# Impact of a minimal social comparison feedback in written picture naming

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## ABSTRACT

The impact of a minimal social comparison feedback in writing was investigated in two experiments. During the first part of each experiment, the participants wrote down the names of pictures as quickly as possible. Before the second part, half of them were given either positive (Experiment 1) or negative (Experiment 2) feedback on their naming speed. The feedback was a virtual score indicating to the participants that they were among the fastest or the slowest writers. In both experiments, the control condition was a message indicating that the continuation of the experiment was being loaded. All the participants then wrote down the names from a different set of pictures. The frequency of the picture names was manipulated. Both types of feedback increased naming speed compared to the no feedback condition but did not alter the size of the frequency effects. We suggest that lexical access in written production is not altered by feedback whereas the criterion which initializes writing is.

**Impact d'un feedback minimal de comparaison sociale sur la dénomination écrite**

## RÉSUMÉ

L'impact d'un feedback minimal de comparaison sociale a été étudié au travers de deux expériences. Lors de la première partie de chacune des deux expériences, les participants devaient écrire les noms d'images le plus vite possible. Préalablement à la seconde partie, la moitié d'entre eux recevait un feedback positif (Expérience 1) ou bien négatif (Expérience 2) sur leur vitesse de dénomination. Le feedback consistait en un score virtuel indiquant aux participants qu'ils étaient parmi les scripteurs les plus rapides ou au contraire les plus lents. Dans les deux expériences, la condition contrôle consistait en un message indiquant que la suite de l'expérience était en train d'être chargée

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par l'ordinateur. Tous les participants produisaient alors les noms d'un autre ensemble d'images. La fréquence lexicale des noms des images était manipulée. Les deux types de feedback se sont avérés augmenter la vitesse de dénomination en comparaison de la condition sans feedback, mais la taille des effets de fréquence est restée inchangée. Ces données suggèrent que l'accès lexical en production verbale écrite n'est pas modulé par un feedback de comparaison sociale alors que l'est par contre le critère d'initialisation de l'écriture.

Social psychologists have shown that providing a social comparison feedback can impact on performance in several tasks (Dumas, Huguet, Monteil, & Ayme, 2005; Huguet, Galvaing, Monteil, & Dumas, 1999; Michinov & Primois, 2005; Monteil & Huguet, 1999; Muller & Butera, 2007; Muller, Atzeni, & Butera, 2004). Social comparison feedback can be defined as information provided by an external agent (including a virtual agent) who, by evaluating the performance, the competence or the status of an individual, places her/him in a situation of comparison to others (Monteil & Huguet, 1999). Several studies have shown that social comparison feedback can improve cognitive performance (e.g., Festinger, 1954; Huguet, Dumas, Monteil, & Genestoux, 2001; Michinov & Primois, 2005; Monteil & Huguet, 1993; Muller & Butera, 2007). For instance, Huguet, Dumas and Monteil (2004) found that participants who competed with a faster or slower coactor, that is to say participants who compared themselves upward or downward on the Stroop task, exhibited lower interference from the incongruent color words (e.g., the word "blue" printed in red) and thus performed better than those who worked in isolation. More generally, a large number of studies have shown that *providing feedback can be a useful source of information which can help to improve performance* in several tasks (e.g., Balzer, Doherty, & O'Connor, 1989; Butler & Roediger III, 2008; Hays, Kornell, & Bjork, 2010; Lewthwaite & Wulf, 2010).

In the present study, we explored the influence of a minimal *virtual* social comparison feedback in written word production. By examining the influence of social comparison feedback in written word production, our study more generally helps to specify the type of cognitive processes that are affected by social comparison feedback. In the specific case of written object naming, our study helps to determine whether this type of feedback affects the mechanisms underpinning written word production and especially those that are involved in lexical access. In two experiments we investigated the influence of a virtual score, which informed participants of how fast they were in a written picture naming task compared to other (control) participants who did not receive any feedback, i.e., the score was said to be computed by a software program on the basis of their naming responses provided during the first part of the experiment. Likewise participants were informed that their mean naming speed placed them among the fastest (positive feedback, Experiment 1) or the slowest (negative feedback, Experiment 2) individuals who had already taken part in the experiment. As a control (no feedback) condition, in the two experiments participants were simply informed that the second part of the experiment was being loaded by the computer. Given the studies which have shown that providing feedback is a useful source of information which helps to improve performance (e.g., Huguet et al., 2001; Huguet et al., 2004; Michinov & Primois, 2005; Muller & Butera, 2007), we predicted in both experiments that the written naming performance would also improve with participants being faster after a social comparison feedback. A key issue was to determine the level—lexical versus post-lexical—of the written word production system at which social comparison feedback would act. To make the object of the study clearer, the levels underpinning written word production are indicated in detail below.

Written production is generally thought to be a very difficult task (Levy, 1995) which make it necessary to juggle with various constraints: audience, topic knowledge, choices of lexical terms and alternative syntactic frames, orthography (see Kellogg, 1999; Levy & Ransdell, 1996; Piolat, 2004 for a comprehensive reviews). The issue of the influence of feedback in written text production was explicitly investigated in two studies conducted by Traxler and Gernsbacher (1992, 1993). In order to help writers produce texts of better quality, these authors provided them with a minimal feedback. They hypothesized that feedback is useful to writers because it helps them build an appropriate representation of the audience's information needs. More precisely, Traxler and Gernsbacher (1992) investigated the effect of a minimal feedback in the written production of descriptive texts. The participants had to write texts describing complex geometric figures (i.e., solid black geometric shapes) to adults who, after reading the text, had to select a target figure among several geometric distracter figures. Informing writers of the number of participants who were able to select the correct target figure after reading their descriptions had a positive impact on the quality of the texts which were then revised by the writers. Thus, providing information that helps writers to perceive how readers interpret their texts enables them to write descriptive texts of better quality. The question of exactly how this type of feedback influences the management of the writing processes was not addressed by these studies.

## WRITTEN WORD PRODUCTION: LEXICAL ACCESS AND THE INFLUENCE OF WORD FREQUENCY

As stated above, in the present study, we were interested in the influence of a minimal (virtual) social comparison feedback at a micro level of written word production, namely the process of lexical access. *Lexical access* is the process of selecting a lexical entry and encoding its word form (as we shall describe below, lexical access in written naming takes place at the orthographic L-level and the grapheme level, see Figure 1). Although a number of studies have addressed the issue of lexical access in spoken word production, it has been the object of less interest in written production. This is due to the fact that, until now, psycholinguistic studies of lexical processing do not generally take into account the social environment of cognition. It is worth pointing out that we were not interested in the impact of feedback on potential improvements in the quality of production, as in the Traxler and Gernsbacher (1992, 1993) studies (see also Kellogg, Whiteford, & Quinlan, 2010), but in the influence of feedback on the on-line management of written word production in the simple task of picture naming. Picture naming is a popular and experimentally tractable task which has been widely used to investigate lexical access in both spoken (Griffin & Ferreira, 2006) and written word production (e.g., Bonin & Fayol, 2000; Bonin, Roux, Barry, & Canell, 2012; Roux & Bonin, 2011). Indeed, our study aimed at determining whether the influence of a minimal and virtual feedback on naming speed can be observed at the micro level of written word production. To help readers understand the rationale of our study, we describe the levels of processing in written word production and the influence of word frequency since this variable has been taken to be an index of lexical access.

As shown in Figure 1, when naming from an object, object comprehension is the first processing level which is involved. This level results in the activation of both conceptual and structural representations (Humphreys, Riddoch, & Quinlan, 1988). Some theorists posit that the next level is the lemma level (Levelt, 1989; Levelt, Roelofs, & Meyer, 1999). Lemmas are neutral lexical entries that provide information about the syntactic category of the word and gender information. Certain researchers (Caramazza, 1997; Caramazza & Miozzo, 1997, 1998) assume that the conceptual level maps directly onto the wordform (or lexeme) level, which in turn corresponds to both holistic lexical and sublexical representations. Given that the distinction between lemmas and lexemes is

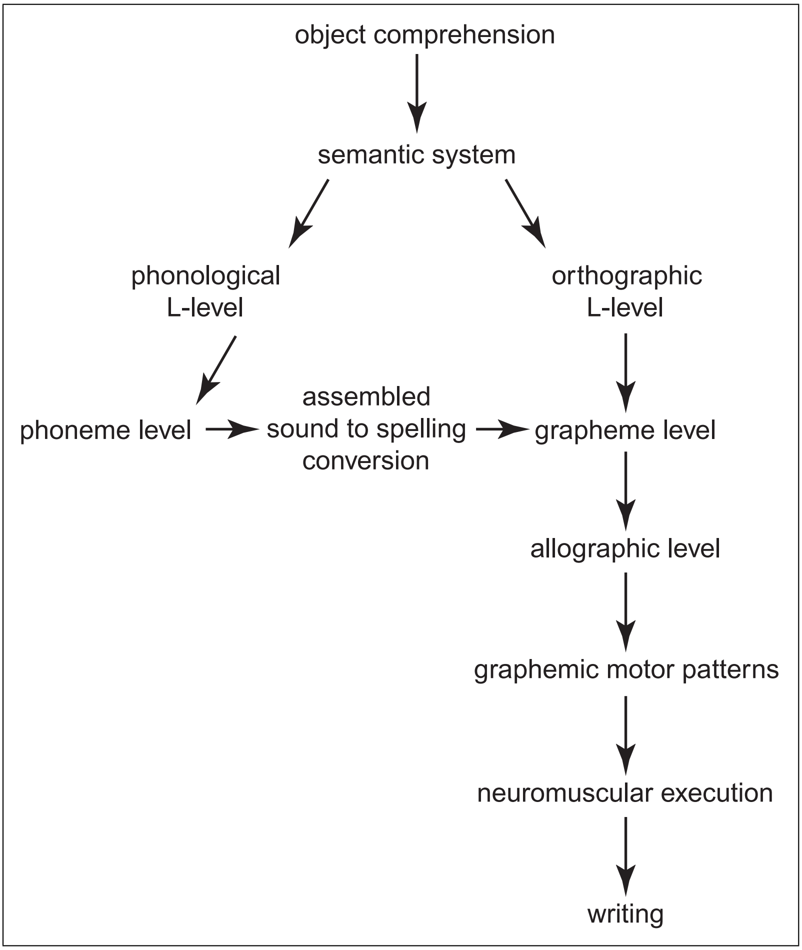


**Figure 1.** A general written word production model (adapted from Bonin et al., 2012).

not critical for the current issue, we shall follow Goldrick and Rapp's (2007) terminology in using the more neutral term of "L-level" to distinguish between these holistic lexical representations (the orthographic L-level in Figure 1) and sublexical representations, i.e., individual sounds in speech or individual graphemes in writing (the grapheme level in Figure 1). As can been in Figure 1, the individual phonemes and graphemes are linked via an assembled conversion phoneme-to-grapheme process (see Bonin, Peereman, & Fayol, 2001). The sequences of graphemes are kept activated in an orthographic working memory (Jones, Folk, & Rapp, 2009). The graphemic representations then pass through *post-lexical* stages in order to be executed in handwriting. At the allographic level, an allographic code is selected for each letter, which specifies whether it is to be produced in upper- or lower-case and in printed or cursive writing. Allographic codes access graphemic motor patterns that specify the sequence, direction, and relative size of the letter strokes that are executed to produce the handwritten trace.

One major finding in spoken word production research is the word frequency effect. It corresponds to the observation that high-frequency words are produced faster (and more accurately) than low-frequency words. Most researchers attribute the effects of word frequency in spoken naming to the wordform level (e.g., Jescheniak & Levelt, 1994). As a result, word frequency has often been to index this level of processing. Although views concerning the precise locus of word frequency effects in spoken word production differ somewhat (Dell, 1990; Navarrete, Basagni, Alario, & Costa, 2006), the large body of available evidence most strongly favors the hypothesis that a major locus for these effects in word production lies at, or around, the wordform level (Knobel, Finkbeiner, & Caramazza, 2008). In the experiments described below, word frequency effects were taken to be a genuine indication that the wordform level is involved in written word production. In effect, according to Mädebach, Jescheniak, Oppermann and Schriefers (2011), word frequency is a reliable and established way to manipulate the ease with which the phonological form or, in writing, the orthographic form of an item can be retrieved. Word frequency is assumed to index L-level processing (either during the retrieval of word-forms, word-form encoding or execution) and, as far as written naming is concerned, following Bonin et al. (2012), it is quite reasonable to assume that word frequency also operates at the orthographic L-level (see Figure 1). Indeed, word frequency has been found to be a reliable determinant of both spoken and written naming latencies (Alario, Ferrand, Laganaro, New, Frauenfelder, & Segui, 2004; Bonin, Chalard, Méot, & Fayol, 2002).

A key issue examined in the present study was whether a virtual social comparison feedback would have an influence on the speed with which wordform representations are retrieved and selected. In language production, the process of lexical access has been thought to demand less attention than concept activation and selection (Roelofs, 2008). However, in recent years, the few studies which have addressed the capacity demands of speech production on basis of the dual-task technique (e.g., spoken naming: task 1 + categorizing a tone: task 2) have provided evidence that lexical selection (the selection of an L-unit among the cohort of activated L-units) and wordform encoding are capacity-demanding processes (Ayora, Janssen, Dell'Acqua, & Alario, 2009; Cook & Meyer, 2008; Ferreira & Pashler, 2002). If these findings are correct, the process of lexical selection could be strategically controlled. Although the precise mechanism which underpins word frequency effects in word production is still unknown, two main accounts deserve consideration. Frequency effects can be thought of as being due to differences either in the resting activation level of the lexical nodes, or the activation thresholds or verification times for high and low-frequency words, respectively. In WEAVER++ (Roelofs, 2000), the influence of word frequency is due to differences in the time taken to verify the links between the lemma and the lexeme levels, with those of high-frequency items taking less time to verify than those of low-frequency items. This account permitted us to hypothesize that participants would take less time to verify the links of words after receiving feedback in order to increase naming speed, the implied or explicit information provided by the social comparison feedback being that participants' performance should be maintained or improved. Since low-frequency items take more time to verify than high-frequency items, the word frequency effect should be reliably reduced after a feedback compared to a control condition in which no feedback is provided. In contrast, if access to wordform representations in word production is a mandatory, hard-wired process, the process of lexical access should not be altered by feedback, as for instance in Dell's (1990) model in which lexical frequency is implemented in the resting activation levels of lexical nodes in a localist spreading-activation network. In effect, if frequency effects are the result of different resting activation levels (differential activation thresholds) with high-frequency lexical entries having lower resting activation levels (or activation thresholds) than low-frequency lexical entries, there is no possibility of a strategic control over the way information flows through the lexical system. However, it is still possible for feedback to influence the general speed of written naming at a post-lexical level by altering the time needed to initiate writing. We will refer to this account as the flexible time-criterion account (Bonin, Collay, Fayol, & Méot, 2005). According to this account, adults do not always initiate writing execution as soon as they are ready to do so. Thus, compared to a no feedback control condition, participants who receive a feedback should alter the criterion on the basis of which they initialize writing and, as a result, should start writing sooner compared to what they did before receiving any feedback.

# EXPERIMENT 1 (POSITIVE FEEDBACK)

In Experiment 1, the participants started writing words from pictures whose names varied in frequency. This activity was followed by an interval during which, half of them were informed that their naming score placed them among the fastest writers whereas the remaining half did not receive any information about their naming performance. They just read a message presented on the screen informing them that the software was loading the remainder of the experiment. After the break, all the participants again wrote down the names of a different set of pictures whose names again varied in frequency. We predicted that, compared to the control condition, positive feedback would lead participants to confirm their good performance by accelerating their naming speed during the second part of the experiment. One critical issue was whether the word frequency effect on naming speed would be modulated by this feedback.

## Method

### Participants

40 psychology students from University Blaise Pascal (mean age: 18 years) took part in the experiment in exchange of course credits. The participants were native speakers of French and reported having normal or corrected-to-normal vision.

### Stimuli

There were 68 black-and-white drawings: 43 were selected from the Snodgrass and Vanderwart (1980) set, 17 from the Bonin, Peereman, Malardier, Méot and Chalard (2003) database and 8 from an unpublished database.

As can be seen from Table 1, the pictures had either a high-frequency name or a low-frequency name in terms of objective adult word frequency. Two different adult word frequency databases (values were obtained from http://www.lexique.org) were used: "book" and "film" frequency (New, Pallier, Brysbaert, & Ferrand, 2004; New, Brysbaert, Véronis, & Pallier, 2007) and child word frequency was also used (Manulex: Lété, Sprenger-Charolles, & Colé, 2004). The two sets of pictures were matched on rated visual complexity, imageability (with the use of five-point scales), and name agreement (% and H statistics). The picture names were controlled for the number of letters, phonemes and syllables. The sublexical variables of initial and total bigram frequency and syllable frequency were controlled for. Finally, the high and low-frequency names were matched on several measures of phoneme-to-grapheme consistency (Peereman, Lété, & Sprenger-Charolles, 2007). The statistical characteristics corresponding to the different matched variables are listed in Table 1 together with the various sources from which the different values corresponding to these variables were taken.

**Table 1.** Characteristics of the stimuli used in Experiments 1 and 2

| | High-frequency names | Low-frequency names | Significance |
|---|---|---|---|
| Freqlivres* | 42.4 | 5.4 | <.01 |
| Freqfilms2* | 32 | 4.6 | <.01 |
| Manulex frequency** | 220.1 | 51.4 | <.01 |
| Name Agreement (%NA and H) | 94.4 (.2) | 87.9 (.4) | ns |
| Visual complexity | 2.6 | 2.9 | ns |
| Imageability | 4.4 | 4.4 | ns |
| Number of letters* | 5.1 | 5.3 | ns |
| Number of phonemes* | 3.6 | 4 | ns |
| Number of syllables* | 1.4 | 1.6 | ns |
| Bigram frequency (total)* | 1092.9 | 915.8 | ns |
| Bigram frequency (initial)* | 466 | 348.1 | ns |
| Syllable frequency (Initial)* | 247.6 | 223.5 | ns |
| PO consistency (total)** | 76.2 | 77.4 | ns |
| Initial PO consistency** | 96.8 | 87 | ns |
| Middle PO consistency** | 83.1 | 84.9 | ns |
| Final PO consistency** | 42.7 | 50.4 | ns |

*values taken from Lexique (http://lexique.org); **values taken from Peereman et al. (2007); %NA, H and Visual complexity: scores taken from Alario & Ferrand (1999) and from Bonin et al. (2003); Imageability: scores taken from Bonin, Méot et al. (2003); PO (phoneme-grapheme) consistency scores taken from eManulex (http://www.manulex.org/fr/home.html)

The pictures were then divided into two sets (A and B) for use during the first and second part of the experiment respectively. The two sets of pictures were counterbalanced across both phases of the experiment. Thus, half of the participants named the set A during the first part of the experiment and set B during the second part, while the opposite sequence was used for the other half of the participants.

## Apparatus

The pictures were presented on a Macintosh computer running the Psyscope v.1.2.5 software (Cohen, MacWhinney, Flatt & Provost, 1993). A graphic tablet (Wacom Intuos 2), with a contact pen (UP-401), was used to record written naming latencies.

## Procedure

The participants were randomly assigned to one of two groups: the positive feedback group (i.e., the participants were informed that their naming score placed them among the fastest writers) or the no feedback group (i.e., nothing was said about the performance), as well as one of the two sets of pictures (A or B). The participants were tested individually, seated comfortably in a quiet room. During a familiarization phase, the entire set of experimental pictures, along with their printed names, was randomly presented. In the experimental phase, the pictures were presented alone in a different random order and the participants had to write down their names as quickly as possible. Each trial had the following structure: A fixation point (+) was displayed in the middle of the screen for 500 ms. A picture was then displayed in the middle of the screen and remained there until the participant's response. The inter-trial interval was 5 seconds. Participants were instructed to write down the name of the picture as quickly (and as accurately) as possible on the graphic tablet. Written latencies were measured from the onset of the visual display to the initialization of the first handwriting movement corresponding to the production of the first letter in the object's name. Ten practice trials preceded the presentation of the experimental trials.

## Results and Discussion of Experiment 1

Responses were discarded from the latency analyses whenever any of the following conditions applied: (a) a spelling error was produced; (b) a technical error occurred; (c) the participant did not remember the picture name or used a name other than the target; (d) the written latency was longer than 3,000 ms or (e) the latency was more than two standard deviations above from both the participant and item means. The application of these criteria resulted in the exclusion of 12.8% of the data.

Analyses of variance were performed on written latencies and on errors with the factors Phase (first part, second part), Feedback (feedback versus no feedback), Word frequency (high, low). Analyses were conducted separately with participants ($F_1$) and items ($F_2$) as random factors. Mean written naming latencies in each condition, together with their standard deviations and error rates, are presented in Table 2.

Written naming latencies were faster (on average by 103 ms) during the second phase than during the first phase of the experiment, $F_1(1, 38) = 16.21$, $MSE = 8{,}016.08$, $p < .001$; $F_2(1, 66) = 36.4$, $MSE = 5{,}813.64$, $p < .001$. Also, latencies on high-frequency names were faster than those on low-frequency names, $F_1(1, 38) = 105.06$, $MSE = 3{,}420.45$, $p < .001$; $F_2(1, 66) = 17.53$, $MSE = 40{,}403.58$, $p < .001$. A main effect of Feedback was found in the by-items analyses only, $F_1 < 1$; $F_2(1, 66) = 19.95$, $MSE = 5{,}859.34$, $p < .001$. Importantly, the interaction effect between Phase and Feedback was significant, $F_1(1, 38) = 15.82$, $MSE = 8016.08$, $p < .001$; $F_2(1, 66) = 12.12$, $MSE = 17{,}963.65$, $p < .001$. After the feedback, the participants took less time to write down the picture names than before receiving it, $t_1(38) = 2.18$, $p = .036$; $t_2(67) = 5.28$, $p < .001$. In contrast, the participants

**Table 2.** Mean written latencies (in ms), standard deviations (in parenthesis) and percentages of errors (into brackets) as a function of phase, feedback and word frequency in Experiment 1 (positive FB)

| | Phase 1 | | Phase 2 | |
|---|---|---|---|---|
| | No Feedback | Feedback | No Feedback | Feedback |
| High-frequency names | 1095 (164) [2.06] | 1093 (159) [2.65] | 1085 (146) [0.88] | 980 (120) [3.82] |
| Low-frequency names | 1170 (163) [5.88] | 1198 (193) [6.47] | 1179 (174) [6.18] | 1085 (157) [9.41] |
| | 1132 (160) [3.97] | 1146 (171) [4.56] | 1132 (153) [3.53] | 1033 (135) [6.62] |

in the no feedback condition did not change the amount of time taken to initialize writing, $t_1$ and $t_2 < 1$. No other interaction was reliable: Word Frequency x Feedback, $F_1(1, 38) = 1.29$; $F_2(1, 66) = 1.64$; Phase x Word Frequency and Phase x Feedback x Word Frequency, $F_1$ and $F_2 < 1$. As far as the two-way interaction is concerned, this indicates that the influence of word frequency did not reliably change across the two phases of the experiment or as a function of the type of information received during the break.

The analyses of the errors—excluding technical errors—revealed a main effect of word frequency, $F_1(1, 38) = 40.22$, $MSE = .0021$, $p < .001$; $F_2(1, 66) = 13.4$, $MSE = .0109$, $p < .001$, with fewer errors being observed for high-frequency pictures than for low-frequency pictures. A main effect of Feedback was also observed but was reliable only in the by-items analysis, $F_1(1, 38) = 2.05$; $F_2(1, 66) = 7.42$, $MSE = .0031$, $p < .01$,with fewer errors occurring in the feedback condition. The analyses restricted to spelling errors showed only a significant main effect of word frequency, $F_1(1, 38) = 7.48$, $MSE = .0004$; $p < .01$; $F_2(1, 66) = 3.8$, $MSE = .0014$, $p = .055$.

The findings from Experiment 1 replicate the word frequency effect in picture naming: High-frequency picture names were written faster than low-frequency picture names. More interestingly, the participants who received a positive feedback were faster during the second part of the experiment than those in the control group. There was therefore a clear effect of social virtual feedback on written naming speed. Crucially, the word frequency effect did not vary reliably as a function of feedback condition. In Experiment 2, the same design was used but a negative feedback was used.

# EXPERIMENT 2 (NEGATIVE FEEDBACK)

Experiment 2 used exactly the same material, design and procedure as Experiment 1. The only change was that the participants in the feedback group were given negative feedback. We predicted that, compared to the control condition, negative feedback would cause the participants to counteract their "bad" performance by accelerating their naming speeds during the second part of the experiment.

## Method

### Participants

56 psychology students (mean age: 18 years) from University Blaise Pascal took part and received course credits.

### Stimuli

The same stimuli as in Experiment 1 were used.

### Procedure

The same procedure as in Experiment 1 was employed. The only change was the nature of the feedback, with the participants in the feedback condition receiving a negative feedback informing them that they were among the slowest participants who had previously taken part in such an experiment.

## Results and Discussion

The same criteria as those applied in Experiment 1 led us to exclude 13.2% of the data.

The latencies required to write down picture names were faster during the second phase than during the first phase of the experiment, $F_1(1, 54) = 62.89$, $MSE = 9{,}468.57$, $p < .001$; $F_2(1, 66) = 238.61$, $MSE = 2{,}853.65$, $p < .001$. The participants responded faster to the high-frequency pictures than the low-frequency pictures, $F_1(1, 54) = 85.24$, $MSE = 4{,}722.15$, $p < .001$; $F_2(1, 66) = 14.44$, $MSE = 34{,}905.36$, $p < .001$. The main effect of Feedback was significant, $F_1(1, 54) = 8.13$, $MSE = 79{,}833.72$, $p < .01$; $F_2(1, 66) = 211.62$, $MSE = 3{,}554.57$, $p < .001$. Importantly, the interaction effect between Phase and Feedback was significant, $F_1(1, 54) = 64.23$, $MSE = 9{,}468.57$, $p < .001$; $F_2(1, 66) = 199.43$, $MSE = 3{,}540.88$, $p < .001$. As can be seen from Table 3, after the feedback, the participants took less time

| | Phase 1 | | Phase 2 | |
|---|---|---|---|---|
| | **No Feedback** | **Feedback** | **No Feedback** | **Feedback** |
| High-frequency names | 1163 (138) [3.21] | 1150 (153) [1.93] | 1154 (142) [5.36] | 934 (130) [4.07] |
| Low-frequency names | 1229 (166) [10.43] | 1235 (189) [4.93] | 1240 (173) [8.93] | 1036 (145) [6.43] |
| | 1196 (148) [6.82] | 1192 (164) [3.43] | 1197 (151) [7.14] | 985 (133) [5.25] |

writing more quickly after this feedback. Again, we did not find that the word frequency effect on naming speed was reliably altered by feedback.

## COMBINED ANALYSIS OF EXPERIMENTS 1 AND 2

Before discussing the findings, it is worth addressing a potential concern that might be raised in connection with the use of a between-subjects design in Experiments 1 and 2. In effect, an examination of the data indicates that the different groups of participants across the two experiments had different overall mean written latencies. We therefore performed combined analyses on the naming latency data using a within experiment *z*-score transformation to obtain an overall picture of the effect of feedback across experiments. The analyses were performed on both participants and items as described in the Result sections except that Feedback had now four levels (No Feedback in Experiment 1, No Feedback in Experiment 2, positive feedback, negative feedback). The mean z-scores are depicted in Figure 2.

The main effects of Phase, $F_1(1, 92) = 67.39$, $MSE = .134$, $p < .001$; $F_2(1, 66) = 177.45$, $MSE = .070$, $p < .001$, Word frequency, $F_1(1, 92) = 181.48$, $MSE = .063$, $p < .001$; $F_2(1, 66) = 18.06$, $MSE = 1.016$, $p < .001$, and Feedback, $F_1(3, 92) = 2.84$, $MSE = 1.265$, $p = .042$; $F_2(3, 198) = 47.02$, $MSE = .092$, $p < .001$, were all reliable. The only interaction effect that reached significance was that of Phase and Feedback, $F_1(3, 92) = 29.07$, $MSE = .134$, $p < .001$; $F_2(3, 198) = 37.43$, $MSE = .132$, $p < .001$. The interaction between Phase and Feedback is depicted in Figure 2. Averaging across the frequency levels revealed that the effect of Feedback during the first phase was not reliable, $F_1(3, 92) = .18$; $F_2(3, 201) = 1.40$, and that the no feedback conditions did not differ between the two phases in either experiment, $t_1(19) = .04$; $t_2(67) = -.04$ and $t_1(27) = -.07$; $t_2(67) = -.17$. During the second phase, the mean latencies in both the positive and negative feedback conditions were significantly shorter than those in the no feedback conditions, $t_1(92) = -5.94$, $p < .001$; $t_2(67) = -20.53$, $p < .001$ and $t_1(92) = -2.44$, $p < .05$; $t_2(67) = -5.27$, $p < .001$. Interestingly, the positive feedback condition was different from the negative feedback condition, but reliably so only in the by-item analyses, $t_1(92) = -1.82$, $p = .072$; $t_2(67) = -7.28$, $p < .001$. The findings suggest that the effect of a negative feedback on naming speed is stronger than that of a positive feedback. Thus, the analyses on the *z*-scores confirm that feedback enhances the speed of writing but does not modify frequency effects.

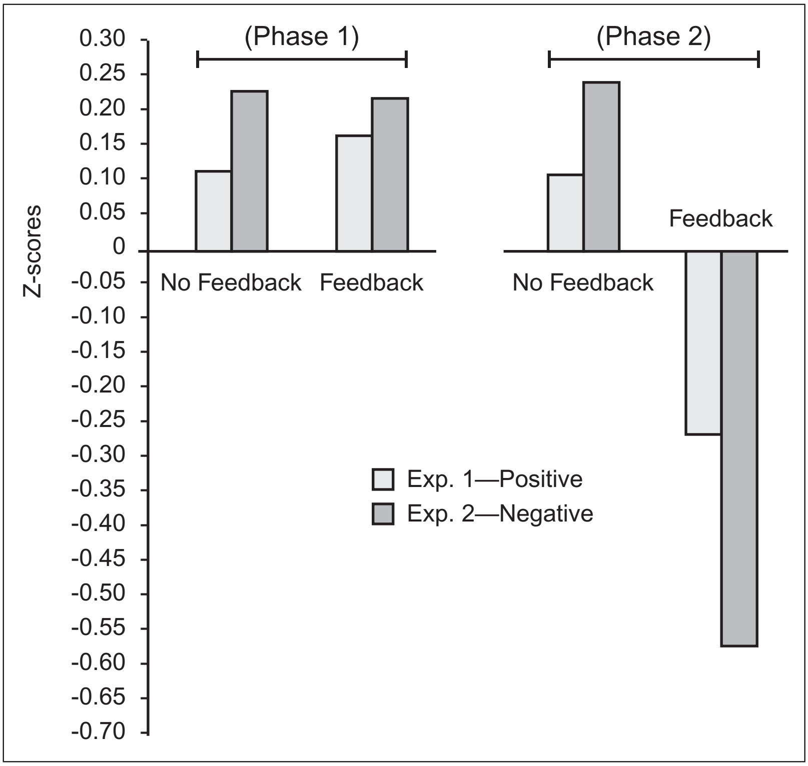


**Figure 2.** Z-scores as a function of Phase, Feedback and Experiment (Exp. 1, Exp. 2).

# GENERAL DISCUSSION

In two experiments, we investigated the influence of a minimal (virtual) social comparison feedback in written word production. Our study therefore helps to identify the cognitive processes that are modulated by social comparison feedback. Also, in the specific case of written word production, we wanted to determine whether this type of feedback acts at the micro level of lexical access or at a more general (post-lexical) level of the writing system. After an initial phase requiring the written naming of a set of pictures whose names varied in lexical frequency, half of the participants were given a positive (Experiment 1) or negative (Experiment 2) feedback concerning their naming speeds while in both experiments the remaining half were given no feedback. Between the two halves of the experiment, the feedback took the form of a numerical value (a virtual score that appeared on the computer screen) and an arrow indicating to the participants they were among the fastest (positive feedback) or the slowest writers (negative feedback). In both experiments, the control condition consisted of neutral information, namely that the continuation of the experiment was being loaded by the computer. The findings from the two experiments are clear-cut. Both types of feedback increased naming speed compared to the control conditions but did not reliably alter word frequency effects.

As far as the word frequency of the picture names are concerned, in the Introduction we contrasted two hypotheses concerning the influence of feedback in written word production. According to one hypothesis, feedback has an influence on the speed with which wordform representations are retrieved and selected. Consequently, since the frequency of picture names is believed to truly index the ease with which wordform information can be retrieved in picture naming (Mädebach et al., 2011), we hypothesized that word frequency effects could be altered by feedback in a way that depends on the way these effects are accounted for. According to one influential view of spoken word production, the word frequency effect on naming speed is thought to be the result of a verification process (Roelofs, 2000; see also Levelt et al., 1999). It is assumed that more time is needed to check the links of low-frequency items than those of high-frequency ones. Within this view, providing feedback should increase written naming speed by altering the process of lexical access. More precisely, the time taken to verify the links should diminish after a negative/positive feedback and, since low-frequency items take more time to check than high-frequency ones, the word frequency effect should be reliably reduced. According to another hypothesis, access to wordform representations in word production is a mandatory hard-wired process (Caramazza, 1997; Dell, 1990). Word frequency effects emerge as a result of different resting activation or activation threshold levels for high and low-frequency items. According to this account, the process of lexical access cannot be altered by feedback.

In the light of the studies which have reported that social comparison feedback improve cognitive performance (e.g., Huguet et al., 2004; Huguet, et al., 2001; Michinov & Primois, 2005; Monteil & Huguet, 1993; Muller & Butera, 2007), we hypothesized that providing a feedback could influence the general speed of written naming at a post-lexical level by altering the time taken to initiate writing (in Figure 1 from the graphemes which are held in orthographic working memory (Jones et al., 2009) through to the graphemic motor patterns that are then executed to produce a written trace on a sheet of paper). Given that in our two experiments, both types of feedback were found to increase written naming speed, without, however, modifying word frequency effects, we suggest that this minimal virtual social comparison feedback has an influence in that it modulates the settings of the time criterion for the initialization of writing (Bonin et al., 2005). Indeed, this hypothesis – referred to as the flexible time-criterion account in the word reading literature – has already been put forward to account for list-composition effects in picture naming, word reading (e.g., Chateau & Lupker, 2003; Kinoshita & Lupker, 2003; Taylor & Lupker, 2001) and spelling-to-dictation (Bonin et al., 2005). According to this hypothesis, adults do not always initiate articulation (or for our purposes here, writing execution) as soon as they are ready to do so. The position of the time criterion is set on the basis of the relative difficulty of the items in the list. In the case of lists consisting of fast stimuli only, the latencies are faster for a set of critical stimuli than when the same set of stimuli is presented together with a list of difficult/slow stimuli. According to Taylor and Lupker (2001), the decision as to when to initiate the articulatory processes is driven by some combination of quality of phonological representations and time criteria. According to this account, the feedback provided to participants influences the position of the criterion. They initiate writing sooner after both positive and negative feedback compared to a control condition in which no feedback is provided. Overall our findings illustrate the fact that the speed of naming is not only dependent on the individual properties of the items to be named (e.g., the visual complexity of the pictures, the frequency of the names), but is also influenced by the social environment of cognition (Huguet et al., 2004), here the virtual social context, in which the items are produced. To date, researchers in the field of speech production have focused on the individual characteristics of the items and their relationships with naming times (e.g., Alario et al., 2004; Bonin et al., 2002) but it is already clear that the social context, even a virtual one, can have a genuine influence on naming speed.

Our findings contribute to a better understanding of the very nature of the cognitive processes that are affected by minimal social comparison feedback. Indeed, the fact that we found beneficial effects of negative (upward) and positive (downward) social comparison feedback accords with the findings obtained in social psychology according to which social comparison feedback do not necessarily operate at a conscious level. Huguet et al. (2004) showed that the perspective of a desired reward (a motivational factor) in the Stroop task increased participants' self-reports of task-specific efforts, but did not alter the Stroop performance, which is consistent with the hypothesis that word reading is strongly underpinned by fast and mandatory processes and therefore not open to (strategic) control (see Augustinova & Ferrand, 2012 for further evidence). In fact, the participants faced with upward or downward social comparison feedback performed better in the Stroop task (i.e., they exhibited lower interference in naming the color of words from words meaning a different color compared to a control condition—naming the color of a series of colored Xs—where such a mismatch was absent) when they competed with a slower or a faster coactor regardless of whether a reward was or was not expected. The competition with a slower or a faster coactor did not change participants' self-reports of task-specific efforts but facilitated task performance. Taken together, these findings support the hypothesis that control of semantic-level activation can be unconscious but effective versus conscious but ineffective. Thus, it could be the case that the beneficial effects observed in our two experiments did not necessarily result from conscious control or motivations. Likewise, in Huguet et al.'s (2004) study, the impact of social comparison was a bit stronger when comparison was downward than when it was upward, suggesting that even this asymmetry does not imply that the social comparison feedback in the current study operated at a conscious level. Finally, Huguet et al. (2004) showed that the reduced Stroop effect due to competition (and related upward or downward comparison component) was not linked to an alteration of word processing per se. Competition did cause attention to focus more exclusively on the letter color cues, resulting in a lower interference, but this effect on attention did not occur at the expense of word meaning. Instead, this effect occurred at a later, response stage. It is worth stressing that the main interpretation of our findings—social comparison feedback modulates the general speed of written naming at a post-lexical level—clearly accords with this earlier finding.

To conclude, our study makes a useful contribution by showing for the first time that a minimal social comparison feedback accelerates the speed of lexical access in written word production and, from a general standpoint, it strengthens the view that it is also important to take into account the parameters of the situation of communication, that is to say the social environment of cognition (Huguet et al., 2004), when investigating microaspects of language production.

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