# Preliminary Experiments Toward Personalized Nudging Strategies for Extensive Reading of English

**Sadafumi Tonomoto**
**Motoi Iwata**
**Koichi Kise**
tonomoto@m.cs.osakafu-u.ac.jp
iwata@cs.osakafu-u.ac.jp
kise@cs.osakafu-u.ac.jp
Dept. of Computer Science and Intelligent Systems,
Graduate School of Engineering,
Osaka Prefecture University
Sakai, Osaka Japan

## ABSTRACT

Extensive reading is a way of improving language ability by just reading a lot. Although there are some recommended rules to follow, it is sometimes difficult to sustain the user's engagement in reading. It would be helpful to have the technology for sustainment. In this paper we report our first trial to establish nudging strategies for this purpose. From the experiments with 29 participants for 25 days in total, we have found that setting the goal of the amount of reading, as well as sharing the goal with a peer group of users with a similar ability is effective nudging strategies. Although the goal setting is not effective to the majority of users, we have been successful to prepare a prescription by which

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

*COBI2020, April 25, 2020, Honolulu HI, USA.*

© 2020 Copyright held by the owner/author(s).

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM.
https://doi.org/10.1145/nnnnnnn.nnnnnnn

users with positive effects are selected based on their personal traits and the amount of reading. From the results, we are able to approach to personalized nudging strategies.

## CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

## KEYWORDS

extensive reading, nudging strategy, wordometer, prescription, goal setting, peer group

**ACM Reference Format:**
Sadafumi Tonomoto, Motoi Iwata, and Koichi Kise. 2020. Preliminary Experiments Toward Personalized Nudging Strategies for Extensive Reading of English. In *Proceedings of the CHI 2020 Workshop on Detection and Design for Cognitive Biases in People and Computing Systems, April 25, 2020, Honolulu HI, USA. .* ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

## INTRODUCTION

Extensive reading [1] — simply reading a lot of text is a promising way to improve language skills. The following three principles are important to keep the user reading: (1) do not look up the dictionary, (2) do not hesitate to skip the part difficult to understand, (3) skip the whole document and find the next if the reader does not like it. However, it is not easy for some readers to keep reading a lot by simply following the principles. In order to prevent them from the dropout, it is necessary to sustain user engagement.

In this paper, we propose a method to sustain user engagement in the case of extensive reading of English text. Our method employs some "actuators" such as showing the total number of read words to sustain/improve the engagement. An important issue is that the effectiveness of an actuator sometimes depends on the user; an actuator is effective for some users but ineffective for others. The effectiveness is also dependent on the parameters of an actuator, e.g., when and how to show the number of read words, as well as the combination with other actuators.

In order to apply actuators that can sustain/improve the engagement of the user, we prepare a prescription of a combination of actuators with appropriate parameter values. We call it the nudging strategy. In other words, we consider personalized nudging strategies implemented as their prescriptions are mandatory for sustaining the engagement of many users.

This paper reports our first trial to establish nudging strategies for extensive reading of English. We have tried the following four actuators as building blocks of the nudging strategies: (1) showing the number of read words, (2) setting the goal of the number of read words, (3) finding the location and the time for frequent reads, (4) sharing the number of read words within a peer group. Based on the experiments with 29 participants for 25 days in total, we have established that two nudging

[1] https://en.wikipedia.org/wiki/Extensive_reading

strategies with actuators (2) and (4) are effective in sustaining/improving user engagement. Although the nudging strategy with (4) is effective for the majority of users (75%), the nudging strategy (2) is not (63%). This problem has been solved by preparing a classifier that selects users with positive effects. This allows us to increase the effectiveness up to 85% for the selected users. This research has been approved by the ethical committee of the graduate school of engineering, Osaka Prefecture University.

## RELATED WORK

Nudge is a concept of positive reinforcement and indirect suggestions as ways to influence the behavior and decision making [10]. It has been widely investigated in many fields, including human-computer interaction [3]. Nudging for learning has been attempted by researchers in many different ways. Here we focus on two research trials that are most relevant to our research. One is about the effectiveness of the goal setting, and the other is about the use of peer groups.

Clark *et al.* have employed the goal setting to use "loss aversion" about missing the goal, as well as to stimulate the self-efficacy when it is completed [5]. They tried two different goals for college students: the task-based goal measured by the amount of learning and the performance-based goal by the score of the achievement test. They found that the former is more effective than the latter, because of less uncertainty of the goal.

Carrell *et al.* have investigated the effect of peer groups by changing members with various abilities for freshmen of the US Air Force Academy [4]. When the peer group includes students with high and low abilities, there is no difference for the high ability students but the performance of low ability students tends to be lower. On the other hand, the peer group formed by students with similar ability is effective to improve the performance.

The above related work has given some guidelines to build nudging strategies in the context of learning. The goal is better to be about the task-based, and the peer group should be formed by taking into account the ability of members.

## PROPOSED METHOD

### Overview

In order to evaluate the effectiveness of nudging strategies for extensive reading, we have built a system shown in Figure 1. The user reads English documents through the application called "wordometer," which is to estimate the number of read words [9]. Based on the estimated read words, feedback is given to the user based on nudging strategies. The effectiveness of each nudging strategy is recorded as a learning experience, along with the user's personal trait. We make the prescription of each nudging strategy based on their effectiveness and personal traits.

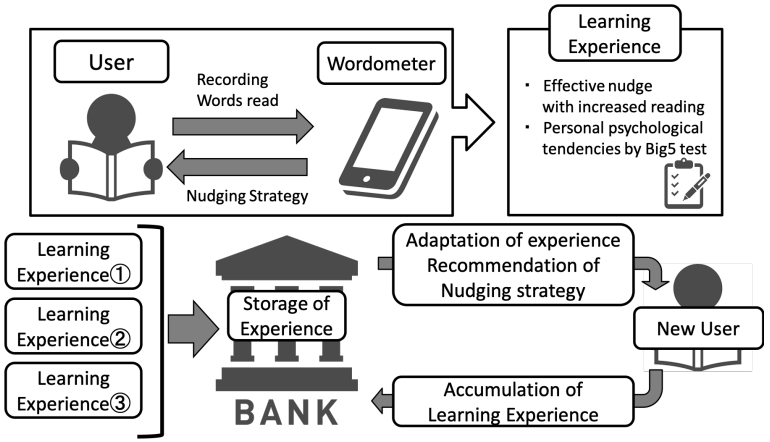


**Figure 1: A system for extensive reading.**

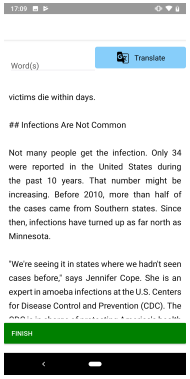


**Figure 2: Wordometer for reading English documents.**

We collect such learning experiences with their prescriptions and store them in the experience bank. A new user can find nudging strategies that fit to him/her by matching his/her personal trait with the stored ones in the bank. This allows us to realize personalized nudging strategies.

### Wordometer

We have implemented the wordometer by using several devices such as mobile and stationary eye trackers [1], as well as the EOG glass called JINS MEME [8]. In our current system, we employ a simplest version implemented on a mobile phone as shown in Figure 2, which assumes that the user reads the displayed document.

### Actuators and Nudging Strategies

As elements to build nudging strategies, we employ the following actuators (See also Figure 3).

**AC1** The number of words read on the current document, as well as the number of read words in each of the last five days are shown.

**AC2** The goal of the number of words to be read in a day is set, and the remaining amount to the goal is shown.

**AC3** Notification is sent if the user is either in the region where he/she often reads, or at the timing when he/she often reads.

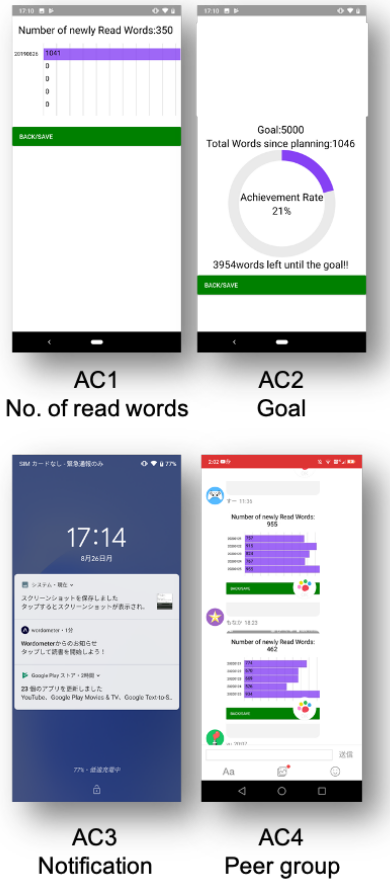


**Figure 3: Actuators.**

**AC4** A peer group is set, and the number of read words is shared within the group.

AC1 is to use the function of wordometer to let the user know the current status. AC2 is based on Clark *et al.* [5]. As the goal, we employ the number of words, which is a task-based goal like the amount of learning used by Clark *et al.* AC3 would be effective if the user reads documents at fixed locations and time, such as during the commutation. AC4 is based on Carrell *et al.* [4]. In order to set up an effective peer group, we employ a vocabulary test to make sure that the level of English in the group is similar.

Based on the above actuators, the nudging strategies are defined as combinations of actuators with specific parameter values. The important parameter of AC1, 2, 4 are "when" to apply them. Possible choices are to apply at random, with a fixed interval, at the beginning or end of the day, and before or after finishing the reading. We select the timing after reading. The best timing, which may depend on the user, will be investigated as future work. AC2 has an important parameter of the number of words set as the goal. We select 1.2–1.5 times the average of the number of read words without any actuators.

As combinations, the following nudging strategies are employed:

**NS1** The use of AC1 alone
**NS2** The combination of AC1 and AC2, because AC2 is more meaningful to know the current state of the number of read words given by AC1.
**NS3** The combination of AC1, AC2, and AC3. This is simply because we are interested in the additional effect of AC3.
**NS4** The combination of AC1 and AC4, because of the same reason as NS2.

## Recording of Experiences and Preparing Prescriptions

In order to know which are good nudging strategies for whom, we record the user's personal traits measured based on the Big-5 test [7], in addition to the performance results before and after the use of a nudging strategy. We consider that the nudging strategy is effective if the user is successful in improving the number of read words to 1.2 times of the number without any nudging strategies.

By combining the above information, we are able to prepare a prescription for each nudging strategy. This is done by defining a classifier that selects effective users for a nudging strategy. As the features for classification, we employ the following:

- the values of Big-5 test (5 dimensions)
- the result of the vocabulary test
- the number of read words without any nudging strategies

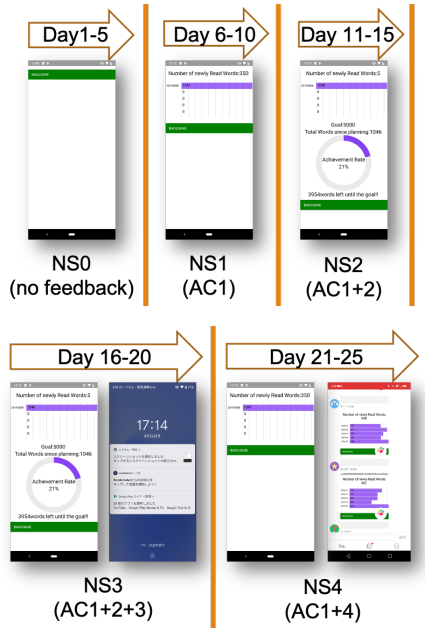


**Figure 4: Experimental procedure.**

[2]http://newsela.com

**Table 1: The number of participants who had positive effects by nudging strategies.**

| NS1 | NS2 | NS3 | NS4 |
|---|---|---|---|
| 7/29 (24.1%) | 18/29 (62.1%) | 7/14 (50.0%) | 12/16 (75.0%) |

## PRELIMINARY EXPERIMENTS

As a first step to realize personalized nudging strategies, we have experimented to collect recordings of experiences and to prepare the prescriptions.

### Experimental Conditions

The wordometer and the nudging strategies were installed to Android mobile phones and used for the experiments. Before the experiments, we asked participants of the experiments to answer the Big-5 test by Goldberg *et al.* [7] and the vocabulary test called San Diego Quick Assessment of Reading Ability [6]. During the experiments, we asked the participants to use the wordometer in their daily life.

As the documents to be read, we installed the reading materials from a news article site called Newsela [2], which have several levels of representations for a single article. By comparing the levels of articles to the user's vocabulary level, the user can select appropriate articles.

During the experiments, we systematically changed the nudging strategy to collect experiences from users, as shown in Figure 4. For the first five days (Day1–5), we did not apply any nudging strategies to know users' normal reading amount. In the next five days (Day6–10), we apply NS1 to evaluate its effect. In the following five days (Day11-15), NS2 was applied to know the effect of the goal-setting by AC2. Then we applied NS3 and NS4 during Day16–20 and Day21–25, respectively.

The participants of the experiments were as follows. For the first three nudging strategies, we employed 9 undergraduate students, 3 graduate school students, one employed person (6 males and 7 females). As the honorarium for the experiments for 20 days, a gift card of 40K JPY was given to each participant. In addition, we conducted the experiments for all four nudging strategies with six undergraduate, 10 graduate students (12 males and 4 females). They received a gift card of 30K JPY.

### Results and Discussions

Figure 5 shows the numbers of read words for each nudging strategy, by normalizing them with the number without nudging. Table 1 summarizes whether or not each nudging strategy had a positive effect on the number of read words, i.e., the normalized number of words greater than or equal to 1.2 times of the number of read words with no nudging strategy. NS1 was effective only for 1/4 of the users. NS2 was much better, though it is still unsatisfactory. NS3 was tested for 14 users who had fixed locations or the timing of reading. The effectiveness was 50%. NS4 was tested by the participants who continued to use the wordometer for 25 days. As compared to other nudging strategies, it was effective for the majority: 3/4 of the users. From this result, we have confirmed that (1) none of the nudging strategies was effective for all users, (2) some users experienced negative effects by nudging strategies, (3) the nudging strategy NS4 is effective for the majority of users, but others are not.

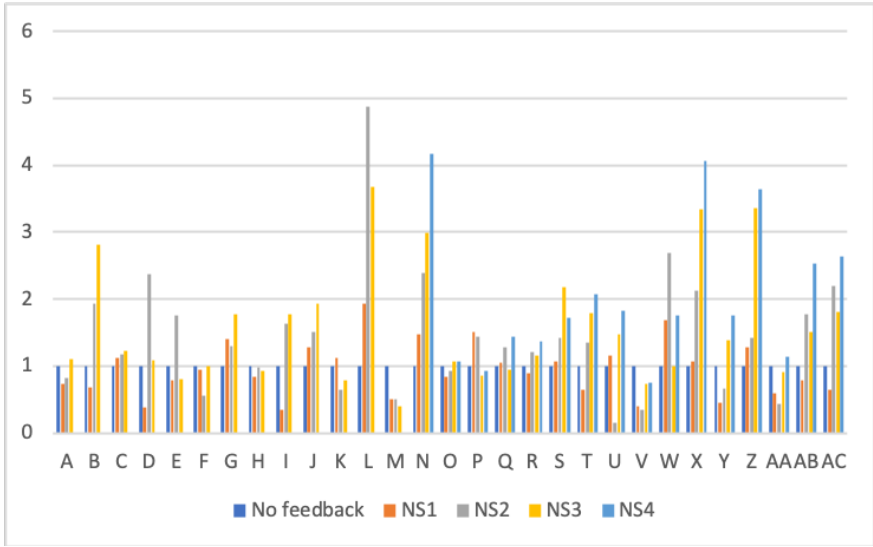


**Figure 5: The normalized number of read words after applying each nudging strategy.**

For the nudging strategy NS4, we can define its prescription that it is suitable for the majority of users. However, for other nudging strategies, we need to find to whom they are applied.

In order to evaluate whether we can prepare a prescription for the nudging strategies NS1 and NS2, we trained SVM by 4-fold cross-validation. We applied oversampling by SMOTE to deal with unbalanced labels. The result was evaluated using the balanced accuracy [2] where the chance rate is 50%. We obtained an accuracy of 50% for NS1 and 85% for NS2. As compared to the original accuracy shown in Table 1, both were improved. After applying SVM, the effectiveness of NS2 was improved to the level similar to NS4. The most important feature is the number of read words with no nudging strategy. Other features contributed to improving the accuracy to 85% — the accuracy only with the feature of the number of read words was 70%.

For NS3, we analyzed the data distribution and found that there is no clear relevance to the Big-5 scores. Other evaluation criteria should be employed to build a prescription for NS3.

## CONCLUSION

This paper presented our first trial of finding personalized nudging strategies for extensive reading of English, and the preparation of their prescriptions. Among the four nudging strategies built upon four

actuators, we have found that the goal (NS2) and the peer group (NS4) were effective. Although the latter was effective for 75% of the users, the former was for 62%. For the former case, we prepared its prescription by using SVM based on the user's Big-5 personal traits, the vocabulary level, as well as the amount of reading with no nudging strategy. As a result, the accuracy of expectation to be effective was improved to 85%. On the other hand, we were not able to prepare prescriptions for the remaining two nudging strategies.

Future work includes the increase of the number of participants of the experiments as well as the duration in addition to the trials of different nudging strategies. To know whether the effect of nudging strategies can last longer is also an important future work.

## ACKNOWLEDGMENT

This work was supported in part by the grant JST CREST No. JPMJCR16E1.

## REFERENCES

[1] Olivier Augereau, Charles Lima Sanches, Koichi Kise, and Kai Kunze. 2017. Wordometer Systems for Everyday Life. *PACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1 (2017).

[2] Kay Henning Brodersen, Cheng Soon Ong, Klaas Enno Stephan, and Joachim M Buhmann. 2010. The balanced accuracy and its posterior distribution. In *Proceedings of the 20th International Conference on Pattern Recognition* (Istanbul, Turkey) *(ICPR 2010)*. 3121–3124.

[3] Ana Caraban, Evangelos Karapanos, Daniel Gonçalves, and Pedro Campos. 2019. 23Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Uk) *(CHI 2019)*. 1–15.

[4] Scott E Carrell, Bruce I Sacerdote, and James E West. 2013. From natural variation to optimal policy? the importance of endogenous peer group formation. *Econometrica* 81 (2013), 855–882. https://doi.org/10.3982/ECTA10168

[5] Damon Clark, David Gill, Victoria Prowse, and Mark Rush. 2016. Using goals to motivate college students: Theory and evidence from field experiments. *Review of Economics and Statistics* (2016), 1–45. https://doi.org/10.2139/ssrn.2856767

[6] Linda Gutlohn (Editor). 1999. *Assessing reading: multiple measures for kindergarten through eighth grade.* Academic Therapy Pubns.

[7] Lewis R Goldberg. 1992. The development of markers for the big-five factor structure. *Psychological assessment* 4 (1992), 26–42.

[8] Shoya Ishimaru, Kai Kunze, Koichi Kise, and Andreas Dengel. 2016. The wordometer 2.0: estimating the number of words you read in real life using commercial EOG glasses. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct* (Hidelberg, Germany) *(Ubicomp 2016)*. 293–296.

[9] Kai Kunze, Hitoshi Kawaichi, Kazuyo Yoshimura, and Koichi Kise. 2013. The wordometer — estimating the number of words read using document image retrieval and mobile eye tracking. In *Proceedings of the 12th International Conference on Document Analysis and Recognition* (Washington DC, USA) *(ICDAR 2013)*. 25–29.

[10] Richard H Thaler and Cass R Sunstein. 2009. *Nudge: Improving decisions about health, wealth, and happiness.* Penguin Books.