading behaviors were reported across participants. These behaviors were: use of spell/grammar checker, rereading papers, peer editing, use of dictionary/thesaurus, printing paper copies to hand edit, no rereading after spell checking, and does not use spell/grammar checker. The number

Table 1. Self-report of spelling behavior descriptive measures for good and poor spellers (Likert 1–5)

	Good spellers <i>M</i> (<i>SD</i>)	Poor spellers <i>M</i> (<i>SD</i>)
Spelling ability	3.66 (.60)	2.75 (.76)
Putting in less effort	2.50 (1.11)	3.31 (1.15)
Frequency of using spell checker	4.03 (1.06)	4.32 (.93)
Using spell checker without re-reading	1.97 (.82)	2.13 (1.04)
Using spell checker and re-reading	4.09 (.73)	4.06 (1.05)

of participants that engaged in each behavior was recorded and used to calculate percentages on the most commonly reported proofreading practices. Out of the 64 participants, 83% reported that they re-read their work, 81% reported regularly using a spell/grammar checker, 44% reported engaging in some form of peer-editing, 8% reported that they prefer to print a paper copy of their work and then made corrections with a pen, 5% reported that they use a dictionary or thesaurus, and 3% reported to never using spell/grammar checker. Still another 2% reported that they do not re-read their work after using spell checker.

Recognition activity

For identifying the errors in the recognition activity, a 2 (Type of speller) × 2 (Presentation) × 2 (Type of error) ANOVA was conducted. Results showed significant main effects of type of speller, $F(1, 60) = 20.71$, $MSE = .73$, $p < .001$, $\eta^2 = .13$, presentation, $F(1, 60) = 41.89$, $MSE = 1.48$, $p < .001$, $\eta^2 = .26$, and type of error, $F(1, 60) = 10.46$, $MSE = .26$, $p = .002$, $\eta^2 = .05$. These main effects were moderated by two two-way interactions, while the three-way interaction between type of speller, presentation, and type of error was not significant, $p = .090$. The interaction between type of speller and type of error, $F(1, 60) = 4.44$, $MSE = .11$, $p = .039$, $\eta^2 = .02$, showed that good and poor spellers differed in their recognition of homophone errors, $p < .001$, such that good spellers recognized more homophone errors than poor spellers. However, good and poor spellers did not differ in their recognition of spelling errors, $p = .090$. The interaction between presentation and type of error was also significant, $F(1, 60) = 117.73$, $MSE = 2.94$, $p < .001$, $\eta^2 = .52$. Follow up tests showed that, spelling errors were detected more often with spell checker than without, $p < .001$, but these tests revealed no significant differences in the detection of homophone errors whether spell checker was used or not, $p = .21$.

For accurately correcting errors in the recognition activity, a 2 (Type of speller) × 2 (Presentation) × 2 (Type of error) ANOVA was conducted. Results showed

significant main effects for type of speller, $F(1, 60) = 24.01$, $MSE = .90$, $p < .001$, $\eta^2 = .14$, and presentation, $F(1, 60) = 49.07$, $MSE = 1.83$, $p < .001$, $\eta^2 = .29$. No significant main effect was revealed for type of error, $p = .327$. These main effects were moderated by three significant interactions. The three-way interaction of type of speller, presentation, and type of error was significant, $F(1, 60) = 4.38$, $MSE = 1.47$, $p = .041$, $\eta^2 = .02$ (see Table 2 for means and standard deviations). Good and poor spellers were able to accurately correct more spelling errors with spell checker than without, $p < .001$, but the difference between the percentage of spelling errors corrected with and without spell checker was much smaller for good spellers than for poor spellers. Follow-up tests showed no significant differences in accurately correcting more homophone errors whether spell checker was used or not among good spellers, $p = .171$, as well as with poor spellers, $p = .370$. The interaction between type of error and type of speller, $F(1, 60) = 4.15$, $MSE = .10$, $p = .046$, $\eta^2 = .02$, showed that good and poor spellers differed in their accurate correction of homophone errors, $p < .001$, such that good spellers accurately corrected more homophone errors than poor spellers. However, they did not differ in accurately correcting spelling errors, $p = .06$. The interaction between type of error and presentation was also significant, $F(1, 60) = 135.47$, $MSE = 3.31$, $p < .001$, $\eta^2 = .52$. Spelling errors were accurately corrected more often with spell checker than without, $p < .001$. However, whether spell checker was used or not, no significant differences were found with the number of homophone errors corrected, $p = .251$.

Table 2. Percentage of spelling errors corrected among good and poor spellers

Mode of presentation	Good spellers		Poor spellers	
	<i>n</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>
With spell checker	17	92 (.09)	15	93 (.09)
Without spell checker	15	48 (.17)	17	25 (.11)

Production activity

For examining the errors produced during the production activity, a 2 (Type of speller) \times 2 (Presentation) \times 2 (Type of error) ANOVA was conducted on the raw number of errors produced. Table 3 displays the means and standard deviations. Results showed significant main effects of type of speller, $F(1, 62) = 13.07$, $MSE = 2.26$, $p = .001$, $\eta^2 = 0.12$, presentation, $F(1, 62) = 55.91$, $MSE = 1.09$, $p < .001$, $\eta^2 = .24$, and type of error, $F(1, 62) = 41.54$, $MSE = 1.77$, $p < .001$, $\eta^2 = .29$.

These main effects were moderated by several significant interactions. The interaction between type of error and type of speller was significant, $F(1, 62) = 8.78$, $MSE = 1.77$, $p = .004$, $\eta^2 = .06$, such that while there was a significant difference between the mean number of homophone errors and spelling errors for both good spellers, $p < .001$, and poor spellers, $p < .001$, this difference was larger for poor spellers. The interaction between presentation and type of speller was also significant, $F(1, 62) = 16.06$, $MSE = 1.09$, $p < .001$, $\eta^2 = .07$, such that more errors were made without spell checker than with spell checker for both good spellers, $p < .001$, and poor spellers, $p < .001$, but this difference was larger for poor spellers. The interaction between type of error and presentation was significant, $F(1, 62) = 38.49$, $MSE = 1.12$, $p < .001$, $\eta^2 = .17$, such that for homophone errors, $p = .007$, and spelling errors, $p < .001$, participants produced more errors without spell checker than with spell checker. However, this difference was larger for spelling errors than for homophone errors.

Table 3. Number of homophone and spelling errors produced among good and poor spellers

		Good spellers	Poor spellers
Mode of presentation	Type of error	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
With spell checker	Homophone error	.03 (.18)	.13 (.42)
	Spelling error	.22 (.49)	.44 (.95)
Without spell checker	Homophone error	.09 (.30)	.38 (.49)
	Spelling error	1.06 (1.29)	3.19 (3.02)

Importantly, these interactions were, moderated by the significant three-way interaction of type of speller, presentation, and type of error, $F(1, 62) = 10.56$, $MSE = 1.12$, $p = .002$, $\eta^2 = .05$. Follow-up tests of this interaction revealed that for poor spellers, the effect of presentation was significant both when making homophone errors, $p = .009$, and spelling errors, $p < .001$, such that participants made more errors without spell checker than with spell checker. However, this effect was larger when poor spellers made spelling errors than when making homophone errors. Good spellers showed no significant effect of presentation for homophone errors, $p = .325$, but did show this effect to be significant when making spelling errors, $p < .001$, such that more spelling errors were made without spell checker than with spell checker.

Discussion

The present study investigated whether college students who were good and poor spellers were using spell checker differently in recognition and production of spelling. The data show significant differences between good and poor spellers' spelling performance under different spell checker circumstances. Poor spellers showed better performance during the recognition and production activities with spell checker, whereas spell checker did not demonstrate the same strong impact for good spellers. For the recognition task, there was a larger influence of the spell checker on correction of spelling for poor spellers than for good spellers. This suggests that the spell checker provided a greater advantage to poor spellers in correcting spelling errors, and is consistent with earlier research involving spell checker. It also supports the ideas put forth by the Transmission Deficit Hypothesis, which indicate what poor spellers may have weaker connections between words and their orthography. That is, if the connections were stronger, then poor spellers would more easily access orthography for recognition or production tasks. Furthermore, it is consistent with what the literature currently shows regarding spell checker, which suggests that spell checkers may help improve the writing quality among specific populations (i.e., students with learning disabilities, ESOL students, etc.) who may be more likely to encounter spelling difficulties (e.g., Behrns et al., 2009; Bosman et al., 2007; Gupta, 1998; & MacArthur et al., 1996). Poor spellers may be just one more group of individuals who may experience the benefits of this software. However in the present research, the benefits of the spell checker did not extend to correcting homophone errors. This result may be because a spell checker does not detect homophone errors the way it does spelling errors, and this finding supports research that indicates spell checker is not 100% accurate in detecting and correcting different types of spelling mistakes (e.g., Dobrin, 1990; Bosman et al., 2007; Galletta et al., 2005; MacArthur et al., 1996).

During the production task, all participants produced fewer spelling errors when using spell checker than when not using spell checker, but this difference did not hold for homophone errors. Additionally, poor spellers produced more overall errors (there was no difference here for the type of error) without spell checker than with spell checker, but there were no significant differences in the proportion of overall errors produced with or without spell checker for good spellers. These findings indicate that while spell checker may be useful for all individuals, it may not provide the same benefit for good spellers as for poor spellers. Additionally, these findings suggest that poor spellers may have a greater need for spell checker software than good spellers, again supporting the idea that poor spellers may have weaker connections to words' orthography. The weaker the connections, the more difficulty a speller will have accessing the correct spelling of a word.

Data from the recognition task showed that good spellers overall were better able to recognize and change homophone errors to the correct version of the word than poor spellers, regardless of whether they used or didn't use spell checker. This supported the prediction that good spellers would identify and correct more homophone errors than poor spellers if they did not have access to spell checker, but the prediction that with spell checker there would be no significant differences in correcting homophone errors between good and poor spellers was not supported. Instead, these results suggest that good spellers were able to recognize and correct more homophone errors than poor spellers, regardless of whether a spell checker was used or not. These findings are inconsistent with results from Galletta et al. (2005), who showed that students expected to be good spellers did not differ from students who were expected to be poor spellers in identifying and correcting homophone errors when using spell checker. Results from the current study indicate that good spellers were not as influenced by the use of spell checker in the accurate identification and correction of homophone errors, as those in Galletta et al. (2005), however Galletta et al. (2005) only examined spelling recognition. The inconsistency in these findings could be the result of specific characteristics of the good spellers in the present study. Perhaps the good spellers had better proof-reading practices or were more internally motivated and rewarded by the satisfaction they felt when finding the errors. However, this is purely speculative. Despite this inconsistency, good spellers still significantly identified more homophone errors than poor spellers when not using spell checker (Galletta et al., 2005), which suggests, in conjunction with the current study's findings, that good spellers are more naturally adept than poor spellers in identifying and correcting homophone errors in general. However, with regard to spelling errors, the advantage held by good spellers does not seem to hold. Regardless of which spell checker condition participants were assigned, good spellers did not differ significantly from poor spellers in identifying and correcting more spelling errors. Likely, this results from the fact that spelling errors are more obvious mistakes, whereas homophone errors were errors that created real words.

While the results of the present study highlight the benefits and limitations of spell checker during recognition and production tasks for good and poor spellers, the differences in the performance between good and poor speller is notable. The data suggest that poor spellers may benefit much more from spell checker than good spellers, and demonstrate a greater need for the software. While such a tool can be helpful to poor spellers increase the number of correctly spelled words, they also are at risk of becoming dependent on spell checker to spell for them, particularly if they falsely believe that spell checker can catch all of their mistakes.

According to the questionnaire data collected here, poor spellers rated themselves as having lower spelling ability than good spellers, which means poor

spellers are aware of their spelling difficulties. Furthermore, when compared to good spellers, poor spellers admitted to placing less effort into spelling words the best they can while typing a paper based on the belief that spell checker will correct all of their spelling errors. While this may have been a cover for these participants, rather than admitting that they made errors despite the effort, this is unlikely the case because the questionnaire asked about their behavior in general and not about their specific performance during the experimental session. This would leave less reason for participants to generally make this claim about other writing the researcher would never see.

Placing less effort into spelling words because of the assumption that spell checker is always accurate, suggests that poor spellers may be relying on it too much, and potentially reinforces the belief that poor spellers don't need to learn how to spell words on their own. This can be problematic for poor spellers in several ways, as Transmission Deficit Hypothesis explains. According to this hypothesis, the lack of practice of properly spelling words may result in connections between a word and its orthography to weaken, or in some cases, never fully form resulting in difficulty retrieving the correct spellings of words (Burke et al., 1991; MacKay, 1987; MacKay & Burke, 1990). Poor spellers also face the possibility of being negatively perceived as less intelligent, particularly if they make frequent spelling errors in their writing (e.g., Figueredo & Varnhagen, 2005; Kreiner et al., 2002). Since poor spellers were found to be less inclined than good spellers at correcting and detecting spelling errors, they are at a higher risk of being negatively evaluated by their peers, professors, or potential employers (Russell, 2009).

However, this study is not without its limitations. First, the level of skill in typing abilities was not assessed for these participants. Although all participants were college students who are required to use and be familiar with computers for email and word processing, a lower skill in this domain could have affected the production task both with and without spell checker. Secondly, the level of spelling ability among this college student sample was rather low based on results from the baseline spelling test. Even though participants were able to be classified as good or poor spellers, the overall median of the spelling test, as mentioned earlier, was a 36% out of a 100%. While not out of the realm of reason, given that the words chosen for this baseline test were words that were misspelled between 20 and 80% of the time in previous research (e.g., Margolin & Abrams, 2007), perhaps the words on the spelling test were too difficult for those in this sample, and a better selection of spelling words could have been used. Finally, the present research did not evaluate but one sample of the writers' products, and forced the writers to produce a particular type of sample. This did not allow researchers to examine the kind of writing that these individuals ordinarily produce.

Despite these limitations, the current study does bring to light both the benefits of spell checker as well as the potentially negative consequences spell checker dependency (should it occur) may have on poor spellers in educational and professional settings. While spell checker does have its advantages and can be a helpful aid in improving the overall spelling quality for individuals with spelling difficulties, spell checker dependency puts students at risk for developing poor proofreading practices and may hinder the processes of learning how to spell by limiting practice. To counteract these issues, it may be beneficial for teachers to explain to students, particularly those with spelling difficulties, why it is important that spell checker cannot be solely responsible in identifying overall errors, and why students should not blindly accept all misspelled word suggestions (e.g., Anderson-Inman & Knox-Quinn, 1996; Bangert-Drowns, 1993). In other words, students should be taught to read through their essays to find spelling errors in conjunction with spell checker during the proofreading process.

Additional research into preventative measures is needed, since the present study did not investigate potential solutions for over-reliance on spell checker among students. For instance, the role of reading (academic and leisure) among participants may be useful in exploring whether the amount of time spent reading has an impact on individuals' spelling ability and whether this differs for good or poor spellers. Alternatively, could deliberate, systematic, or programmatic increases in reading improve spelling ability or support the connections between words and their orthography for poor spellers specifically? Further research and increasing awareness within educational institutions of the problems poor spellers may endure rather than relying too much on spell checker is encouraged.

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References

- Anderson-Inman, L., & Knox-Quinn, C. (1996). Spell checking strategies successful students. *Journal of Adolescent & Adult Literacy*, 39, 500–503. Retrieved from <http://www.jstor.org/stable/40014042>
- Bangert-Drowns, R. L. (1993). The word processor as an instructional tool: A meta analysis of word processing in writing instruction. *Review of Educational Research*, 63, 69–93. doi: 10.3102/00346543063001069

- Behrns, I., Hartelius, L., & Wengelin, A. (2009). Aphasia and computerized writing aid supported treatment. *Aphasiology*, 23, 1276–1294. doi: 10.1080/02687030802436892
- Bosman, Anna M. T., van Huygevoort, M., Bakker, Joep T. A., & Verhoeven, L. (2007). Learning to spell in second grade using the spelling checker. *Written & Language Literacy*, 10, 163–183. doi: 10.1075/wll.10.2.01bos
- Burke, D. M., Mackay, D. G., Worthley, J. S., & Wade, E. (1991). On the tip of the tongue: What causes word finding failures in young and older adults? *Journal of Memory and Language*, 30, 542–579. doi: 10.1016/0749-596X(91)90026-G
- Dobrin, D. N. (1990). A limitation on the use of computers in composition. In D. H. Holdstein & C. L. Selfe (Eds.), *Computers and writing: Theory, research, practice* (pp. 40–57). New York: Modern Language Association of America.
- Figueredo, L., & Varnhagen, C. K. (2005). Didn't you run the spell checker? Effects of type of spelling error and use of a spell checker on perceptions of the author. *Reading Psychology*, 26, 441–448. doi: 10.1080/02702710500400495
- Francis, W. N., & Kucera, H. (1982). *Frequency analysis of English usage*. Boston, MA: Houghton Mifflin.
- Galletta, D. F., Durcikova, A., Everard, A., & Brian, M. J. (2005). Does spell checking software need a warning label? *Communications of the ACM*, 48(7), 82–86. doi: 10.1145/1070838.1070841
- Gupta, R. (1998). Can spelling checkers help the novice writer? *British Journal of Educational Technology*, 29, 255–266. doi: 10.1111/1467-8535.00068
- Harm, M. W., & Seidenberg, M. S. (1999). Phonology, reading acquisition, and dyslexia: insights from connectionist models. *Psychological review*, 106(3), 491. doi: 10.1037/0033-295X.106.3.491
- Hult, C. (1985, March). *A study of the effects of word processing on the correctness of student writing*. Paper presented at the 36th Annual Meeting of the Conference on College Composition and Communication, Minneapolis, MN.
- Kreiner, D. S., Schnakenberg, S. D., Green, A. G., Costello, M. J., & McClin, A. F. (2002). Effects of spelling errors on the perception of writers. *Journal of General Psychology*, 129, 5–17. doi: 10.1080/00221300209602029
- MacArthur, C. A., Graham, S., Haynes, J. B., & DeLaPaz, S. (1996). Spelling checkers and students with learning disabilities: Performance comparisons and impact on spelling. *The Journal of Special Education*, 30, 35–57. doi: 10.1177/002246699603000103
- MacKay, D. G. (1987). *The organization of perception and action: A theory for language and other cognitive skills*. New York: Springer-Verlag. doi: 10.1007/978-1-4612-4754-8
- Mackay, D. G., & Burke, D. M. (1990). Cognition and aging: A theory of new learning and the use of old connections. In Thomas M. Hess (Eds.), *Aging and Cognition: Knowledge Organization and Utilization* (pp. 213–263). North Holland: Elsevier Science Publishers. doi: 10.1016/S0166-4115(08)60159-4
- Margolin, S. and Abrams, L. (2007). Individual differences in young and older adults' spelling: Do good spellers age better than poor speller? *Aging, Neuropsychology and Cognition*, 14, 529–544. doi: 10.1080/13825580600826462
- Plaut, D. C., McClelland, J. L., Seidenberg, M. S., & Patterson, K. (1996). Understanding normal and impaired word reading: computational principles in quasi-regular domains. *Psychological review*, 103(1), 56. doi: 10.1037/0033-295X.103.1.56
- Russell, C., (2009). "It sais I have a D how that be." *Journal of College Science Teaching*, 39, 84–86. Retrieved from <http://www.etitlib.org/p/105524>

Van Orden, G. C., Pennington, B. F., & Stone, G. O. (1990). Word identification in reading and the promise of subsymbolic psycholinguistics. *Psychological review*, 97(4), 488.
doi: 10.1037/0033-295X.97.4.488

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