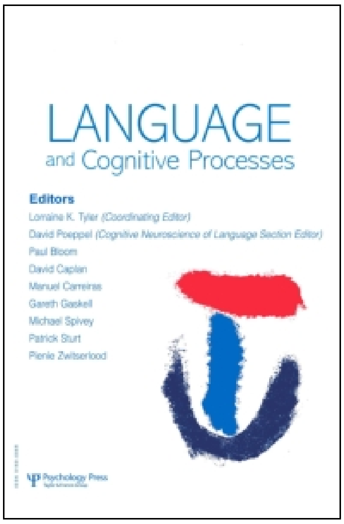


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# The scope of advance planning in written picture naming

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# The scope of advance planning in written picture naming

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The present study focused on the issue of the scope of advance planning in written picture naming. In the first series of experiments, participants had to write down or to speak aloud two bare nouns from pictures presented side-by-side starting with the left one, whereas in the second series of experiments, participants had to produce noun phrases in written naming only. Multiple regression analyses were performed on the naming latencies. In the first type of regression analysis, certain characteristics corresponding to the two pictures (in first and in second position) and their names were introduced as independent variables. In the second type of analysis, the latencies required to name the pictures corresponding to the pairs individually were introduced as independent variables. Overall, the findings suggest that naming is initiated when the processing of the first target is fully complete whereas the processing that is undertaken on the second target is restricted to the structural/semantic levels, i.e., there is no access to name representations. The implications of the findings are discussed.



## INTRODUCTION

Our knowledge of the processes and the representations involved in single spoken word production has increased significantly in recent years (e.g., Levelt, 1999, 2000; Levelt, Roelofs, & Meyer, 1999). We know more about the spoken production of *isolated* words than about the spoken production

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of *multi-word* utterances. This contrast in knowledge levels is even greater in the case of written word production. In this latter research field, as compared with spoken word production, much less is known about both single and multi-word production. The primary goal of the present study was therefore to shed light on the representations that are planned before *writing* is initiated in a well-defined situation, namely the production of two nouns from pictures.

## Processing levels involved in written/spoken production

It is generally agreed that conceptually driven writing/speaking involves the following major processing levels: conceptualisation, formulation, and execution (e.g., Bock & Levelt, 1994; Bonin, 2003; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt et al., 1999). A communicative intention leads to the activation of one or more lexical concepts (Bonin, 2002, 2003; Levelt, 1999, 2000; Levelt et al., 1999; Roelofs, 2000). The output of the conceptualisation process is a preverbal message which is passed on to the next stage, i.e., formulation. In the case of naming real objects or pictured objects, certain authors have explicitly distinguished between the structural level and the conceptual/semantic level (Humphreys, Riddoch, & Quinlan, 1988; Humphreys, Lamote, & Lloyd-Jones, 1995), whereas other authors have integrated the structural properties of objects at the conceptual/semantic level (e.g., Hillis, Rapp, Romani, & Caramazza, 1990). The structural level corresponds to the perceptual descriptions of objects. We will adopt the explicit distinction between the structural and conceptual/semantic levels, but this issue is not critical to our argument. We assume that the structural and the conceptual levels are common to both writing and speaking (Hillis, Rapp, & Caramazza, 1999).

Formulation comprises the two main steps of lexicalisation and grammatical encoding (Dell & O'Seaghdha, 1992; Levelt, 1989, 1999, 2000; Levelt et al., 1999). Grammatical encoding consists of assigning syntactic functions. In speaking, lexicalisation is mostly viewed as a two-step process. First, a modality-neutral lexical entry is activated and selected, i.e., a lemma. This provides syntactic information such as gender or grammatical class. Second, a lexeme is retrieved which triggers the activation of segmental and metrical information (but see Caramazza, 1997, for a different view). Lexemic information is then used by articulatory processes which result in overt speech. As far as the written naming of isolated words is concerned, virtually all our knowledge comes from analyses of brain-damaged patients—and the lemma/lexeme distinction has not often been made explicit in this latter field. Indeed, there is currently some debate concerning the value of positing a modality-neutral level (lemmas) in both speaking and writing (Caramazza, 1997; Caramazza & Miozzo, 1997, 1998; Roelofs, Meyer, & Levelt, 1998). In keeping with most speech production models, we will assume that the lemma level is also involved in writing and is shared by both production modes (see also Pickering & Branigan, 1998 for a study on written sentence production that assumes the lemma terminology). The lexemes in writing are conceived of as abstract orthographic representations. Orthographic representations corresponding to words include several dimensions: graphosyllables, consonant and vowel status of the graphemes, identity of the graphemes and geminates (Tainturier & Caramazza, 1996). In handwriting, i.e., the output mode used in the present experiments, we distinguish between several post-orthographic levels: allographic (which specifies case assignment and style), letter shape assignment, graphic motor pattern retrieval and graphic execution (e.g., Ellis, 1988; Rapp & Caramazza, 1997). One issue in written naming relates to the role of phonological codes in orthographic encoding. Evidence from neuropsychological observations strongly suggests that phonological codes are not obligatory for orthographic retrieval but that they play a constraining role in orthographic encoding (Bonin, Peereman, & Fayol, 2001; Miceli, Capasso, & Caramazza, 1999). This issue is not critical for the purpose of the present article.



## Studies on advance planning in language production

In the present study, we focus on the issue of the scope of advance planning in the production of two nouns in written naming (but also in spoken naming in the first series of experiments) by adopting a multiple regression approach. The issue is the extent to which the initiation of handwriting movements in writing (or of articulation in speaking) for the first target for production is dependent on any aspect of the second target to be produced. In this context, we will use the term ''dependency''. As indicated by Levelt and Meyer's (2000) review of speech production, experimental reports of cases of dependency are not numerous (see below). As far as written naming is concerned, the issue of dependency has not given rise to focused research by means of real-time experiments in well-defined situations. The present study attempts to fill this gap.

Meyer (1996) has addressed the issue of the scope of advance planning in the production of noun phrases and sentences in picture word interference experiments. In Meyer's (1996) study, participants had to describe two pictures of objects that were presented side-by-side, always starting with the left one, using noun phrases such as ''*the baby and the dog*'' or sentences such as ''*the baby is next to the dog*''. Auditory word distractors were presented together with the pictures at different SOAs. In one set of experiments, the distractor words were either semantically related to the first or the second target or unrelated to both. In other experiments, the distractors were phonologically related to the first or the second target or unrelated to both. When the distractors were semantically related to the first or to the second targets, a semantic interference effect was found, that is to say the spoken latencies on targets were longer when accompanied by semantically related than when presented with unrelated distractors. Given that semantic interference effects have often been ascribed to the level of lemma selection (Levelt et al., 1999; Meyer, 1996; Roelofs, 2000; Schriefers, Meyer, & Levelt, 1990, but see Caramazza & Costa, 2000, and Starreveld & La Heij, 1995, 1996, for a different account of semantic interference effects in single word production), the findings have been interpreted as suggesting that both lemmas are retrieved before the initiation of articulation. Therefore, the initiation of articulation is dependent on prior access to the first and the second lemma in the production of noun phrases or sentences involving two content words. Turning to the effects of distractors that are phonologically related to the first or second content words, the results showed that spoken latencies were faster with phonologically related distractors than with unrelated ones only when they were related to the first targets. The phonological facilitation effect was restricted to the first noun, thus suggesting that the initiation of articulation is not dependent on accessing the word form corresponding to the second target. Recently, Griffin (2001) has shown that, in the production of sentences of the form "*The A and the B are above the C*" to describe three pictured objects, the codability, i.e., the degree to which an object can be assigned a given name, and the word frequency of B and C did not affect the time at which speakers began naming A. According to Griffin (2001), this finding suggests that speakers initiate articulation of "*The A...*" when they have a name available for A before they select names for B and C, on the assumption that codability indexes word selection (lemma) while word frequency indexes access to the phonological codes (lexemes) corresponding to the picture names. This study provides further evidence that advance planning is limited in speech production.

Turning now to written naming, using the interference paradigm, Bonin, Fayol, and Malardier (2000) found that, in the production of two nouns from pictures, only the orthographic lexical form corresponding to the first to-be-produced target was selected, thus replicating Meyer's (1996) finding in speech production. However, the Bonin et al. (2000) study did not examine lemma selection and, therefore, we still have to determine whether, as observed in speech production, there is evidence for the hypothesis that both lemmas are activated during the production of two words from pictures.

There are several differences between writing and speaking that may affect advance planning. Therefore, in the first series of experiments, spoken picture naming was also investigated in order to permit direct comparisons between the two production modes with regard to the issue of advance planning. First of all, writing is slower than speaking. More particularly, the initiation of hand movements in writing is slower than the initiation of articulatory gestures (Zesiger, Orliaget, Boë, & Mounoud, 1994). It takes approximately 100–150 ms to produce one stroke while it takes the same amount of time for a whole syllable to be produced (Zesiger et al., 1994). Second, whereas speakers have to strive for fluency, it may not be important to the same extent during writing. As a result, advance planning in writing is expected to be different from what has been observed in speaking. Indeed, it seems very plausible to hypothesise that writing permits more extensive processing of the second target to take place before naming is initiated than is possible in speech.

## Rationale of the present study

One approach to exploring the scope of the processing involved at each level of representation involved in speech production is to manipulate the properties of the items involved in multi-word utterances (e.g., Alario, Costa, & Caramazza, 2002). The aim is to determine whether the effect of a given property on naming latencies depends on the processing level at which the effect of that property arises and on the number of items that are processed concurrently at that level before speech is initiated. In the present study, we have opted for such an approach in order to investigate the issue of the scope of advance planning in the written (and spoken) production of two content words from pictures. Unlike previous studies, we did not rely on factorial designs but decided to use a multiple regression approach. In the first series of experiments, participants had to say aloud or write down the *bare* nouns corresponding to two pictures that were presented side-by-side on a computer screen, always starting with the left one. Responses were to be as fast as possible and written and spoken latencies were recorded. Although written picture naming is the focus of the present study, spoken naming was included in the first series of experiments to allow direct comparisons with written naming. Certain properties corresponding to the first and to the second targets were included as predictors in the multiple regression analyses to determine which characteristics of each target were reliable determinants of the spoken and written naming latencies. Likewise, variables that are assumed to index specific processing levels involved in the production of pictures were included. This makes it possible to draw certain inferences about the levels of processing that are involved in the production of two words from pictures. The multiple regression approach has already been widely used in the production of single words from pictures (e.g., Barry, Morrison, & Ellis, 1997; Bonin, Chalard, Méot, & Fayol, 2002; Morrison, Ellis, & Quinlan, 1992; Snodgrass & Yuditsky, 1996) and it has helped to identify some of the major determinants of naming speed. However, we are not as yet aware of a study of this kind in the production of multi-word utterances.

As explained above, spoken and written picture naming involve several processing levels: object identification, conceptual preparation, lemma selection, lexeme retrieval, and execution. Therefore, the variables included in the regression equations were chosen for their reliability in indexing these processing levels.

Visual complexity and image agreement were included in the regression analyses for their potential to reveal difficulties associated with *object identification*. Visual complexity corresponds to adults' ratings of the number of lines and details in the drawing. In the Alario and Ferrand (1999) study, the participants rated the complexity of each drawing on a 5-point scale (1 = drawing very simple, 5 = drawing very complex) rather than the complexity of the object it represented. The visual complexity of the pictures has not been found to affect naming times in a systematic and robust manner (Barry et al., 1997; Cycowicz, Friedman, Rothstein, & Snodgrass, 1997, but see Ellis & Morrison, 1998). Image agreement refers to the degree to which mental images generated by participants in response to a picture name match the picture's visual appearance. It is evaluated using a point scale, for instance a 5-point scale. A rating of 1 indicates that the picture provides a poor match for the image and a rating of 5 indicates a very good match. Pictures with high agreement ratings are named faster than pictures with lower agreement ratings (Barry et al., 1997; Bonin et al., 2002). Image agreement has been assumed to index the mapping of the visual appearance of a depicted object with the structural representation corresponding to it (Barry et al., 1997; Bonin et al., 2002).

Conceptual familiarity and image variability were included because these variables index the *semantic/conceptual level*. The familiarity of the concept to be named is evaluated using a point scale. Thus far this variable has not been found to affect naming latencies in a systematic and robust manner (Ellis & Morrison, 1998; Jolicoeur, 1985). Image variability indicates whether the name of an object evokes few or many different images for that particular object (for instance, 1 = few images, 5 = many images). It is assumed that image variability reflects the richness of semantic representations (Bonin et al., 2002; Sanfeliu & Fernandez, 1996). Pictures associated with high ratings are named faster than pictures associated with lower ratings (e.g., Bonin et al., 2002).

Name agreement corresponds to the degree of agreement among speakers concerning the name they use when they refer to a picture. It is generally measured by assessing the number of times a given name is used to refer to a given picture by the various participants. Name agreement is an index of the codability of the pictures. Two potential loci have been pointed out regarding name agreement (Vitkovitch & Tyrrell, 1995). When objects are difficult to identify, e.g., ‘‘*ant*’’ → ‘‘*spider*’’, name agreement could arise as the consequence of competing incorrect responses at the level of structural representations. In contrast, when objects can be given alternative correct names, e.g., ‘‘*couch*’’ → ‘‘*sofa*’’, the effect of name-agreement might reflect a competition involving correct responses and the locus would therefore be lexical. Indeed, several authors have used name agreement as a variable which reveals the lexical or *lemma* selection process (Barry et al., 1997; Griffin, 2001; Levelt et al., 1999).

In spoken naming, word frequency and age-of-acquisition (AoA) effects have most often been considered to occur at the level of lexemic representations, i.e., phonological representations, or in the links relating semantic representations to lexemic representations (Jescheniak & Levelt, 1994; Levelt et al., 1999; Morrison, Hirsh, Chappell, & Ellis, 2002). AoA corresponds to the age at which a word is acquired in its spoken or written form. The AoA of the words can be evaluated by asking adults to rate words on a scale in which the values correspond to various age bands. It has been consistently found that rated AoA norms are both reliable and valid (e.g., De Moor, Ghyselinck, & Brysbaert, 2000; Gilhooly & Gilhooly, 1980; Gilhooly & Logie, 1980). The literature testifies to a debate concerning AoA effects. Some authors have claimed that putative word frequency effects are AoA effects in disguise (Morrison et al., 1992), whereas some studies have found effects of both variables (Barry et al., 1997; Ellis & Morrison, 1998). It is worth noting that most previous reports of word frequency effects in picture naming have not taken AoA into account (e.g., Griffin & Bock, 1998; Humphreys et al., 1988; Jescheniak & Levelt, 1994; Oldfield & Wingfield, 1964, 1965). Importantly, as stated above, most accounts of AoA and word frequency effects have located the effects of these variables at the level of phonological representations or in the links relating semantic representations to phonological representations (Barry et al., 1997; Morrison et al., 1992; Morrison et al., 2002, but see Brysbaert, Van Wijnendaele, & De Deyne, 2000 for arguments in favour of a semantic locus of AoA effects), and there is good evidence to support this hypothesis in connection with both spoken (e.g., Izura & Ellis, 2002) and written picture naming speeds (Bonin, Méot, & Boyer, 2003). We have included both variables in the regression analyses in the light of this controversy and, more specifically, for their potential to index access to *lexemic* representations in both speaking and writing.

It is worth mentioning that, very recently, Zevin and Seidenberg (2002) have raised certain concerns about the use of word frequency estimations that do not take account of the frequency of the words encountered during childhood. According to these authors, frequency estimates that take account of chilhood frequencies lead to more reliable estimates of words encountered over the lifespan, i.e., the cumulative frequency of the words. For American-English, the Zeno norms (1995) meet this criterion. Moreover, Zevin and Seidenberg showed that using the Zeno norms in multiple regression analyses had the effect of removing reliable AoA effects in word reading. They also questioned the use of either rated or objective AoA to predict adult performance in word processing tasks because of the circularity problem involved in predicting performance on the basis of performance. According to them, the frequency trajectory—which refers to changes in frequency over ages—should be used to test the influence of age-limited learning effects ('AoA' effects) in word processing in adults because this variable is based on objective word frequency, and is not therefore a behavioural outcome.

We agree with Zevin and Seidenberg that these concerns are very important ones. In the present study, we used FRANTEXT frequency norms, which can indeed be seen as 'adult' frequencies, together with rated AoA, in line with virtually all the studies conducted in the AoA literature. Nevertheless, in order to take account of these serious concerns, all the analyses performed in the current study were also repeated using cumulative frequency instead of adult frequency, and frequency trajectory instead of rated AoA. The cumulative frequency and frequency trajectory scores were derived from the LEXIQUE and the MANULEX (Lété, Sprenger-Charolles, & Colé, 2004) databases. MANULEX provides frequency counts of words from a corpus of 1.9 million words in the main French primary school reading books for four levels (1st grade, 2nd grade, 3rd to 5th grade) and for all grades (1–5). The patterns of findings reported later in the paper were exactly the same when cumulative frequency and frequency trajectory were used in the place of adult frequency and rated AoA respectively. For the sake of concision, these analyses will not be reported. The most important aspect of note is that the main conclusion to be drawn from our study (see later) is not altered by the choice of norms.

Finally, we included two measures of word length, i.e., number of phonemes and number of letters in spoken and in written naming respectively, because these variables are related to output processes involved in both production modes.

Table 1 provides a summary of the variables included in the regression equations and the processing levels they are supposedly indexing in written and spoken naming.

TABLE 1
Summary of the variables used in the regression analyses and the processing levels indexed by the variables in written and spoken picture naming

| *Variables* | *Processing levels* |
|---|---|
| Visual complexity<br>Image agreement | Object identification |
| Conceptual familarity<br>Image variability | Conceptual preparation |
| Name agreement | Lexical selection (lemma selection) |
| Word frequency<br>Age of acquisition (AoA) | Lexical retrieval (lexeme retrieval) |
| Number of letters/phonemes | Output processes in writing/speech |

A second type of regression analysis was also performed on naming latencies. In this analysis, our independent variables consisted of the latencies in speaking aloud and writing down the targets when they were presented individually. The rationale was that this procedure would permit us to evaluate most of the processing difficulties associated with targets in first and in second position respectively. If production of the first target is dependent on accessing properties associated with the second target, then latencies corresponding to second targets alone should, to some extent, predict the latencies in the production of the targets when presented as pairs. More precisely, these analyses allowed us to evaluate the amount of variance accounted for by the latencies corresponding to the individual targets presented in first and in second position in the naming of pairs of pictures and, therefore, to draw inferences about the amount of processing that takes place on the first and on the second targets.

In the first series of experiments, the participants had to produce two bare nouns from pictures. Given the evidence reviewed above on the issue of dependency in spoken production, we hypothesised that dependency would be somewhat limited in spoken naming. More precisely, the levels of processing mobilised by the second targets should be confined to the structural and semantic levels whereas the processing on the first targets should be more complete, that is to say that structural, semantic, and lexical processing should be engaged before initiation starts. Given the differences highlighted above between spoken and written naming, we anticipated that advance planning would be more extensive in writing than in speaking. More precisely, the levels of processing mobilised by the second targets should extend to levels beyond the semantic level in written naming.

## EXPERIMENT 1: Writing and speaking two bare nouns from pictures

### Method

*Participants.* A total of 116 undergraduate students (108 women and 8 men) from Blaise Pascal University (Clermont-Ferrand) participated in the experiment in order to fulfil a course requirement and were given a course credit. All were native speakers of French with normal or corrected-to-normal vision. The participants were randomly assigned to the spoken (30) and the written (30) picture naming tasks involving pairs of targets, and to the spoken (26) and the written (30) picture naming tasks with isolated targets.

*Materials.* 180 pairs of black-and-white pictures of common objects were used as experimental pictures and 10 additional pairs of pictures as warm-ups. Some experimental pictures were taken from the Snodgrass and Vanderwart (1980) database and others from the Bonin, Peereman, Malardier, Méot and Chalard database (2003). The size of the pictures presented on the computer screen was 8 × 8 cm.

The scores corresponding to the independent variables included in the regression analyses for name agreement, image agreement, conceptual familiarity, visual complexity, image variability, and rated AoA were taken from the Alario and Ferrand (1999) and the Bonin et al. (2003) databases. Word frequency values, referred to as FRANTEXT word frequencies, were taken from the LEXIQUE database (New, Pallier, Ferrand, & Matos, 2001), which includes recent frequency counts for French words from a corpus of over 30 million words. In order to avoid multicolinearity problems in the regression analyses between the two sets of characteristics corresponding to the targets in first and in second position, the targets in first and second position were combined such that the R-square between any given independent variable and the remaining independent variables was below .40. In pairing the pictures, care was also taken to avoid any semantic or phonological/orthographical relatedness. More precisely, semantic relatedness was evaluated by third-year psychology students, who did not take part in the production experiments, on a 5-point scale with 1 = unrelated and 5 = very related. The mean relatedness score was 1.13 ($SD$ = .25, min-max = 1–2.7). Orthographic relatedness was computed using Van Orden, Johnston, and Hale's (1988) formula which yielded a mean score of 0.13 ($SD$ = .097, min-max = .02–.39), thus indicating low orthographic similarity (min-max possible score: .01–1.00). The selected pairs of target picture names are listed in the Appendix.

*Apparatus.* The experiment was run using PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) on a PowerMacintosh. The computer controlled the presentation of the pictures and recorded the latencies. A graphic tablet (WACOM UltraPad A5) and a contact pen (SP-401) were used to record the graphic latencies. An AIWA CM-T6 small tie-pin microphone connected to a Button-Box was used to record the spoken latencies. The recording accuracy for the latencies was to the nearest millisecond.

*Procedure.* The participants were tested individually and were randomly assigned to one of the four picture naming tasks:

**Spoken picture naming of two words.** The participants were told that they would have to say aloud, in order and as quickly as possible, the two names of the pictures presented next to each other on the screen, and to avoid saying 'um' or 'er' before a name. In keeping with a previous study of our own in single object naming (Bonin et al., 2002) and to obtain information about naming failures, the participants were told to say aloud "DKN" whenever they did not know the name to use to refer to a given picture or "DKO" whenever they did not know the object represented by a picture. Moreover, when participants felt they knew the name of the object, but were not able to retrieve it immediately, they had to say aloud "TOT" for "tip-of-the tongue". The pairs of pictures were presented centred on the screen at a viewing distance of about 60 cm. They were presented in different random orders to the participants. The experimenter monitored the participants' responses and scored them for correctness. The entire session lasted about 45 minutes.

Each trial had the following structure: A ready signal (+) was presented on the screen for 500 ms immediately followed by a pair of pictures. The next trial began 5000 ms after the participants had initiated their response. This inter-trial delay was established on the basis of similar studies (Bonin & Fayol, 2000; Bonin, Fayol, & Chalard, 2001). A short break was given to the participants approximately every 20 trials in attempt to avoid fatigue, or practice effects.

**Spoken picture naming of isolated words**. The procedure was exactly the same as that described above except that the participants saw only one picture in each trial and the inter-trial delay was 2500 ms.

**Written picture naming of two words.** The procedure was the same as described for the spoken picture naming task with pairs of pictures except that the participants had to write down, in order and as quickly as possible, the bare nouns corresponding to any given pair of pictures. The written responses were timed as follows: The participants sat with the stylus right above the tablet so that the latency was the time taken to make contact after picture onset. In order to avoid any variability in the positioning of the stylus before each pair of words was written, a line was drawn and the participant was obliged to position the stylus directly above the start of the line. We prepared response sheets (size: 21 × 29.7 cm) to enable us to gather all the written responses relating to the different words. These response sheets consisted of three columns of 20 lines each, with the different lines drawn one above the other at a constant interval of 0.6 cm. The lines were 5.5 cm long. The experimenter ensured that the instructions were adhered to and corrected the participants if they failed to observe them. Also, they were instructed to write down either ‘‘DKN’’, ‘‘DKO’’, or ‘‘TOT’’ when the name of the picture was not immediately available.

Each test trial had the following structure. A ready signal (+) was presented for 500 ms followed by a pair of pictures. The participants wrote down the names of the pictures as quickly as possible. The pictures were removed from the screen after the participant had initiated writing. The next trial was presented after a pause of 10 seconds. This interval ensured that all the participants could write down the two nouns before the next trial began and had been established in a similar previous study (Bonin et al., 2000).

**Written picture naming of isolated words.** The procedure was exactly the same as described above except that the participants saw only one picture in each trial and the inter-trial delay was 5000 ms.



## Results

### *Multiple regression analyses with psycholinguistic variables as independent variables (IV)*

Items that had an error rate greater than 50% in speaking or in writing were removed from the corresponding latency data. For the remaining items (162 in both speaking and writing), trials were eliminated as follows. Trials for which a name other than the intended dominant one was produced were discarded: 13.15% and 10.88% for spoken and written picture naming respectively. Trials involving ‘‘DKN’’, ‘‘DKO’’, and ‘‘TOT’’ were set aside: ‘‘DKN’ responses accounted for 2.63% of the data in speaking and 1.54% in writing, ‘‘DKO’’ responses accounted for 1.48% of the data in speaking and 1.30% in writing, while ‘‘TOT’’ responses accounted for 4.86% of the data in speaking and 4.92% in writing. The difference was reliable between speaking and writing only for the proportions of ‘‘DKN’’ responses ($p < .01$). Trials for which only one of the two names was produced accounted for 0.27% of the data in speaking and 0.37% in writing. Trials in which technical problems occurred (with the voice key or the graphic tablet) were also removed: 0.70% in the spoken naming task and 0.51% in the written naming task. Moreover, for this latter task, words that were misspelled (5.06%) or crossed out (0.88%)

were discarded. On the basis of this set of criteria, 23.09% of the trials in speaking and 25.47% in written naming were removed from the analyses. Finally, latencies exceeding two standard deviations above the participant and item means were excluded: 5.45% and 5.53% of the remaining data in spoken and written picture naming respectively. Using this latter criterion, 7 and 11 more items yielded a response rate of under 50% in spoken and written picture naming respectively. They were therefore eliminated from the analyses.

Overall, 155 items were retained for speaking and 150 for writing and, for these items, 27.12% of the trials were discarded in speaking and 29.13% in writing.[1]

In all the analyses, in order to produce a linear relationship with the latencies, word frequency measures were transformed to log(freq + 1) (Carroll & White, 1973).

In both tasks, only the independent variables associated with the first noun had significant correlations with naming latencies. These were the same in the two tasks: image variability (−.36 speaking vs. −.30 writing), AoA (.33 vs. .37), percentage of name agreement (−.27 vs. −.37), and conceptual familiarity (−.27 vs. −.17).

For each picture naming task, an analysis was conducted on the latencies using the following independent variables: AoA, word frequency, name agreement, image agreement, conceptual familiarity, visual complexity, and image variability. Moreover, the number of phonemes was included in spoken naming and the number of letters in written naming. Each type of independent variable was repeated according to the position of the item in both spoken and written naming. For instance, AoA values corresponding to the first targets and AoA values corresponding to the second targets were included in the analyses. No multicolinearity problems were present in the set of items retained for the analyses.

The overall equations given by the simultaneous regression analyses were significant in both tasks (spoken: $R^2 = 0.32$, $p < .001$; written: $R^2 = 0.36$, $p < .001$).

[1] As can be seen, the error rate was high but it is important to note that two names had to be produced spontaneously from pictures. In a previous study (Bonin et al., 2002) in which single names had to be produced from pictures, the error rate was around 15% in speaking and 14% in writing. Also, in a multiple regression study conducted in English, the error rate in single oral picture naming was around 17% (Barry et al., 1997). Given these error rates in single picture naming, it is not surprising that we obtained the current error rates when two names had to be produced from two pictures.

TABLE 2
Summary of multiple regression analyses in spoken and written picture naming in Experiment 1

| *Multiple R* | *Spoken picture naming* .567 | | | | *Written picture naming* .597 | | | |
|---|---|---|---|---|---|---|---|---|
| | *β* | *SE* | *t* | *p* | *β* | *SE* | *t* | *p* |
| AoA 1 | .213 | .097 | 2.20 | .03 | .258 | .091 | 2.84 | .01 |
| Frequency 1 | .070 | .093 | 0.75 | .45 | .146 | .089 | 1.64 | .10 |
| Name agreement 1 | –.262 | .075 | –3.48 | .001 | –.303 | .073 | –4.15 | .001 |
| Image agreement 1 | .002 | .082 | 0.02 | .98 | –.125 | .081 | –1.54 | .13 |
| Familarity 1 | –.136 | .088 | –1.54 | .13 | –.034 | .084 | –0.41 | .68 |
| Visual complexity 1 | .076 | .075 | 1.01 | .32 | .020 | .075 | 0.27 | .79 |
| Image variability 1 | –.201 | .100 | –2.01 | .05 | –.197 | .092 | –2.13 | .04 |
| No. of letters 1 | | | | | .053 | .082 | 0.65 | .52 |
| No. of phonemes 1 | –.132 | .082 | –1.61 | .11 | | | | |
| AoA 2 | .005 | .092 | 0.06 | .95 | .020 | .090 | 0.22 | .82 |
| Frequency 2 | .021 | .099 | 0.21 | .83 | –.042 | .105 | –0.41 | .69 |
| Name agreement 2 | –.100 | .074 | –1.35 | .18 | –.054 | .071 | –0.75 | .45 |
| Image agreement 2 | –.204 | .078 | –2.61 | .01 | –.200 | .074 | –2.70 | .01 |
| Familarity 2 | –.057 | .091 | –0.63 | .53 | .071 | .096 | 0.74 | .46 |
| Visual complexity 2 | .049 | .080 | 0.61 | .54 | .052 | .077 | 0.67 | .50 |
| Image variability 2 | –.138 | .097 | –1.42 | .16 | –.207 | .096 | –2.17 | .03 |
| No. of letters 2 | | | | | –.052 | .077 | –0.67 | .50 |
| No. of phonemes 2 | –.031 | .080 | –0.38 | .70 | | | | |

*Notes*: 1 = first target; 2 = second target; AoA = estimated age of acquisition; No. = number

Table 2 shows that the variables that had significant effects in the two tasks were, for the first targets, name agreement, AoA and image variability and, for the second targets, image agreement. Image variability corresponding to the second targets was also significant but only in the written naming task.

Moreover, the amount of unique variance (square of the semi-partial correlation) accounted for by the set of variables corresponding to the second targets was extremely small in both production modes ($R^2$ changes were .062 and .068 in speaking and writing respectively, compared with .260 and .286 for the set of variables corresponding to the first targets).

### *Multiple regression analyses using the latencies for the individual naming of the pictures included in the pairs as IV*

Items that led to an error rate greater than 50% in speaking or writing were removed from the corresponding RT data. Using this criterion, 20 and 18 items were found to have less than 50% of valid latencies in spoken and written picture naming respectively. For the remaining items (340 in speaking and 342 in writing out of 360), trials were eliminated as follows. Trials for which a name other than the intended dominant one was produced were discarded: 10.11% and 6.66% in spoken and written picture naming respectively. Trials involving "DKN", "DKI", and "TOT" were set aside: "DKN" responses accounted for 1.22% of the data in speaking and 1.39% in writing, "DKI" responses accounted for 1.09% of the data in speaking and 1.33% in writing, while 'TOT' responses accounted for 2.27% of the data in speaking and 3.18% in writing. Trials in which absolutely no response was produced accounted for 0.02% of the data in both tasks. Trials in which technical problems occurred (with the voice key or the graphic tablet) were also removed: 0.95% in the spoken naming task and 0.31% in the written naming task. Moreover, for this latter task, words that were misspelled (3.23%) or deleted (0.65%) were discarded. On the basis of this set of criteria, 15.65% of the trials in speaking and 16.22% in written naming were removed from the analyses. Finally, latencies exceeding two standard deviations above the participant and item means were excluded: 6.05% and 6.81% of the data in spoken and written picture naming respectively.

Finally, the analyses were performed only for the items for which there were at least 50% valid latencies in the naming of both individual targets and pairs of targets. Thus, 136 and 140 pairs of targets were used in spoken and written picture naming respectively.

In these analyses, the spoken and written latencies were used as the dependent variables while the independent variables were the latencies for the individual naming of the pictures included in the pairs.

For spoken naming, only the latencies of the first targets had a significant correlation with the latencies corresponding to the pairs of targets (.70). In contrast, in written naming, the correlations with both types of latencies were significant. However, latencies to the paired targets correlated more strongly with latencies to the first targets (.66) than with latencies to the second targets (.36).

The simultaneous regression analyses were significant for the two tasks. However, the beta-weights associated with the first targets (.74 and .71 in spoken and written naming respectively) were higher than those associated with the second targets (.31 and .43). In both spoken and written naming, the amount of unique variance accounted for by the latencies for the individual naming of the targets was also higher for the first targets than for the second targets (.54 vs .09 in speaking and .49 vs .18 in writing).

## Discussion of Experiment 1

The findings from the first series of experiments strongly suggest that very little processing of the second targets takes place before the initiation of writing or speaking two bare nouns from pictures. In effect, for the second targets, image agreement was the only reliable determinant of naming latencies in both writing and speaking. Because image agreement is assumed to index access to structural representations, this suggests that early visual processing and access to stored structural knowledge of the second object occur before speech and writing onset. The findings are in line with eye-tracking speech production studies which have shown that when speakers prepare two-word utterances, they first look at the first object then start to look at the second for about 200 ms before initialising speech (Meyer, Sleiderink, & Levelt, 1998; Meyer & van der Meulen, 2000). However, before discussing the implications of the findings further, there are several concerns that need be addressed.

First of all, the experiments did not require any type of linguistic frame. The absence of articles and of any sort of conjunction means that the two words were produced in a rather ''artificial'' way. The question of whether the results generalise to more natural communicative situations is therefore debatable. This is an important issue if we wish to shed light on fundamental processes of production.

A second concern is that participants were required to say DKN, DKO whenever they did not know a name or an object or when they were in a TOT state. It is possible that the need to remember these sequences imposed a substantial load on memory which might have interfered with the participants' forward planning abilities. This would indeed be extremely critical since our main goal was to demonstrate the existence of some form of dependency. Therefore, the next series of experiments employed the same material and procedure as the first series of experiments. However, in this new series, the participants had to produce noun phrases (''*an X and a Y*''). In French, the grammatical gender (masculine or feminine) corresponding to nouns is marked on the determinant (''*un*'' for masculine and ''*une*'' for feminine nouns; e.g., ''*un bureau et une pomme*'' a desk and an apple). Other participants had to produce a noun phrase from the presentation of isolated pictures. Moreover, they were not required to say DKN, DKO, or TOT whenever they failed to produce a name for a picture. Given that our main focus in this study was written naming, only written picture naming was investigated in these experiments.

## EXPERIMENT 2: Writing two nouns from pictures using noun phrases

### Method

*Participants.* The participants (60) were taken from the same pool as in the previous experiments (54 women and 6 men) and were given a course credit. They were randomly assigned to the written picture naming task involving noun phrases with two nouns (30), and to the written picture naming task (30) involving the production of a single noun phrase.

*Materials.* The same stimuli as in the previous experiments were used.The proportion of masculine and feminine object names in first position was 28% and 22% respectively, and in second position it was 26% and 24%. The proportion of pairs with the same grammatical gender was 47%.

*Procedure.* The procedure described above for the written naming task was used but this time the participants had to produce noun phrases.

### Results

#### *Multiple regression analyses with psycholinguistic variables as IV*

Items that had an error rate greater than 50% were removed from the corresponding latency data. For the remaining items (176), trials were eliminated as follows. Trials for which a name other than the intended dominant one was produced were discarded (11.86%). Trials for which only one of the two names was produced accounted for 4.3% of the data. Trials in which technical problems occurred (with the graphic tablet) were also removed: 1.79%. Moreover, words that were misspelled (3.59%) or crossed out (0.60%) were discarded. On the basis of this set of criteria, 22.14% of the trials were removed from the analyses. Finally, latencies exceeding two standard deviations above the participant and item means were excluded: 8.72% of the remaining data. Using this latter criterion, 12 more items received less than 50% of responses. They were therefore eliminated from the analyses.

Overall, 164 items were retained and, for these items, 26.4% of the trials were discarded.

The variables associated with the first noun that had significant correlations with written latencies were AoA (.38), name agreement (−.37), conceptual familiarity (−.22), visual complexity (.22) and image variability (−.29). For the second nouns, only image agreement (−.20) had a significant correlation with the written latencies.

TABLE 3
Summary of multiple regression analyses in written picture naming of Study 2

| *Multiple R* | *636* | | | |
|---|---|---|---|---|
| | *β* | *SE* | *t* | *p* |
| AoA 1 | .280 | .081 | 3.473 | .001 |
| Frequency 1 | .077 | .084 | 0.918 | .360 |
| Name agreement 1 | –.354 | .068 | –5.213 | .0001 |
| Image agreement 1 | –.030 | .074 | –0.409 | .683 |
| Familarity 1 | –.093 | .078 | –1.184 | .238 |
| Visual complexity 1 | .141 | .070 | 2.029 | .044 |
| Image variability 1 | –.132 | .087 | –1.522 | .130 |
| No. of letters 1 | –.007 | .077 | –0.097 | .923 |
| AoA 2 | .129 | .082 | 1.568 | .119 |
| Frequency 2 | .063 | .089 | 0.711 | .478 |
| Name agreement 2 | –.095 | .066 | –1.440 | .152 |
| Image agreement 2 | –.214 | .069 | –3.113 | .002 |
| Familarity 2 | –.007 | .083 | –0.085 | .933 |
| Visual complexity 2 | .064 | .071 | 0.901 | .369 |
| Image variability 2 | –.106 | .087 | –1.222 | .224 |
| No. of letters 2 | –.110 | .070 | –1.563 | .120 |

*Notes*: 1 = first target; 2 = second target; AoA = estimated age of acquisition; No. = number.

A simultaneous regression analysis was conducted on the written latencies with the inclusion of the same independent variables as described in the first series of experiments regarding written naming.

The overall equation given by the simultaneous regression analysis was significant: $R^2 = .405$, $F(16, 147) = 6.255$, $p < .001$.

Table 3 shows that the variables that had significant effects were AoA, name agreement and visual complexity for the first targets, and image agreement for the second targets. The amount of unique variance ($R^2$ difference when this set was included in the equation and when it was not) accounted for by the set of variables corresponding to the second targets was extremely small ($R^2$ change was .089, compared with .326 for the set of variables corresponding to the first targets).

### *Multiple regression analyses using the latencies for the individual naming of the pictures included in the pairs as IV*

Items that had an error rate greater than 50% in writing were removed from the corresponding RT data. Using the latter criterion, 14 items for which the level of valid latencies was less than 50% in written picture naming were eliminated. For the remaining 346 items, trials were eliminated as follows. Trials for which a name other than the intended dominant one was produced were discarded: 8.11%. Trials for which no response was produced accounted for 2.34% of the data in both tasks. Trials in which technical problems occurred (with the graphic tablet) were also removed: 0.55%, and words that were misspelled (2.66%) or deleted (0.52%) were discarded. On the basis of this set of criteria, 14.18% of the trials were removed from the analyses. Finally, latencies exceeding two standard deviations above the participant and item means were excluded: 6.36% of the data.

Finally, the analyses were performed only for the items for which the valid latency level was at least 50% in the naming of both individual targets and pairs of targets. Thus, 156 pairs of targets were used.

In these analyses, the written latencies for the picture pairs were used as the dependent variables while the independent variables were the written latencies for individual pictures.

Latencies to the paired targets correlated more strongly with latencies to the first targets (.71) than with latencies to the second targets (.40).

The simultaneous regression analysis was significant. The written latencies for individual pictures associated with the first and the second targets were taken as independent variables. Both were significant. However, the beta-weights associated with the first targets (.72) were higher than those associated with the second targets (.41). The amount of unique variance accounted for by the latencies for the individual naming of the targets was also higher for the first targets than for the second targets (.51 vs. .17).

The mean naming latencies for the items used in the multiple regression analyses of Study 1 and 2 are reported in Table 4. There are four aspects of note. First of all, naming latencies were longer when naming pairs of targets than when naming individual targets in both writing and speaking. Second, as already found in previous object-naming studies (e.g., Bonin et al., 2001, 2002), written latencies were longer than spoken latencies. Third, as far as written naming is concerned, the bare noun latencies were comparable with the phrase latencies which suggests that noun phrase

TABLE 4
Mean naming latencies (in ms) for the items used in the mutliple regression analyses from Study 1 and 2

| | *Two targets* | *First target* | *Second target* |
|---|---|---|---|
| Spoken naming (study 1) | 1572 | 1004 | 994 |
| Written naming (study 1) | 2370 | 1495 | 1450 |
| Written naming (study 2) | 2380 | 1260 | 1240 |

planning is not a demanding process. Finally, the individual naming latencies for the items that appeared in first and second position in the pairs were comparable.

## Discussion of Experiment 2

In contrast to Experiment 1, the current series of experiments was conducted in written naming only and required the production of a linguistic frame, i.e., noun phrases. Moreover, participants were not told to say DKO, DKN, or TOT when they were not able to give a name to a picture.Overall, the findings are in accordance with those from Experiment 1. In effect, the first type of regression analyses showed that for the second targets, image agreement was the only reliable determinant of naming speed and the second type of analyses revealed that most of the explained variance was accounted for by the latencies corresponding to the first targets. Therefore, when the load on memory is minimised (by not requiring participants to say DKO, DKN, or TOT) and a linguistic frame involving noun targets has to be produced, the scope of the advance planning corresponding to the second targets is limited.



# GENERAL DISCUSSION

In the present study, we addressed the issue of the scope of advance planning in the production of two nouns from pictures. To this end, we investigated the extent to which the characteristics corresponding to the second to-be produced targets (and, of course, also those corresponding to the first to-be produced targets) influence the time taken to initiate execution. Two series of experiments were conducted to address this issue. In the first series of experiments, both the spoken and written naming of two bare nouns from pictures was investigated, whereas in the second series of experiments the production of noun phrases in written naming only was investigated.

As stressed by Levelt and Meyer (2000), experimental reports of cases of dependency in speaking are relatively rare. The originality of our study lies in the fact that we adopted a multiple regression approach in order to investigate this issue further and that we focused on written production. It should be remembered that, thus far, the issue of dependency has not been directly addressed in written production by means of real-time experiments.

In the first series of experiments, participants had to produce two bare nouns from pictures. In the first analysis, a set of variables corresponding to the first targets was introduced together with a set of variables corresponding to the second targets. It was found that for the second targets, image agreement made a strong and reliable independent contribution in both speaking and writing whereas image variability made reliable independent contributions only in writing. Moreover, the amount of unique variance accounted for by the set of variables corresponding to the second targets was extremely small in both production modes. These findings strongly suggest that very little processing of the second targets takes place before the initiation of the writing or speaking of two bare nouns.

In the second analysis, we used the latencies for speaking aloud and writing down the targets in first and second position respectively as independent variables when these targets were named in isolation. The rationale was that the time taken to initiate writing or speaking when target pictures are presented in isolation should capture most of the processing difficulties associated with these targets. We were therefore able to determine the amount of unique variance attributable to the first and to the second targets respectively, and thus to infer the extent to which the processing difficulties associated with the first and the second targets respectively would be reflected in the naming latencies. Our analysis revealed that the amount of unique variance accounted for by the latencies corresponding to the second targets was somewhat small, and that most of the variance was accounted for by the latencies corresponding to the first targets.

Given that the first series of experiments did not require the production of any type of linguistic frame, a second series of experiments focusing on written naming was performed using noun phrases. The goal was to determine whether the pattern of results found for written naming in the first series of experiments would generalise to a more realistic communicative situation. Moreover, unlike in the first series of experiments, the participants were not required to say DKO, DKN, or TOT whenever they failed to provide a name for a picture. In effect, requiring participants to hold these sequences in memory might have imposed a load on memory and limited the scope of advance planning. Again, the first type of regression analysis revealed that, as far as the second targets were concerned, only image agreement was a strong and reliable determinant of written naming speed. The second type of analysis also indicated, that the amount of unique variance accounted for by the written latencies corresponding to the second targets was small, and that most of the variance was accounted for by the latencies corresponding to the first targets.

Taken together, the findings strongly suggest that the initiation of the production of two target names from pictures depends to a large extent on the processing that takes place on the first target and, to a very small extent, on the processing that takes place on the second target. Clearly, the initiation of naming is dependent on very few aspects of the processing of the second targets. We shall return to a more precise characterisation of these aspects later.

As far as the first targets are concerned, the first series of experiments indicated that the variables that were found to contribute to the naming latencies were similar in both production modes. More precisely, the first type of analysis revealed that name agreement and AoA were reliable determinants of naming latencies in both speaking and writing. Image agreement was also a significant determinant of written latencies whereas visual complexity and phonological length were reliable determinants of spoken latencies. The second series of experiments revealed that, again, name agreement and AoA were strong and reliable determinants of written latencies. Visual complexity was also a significant determinant but its contribution was smaller than that of name agreement and AoA. Despite some discrepancies between the reliable determinants of written naming speed across the two series of experiments, the most important predictors were the same, namely name agreement and AoA.

The findings are in line with previous studies on the spoken and/or written production of single words from pictures. In these studies also, among the variables which have been taken into account in the multiple regression analyses, name agreement and AoA have been found to be strong and reliable determinants of naming speed (Barry et al., 1997; Bonin et al., 2002; Ellis & Morrison, 1998; Gilhooly & Gilhooly, 1979; Lachman, 1973; Lachman, Schaffer, & Henrikus, 1974; Morrison et al., 1992; Snodgrass & Yuditsky, 1996; Vitkovitch & Tyrrell, 1995).

One aspect that is worth noting is the observation that AoA, but not word frequency, was a reliable determinant of naming latencies. Although some studies have found some contribution of word frequency in addition to that of AoA in picture naming (Ellis & Morrison, 1998; Snodgrass & Yuditsky, 1996), other more recent picture-naming studies have failed to find a reliable contribution of word frequency when AoA was also taken into account (Barry, Hirsh, Johnston, & Williams, 2001; Bonin et al., 2002; Chalard, Bonin, Méot, Boyer, & Fayol, 2003). More work is needed to resolve this discrepancy. However, for our purposes, the most important consideration is that AoA has been widely recognised to be a variable which indexes representations at the phonological level (Barry et al., 1997; Izura & Ellis, 2002; Morrison et al., 1992, 2002).

As far as the second targets are concerned, we found that very few of their characteristics made a reliable contribution to predicting the naming latencies. It could be argued that the observation that AoA and name agreement did not make independent contributions for the targets in second position across the two series of experiments is related to the fact that, for whatever reason, these targets were not sensitive enough to the variables in question to reveal true effects. We therefore performed a number of multiple regression analyses on the latencies corresponding to the second targets when named in isolation. The same set of independent variables as those introduced in the first analysis reported above were used. In the two series of experiments, these analyses revealed that name agreement and AoA were reliable determinants of naming latencies. Therefore, the lack of reliable effects of name agreement and AoA in the regression analyses for the second targets, when these targets are presented as pairs of pictures, cannot be attributable to any specific characteristics of the pictures and their names when presented in second position, but is instead related to the way they are processed when occurring in second position. It should also be remembered that the analyses of the mean naming latencies for the items used in the mutliple regression analyses in Studies 1 and 2 indicated that the individual naming latencies for the items that appeared in first and second position in the pairs were comparable.

Given that the variables that were considered for inclusion in the multiple regression analyses were chosen for their reliability in indexing certain processing levels involved in picture naming, we are now in a position to draw some inferences about the levels of processing that are mobilised before naming is initiated in the production of two nouns from pictures. In the following, we will concentrate on the pattern of results which was consistent across the two series of experiments. As explained in the Introduction, image agreement has been taken to be a variable which indexes access to structural representations (Barry et al., 1997; Bonin et al., 2002). Name agreement has been understood to be a marker of lemma selection (Barry et al., 1997; Griffin, 2001) or a signal of the difficulties at level of structural representations (Vitkovitch & Tyrrell, 1995). As far as AoA is concerned, most researchers have located the effects of this variable at the lexemic level (Barry et al., 1997; Morrison et al., 1992, 2002). Given that name agreement and AoA corresponding to the first targets were found to be reliable determinants of naming latencies in both speaking and writing, this suggests that processing at the lemma and lexeme levels is engaged before the initiation of writing or speaking. Because only image agreement corresponding to the second targets in both production modes made a reliable contribution, whereas AoA and name agreement did not (but they make reliable contributions when the targets are presented in isolation in standard picture naming tasks), the processing that is undertaken on the second target before writing or speaking starts is restricted to the structural/semantic levels. Thus, there is no access to name representations, that is to say access to lemma and lexeme representations. As far as the lexeme level is concerned, our findings are clearly in accordance with previous findings reported in the literature which have, thus far, failed to reveal any cases of word form access dependency in multi-word utterance production (e.g., Griffin, 2001; Meyer, 1996).

The findings have important implications for written naming. As explained in the Introduction, there are certain differences between speaking and writing that led us to anticipate processing differences concerning the way planning processes are coordinated. More particularly, the observation that writing takes longer to initiate than speaking, and the fact that fluency may not be as important in writing as in speaking, led us to anticipate more extensive planning in writing than in speaking. More precisely, we hypothesised that advance planning in writing would be extended to processing levels beyond the semantic level. On the contrary, the present study has revealed that, as far as the second targets are concerned, only the independent variables that index initial levels of processing were reliable determinants of written latencies. Moreover, in the second series of experiments, in which noun phrases were produced, the same pattern of results was found. It therefore appears that the processes involved in the written production of two nouns from pictures are coordinated in the same way as in speaking. Thus, this suggests a functional similarity between writing and speaking in the production of two nouns from pictures, as has already been proposed by the few studies that have investigated the speaking and writing of isolated words (e.g., Bonin et al., 2002).

Given the above discussion, one logical inference is that some processing of the second targets is undertaken when articulating the first target in speaking and when executing handwriting movements in writing. Although it is beyond the scope of the present study, the next step is to investigate this issue.[2] In written production, there is some evidence that strongly suggests that certain linguistic processes are reflected in writing durations, grammatical rule application for instance (Zesiger et al., 1994).

Do these findings indicate that the dependency is fixed? We have investigated a well-defined situation and have found that this dependency is somewhat limited. However, our findings, as well as others reported in the literature, do not exclude the possibility that dependency may vary as a function of the type of utterance that is to be produced, the experimental paradigm used and certain constraints relating to the communicative situations. Schriefers and Teruel (1999) have indeed found that the initiation of articulation in the production of noun phrases can be based on the phonological encoding of the first syllable for some participants, and on the second one for others. Furthermore, Meyer (1997) found no semantic

[2] It is important to note that the use of the PsyScope software did not permit the recording of handwriting movements and pause durations between words.

priming effects for the second noun when describing pictures such as those used in Meyer's (1996) study (e.g., "*the baby and the dog*"), an observation which is taken to suggest that participants may value speed more than fluency. The initiation of articulation and handwriting movements might be under strategic control. As far as single word production is concerned, there is evidence in the literature that strongly suggests that participants are able to generate internal deadlines for the initiation of articulation. For instance, Meyer, Roelofs, and Levelt (2003) have reported a study conducted in Dutch which replicated the experiments conducted by Bachoud-Lévi, Dupoux, Cohen, and Mehler (1998). In the Meyer et al. (2003) study, contrary to Bachoud-Lévi et al. (1998), a length effect was found on latency only when monosyllabic and disyllabic picture names were blocked for length and not when they were mixed as in the Bachould-Lévi et al. (1998) study. The authors accounted for these findings by suggesting that speakers can strategically control the criterion used for the initiation of articulation, which would be optimal for words in blocked lists. As claimed by Meyer et al. (2003), an important task for psycholinguists is to determine the precise conditions that lead speakers to establish a response criterion. As stressed by Levelt and Meyer (2000), in most experiments, as in ours, and as in many real-life situations, the speaker is subject to two pressures: the need for speed and fluency, i.e., speaking without hesitations or interruptions. Therefore, it is possible that when speed is emphasised, dependency may be attenuated even further or, in contrast, when fluency is emphasised, dependency may be heightened. Because our participants were asked to avoid producing a filled pause before their response, they were probably motivated to be fluent. Therefore, they might have been encouraged to plan more carefully in order to be fluent. Yet, they did not plan very far ahead at all.

Given that the scope of advance planning is limited during speech and writing, one issue is to account for naturally occurring speech errors involving more than one word, for instance phoneme exchanges (e.g.,"*sed rock*" instead of "*red sock*"). Speech errors can be viewed as a derailment of the normal speech production process (Levelt et al., 1999). According to Levelt and Meyer (2000), people probably spread phonological encoding processes thinly to keep the processing load at a comfortable level. Planning too far ahead would increase the chance of producing interference in the encoding of subsequent words. Indeed, we suggest that planning too far ahead is what leads to certain types of speech errors.

To conclude, our study adds further support to Levelt and Meyer's (2000) claim with regards to speaking, while extending it to writing, that, in general, people access the lexemic form of the first target in multi-word utterances without having to bother about access to the lexemic form of later targets.

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## Appendix

List of the pairs of items used in the experiments with their approximate English translations

| *Stimuli* | *English translation* |
|---|---|
| Abeille—Cadenas | Bee—Padlock |
| Accordéon—Règle | Accordion—Ruler |
| Aile—Moto | Wing—Motorcycle |
| Aimant—Pile | Magnet—Battery |
| Allumette—Micro | Match—Microphone |
| Ambulance—Crâne | Ambulance—Skull |
| Anse—Seau | Handle—Bucket |
| Antenne—Ile | Aerial—Island |
| Araignée—Cage | Spider—Bird Cage |
| Arc—Huître | Bow—Oyster |
| Artichaut—Poing | Artichoke—Fist |
| Asperge—Prise | Asparagus—Plug |
| Aspirateur—Domino | Vacuum Cleaner—Domino |
| Avocat—Os | Avocado—Bone |
| Baignoire—Hamac | Bathtub—Hammock |
| Balançoire—Casquette | Swing—Cap |
| Baleine—Volant | Whale—Steering Wheel |
| Balle—Labyrinthe | Ball—Maze |
| Banane—Volcan | Banana—Volcano |
| Bec—Cargo | Beak—Boat |
| Béret—Autruche | Beret—Ostrich |
| Biberon—Hibou | Feeding-Bottle—Owl |
| Bison—Roue | Buffalo—Wheel |
| Bol—Clown | Bowl—Clown |
| Bonnet—Spot | Hat—Spot |
| Botte—Coq | Boot—Rooster |
| Bougie—Maison | Candle—House |
| Boule—Ours | Ball—Bear |
| Boulet—Palme | Prisoner's Ball—Flipper |
| Bras—Escargot | Arm—Snail |
| Bureau—Avion | Desk—Airplane |
| Cadeau—Marin | Present—Sailor |
| Caisse—Enveloppe | Crate—Envelope |
| Calendrier—Tasse | Calendar—Cup |
| Caméra—Saxophone | Camera—Saxophone |
| Canapé—Lunettes | Couch—Glasses |
| Canne—Rhinocèros | Cane—Rhinoceros |
| Canon—Momie | Cannon—Mummy |
| Carabine—Douche | Rifle—Shower |
| Carotte—Boîte | Carrot—Box |
| Casserole—Panier | Pot—Basket |
| Cendrier—Pélican | Ashtray—Pelican |
| Cerf—Porte | Deer—Door |
| Cerise—Aigle | Cherry—Eagle |
| Cerveau—Louche | Brain—Ladle |

| *Stimuli* | *English translation* |
|---|---|
| Chaise—Lézard | Chair—Lizard |
| Champignon—Violon | Mushroom—Violin |
| Chat—Bibliothèque | Cat—Book-Shelves |
| Cheveux—Téléphone | Hair—Telephone |
| Chignon—Loup | Bun—Wolf |
| Chronomètre—Punaise | Stop Watch—Drawing-Pin |
| Cigarette—Fouet | Cigarette—Whip |
| Cintre—Baril | Hanger—Barrel |
| Circuit—Lama | Circuit—Llama |
| Ciseau—Panda | Scissors—Panda |
| Citron—Harpe | Lemon—Harp |
| Citrouille—Agenda | Pumpkin—Diary |
| Classeur—Raie | Box File—Ray |
| Clef—Bouteille | Key—Bottle |
| Coeur—Sablier | Heart—Hourglass |
| Cou—Ancre | Neck—Anchor |
| Crêche—Evier | Crib—Sink |
| Crête—Trompette | Comb—Shrimp |
| Cuillère—Note | Spoon—Notes |
| Cygne—Hamburger | Swan—Hamburger |
| Doigt—Equerre | Finger—Set Square |
| Drapeau—Oie | Flag—Goose |
| Eclair—Arbre | Flash of Lighting—Tree |
| Eglise—Bus | Church—Bus |
| Empreinte—Plongeur | Fingerprint—Diver |
| Epée—Jumelles | Sword—Binoculars |
| Feuille—Koala | Leaf—Koala |
| Fléche—Collier | Arrow—Necklace |
| Flipper—Table | Pinball Machine—Table |
| Fourche—Poussin | Fork—Chick |
| Fourchette—Verrou | Fork—Bolt |
| Fraise—Girafe | Strawberry—Giraffe |
| Fusée—Entonnoir | Rocket—Funnel |
| Gâteau—Dent | Cake—Tooth |
| Girouette—Couteau | Weather Vane—Knife |
| Globe—Drap | Globe—Sheet |
| Griffe—Robot | Claw—Robot |
| Haie—Coccinelle | Fence—Ladybug |
| Haltère—Carte | Bar-Bell—Playing Card |
| Hélicoptère—Biche | Helicopter—Deer |
| Hippopotame—Chaussette | Hippopotamus—Sock |
| Houx—Escalier | Holly—Stairs |
| Igloo—Lionceau | Igloo—Lion Cub |
| Jambon—Hérisson | Ham—Hedgehog |
| Journal—Chandelier | Newspaper—Candlestick |
| Jupe—Croix | Skirt—Cross |
| Klaxon—Gant | Horn—Glove |

| *Stimuli* | *English translation* |
|---|---|
| Langue—Filtre | Tongue—Coffee Filter |
| Lapin—Cactus | Rabbit—Cactus |
| Larme—Cigare | Tear—Cigar |
| Lettre—Cuisine | Letter—Kitchen |
| Licorne—Poêle | Unicorn—Frying Pan |
| Lion—Quille | Lion—Skittle |
| Loupe—Partition | Magnifying Glass—Score |
| Lune—Cicatrice | Moon—Scar |
| Maïs—Poche | Corn—Pocket |
| Marelle—Cafetière | Hopscotch—Coffeepot |
| Marteau—Cloche | Hammer—Bell |
| Masque—Planète | Mask—Planet |
| Médaille—Interrupteur | Medal—Light Switch |
| Menottes—Luge | Handcuffs—Sled |
| Métre—Chapeau | Tape Measure—Hat |
| Microscope—Seringue | Microscope—Syringe |
| Miroir—Crocodile | Mirror—Alligator |
| Montagne—Branche | Mountain—Branch |
| Mouche—Bouton | Fly—Button |
| Moufle—Squelette | Mitten—Skeleton |
| Moustache—Oiseau | Mustache—Bird |
| Mur—Orange | Wall—Orange |
| Natte—Ane | Plaits—Donkey |
| Nid—Puits | Bird Nest—Well |
| Noeud—Lampe | Bow—Lamp |
| Nuage—Lévres | Cloud—Lips |
| Oeuf—Sifflet | Egg—Whistle |
| Oignon—Brouette | Onion—Wheelbarrow |
| Oreiller—Casque | Pillow—Helmet |
| Palmier—Salière | Palm Tree—Salt Shaker |
| Papillon—Chaîne | Butterfly—Chain |
| Parapluie—Cacahouète | Umbrella—Peanut |
| Passoire—Infirmière | Colander—Nurse |
| Peigne—Champ | Comb—Meadow |
| Pelle—Ceinture | Shovel—Belt |
| Pelote—Stéthoscope | Ball of Wool—Stethoscope |
| Perruche—Caravane | Parrot—Caravan |
| Piano—Fille | Piano—Girl |
| Pièce—Fée | Coin—Fairy |
| Pince—Cercueil | Pliers—Coffin |
| Pinceau—Commode | Paintbrush—Dresser |
| Pingouin—Sirène | Penguin—Mermaid |
| Placard—Train | Closet—Train |
| Plante—Tétine | Plant—Dummy |
| Plat—Oreille | Dish—Ear |
| Poignée—Sandwich | Doorknob—Sandwich |
| Poireau—Route | Leek—Road |

| *Stimuli* | *English translation* |
|---|---|
| Poisson—Télévision | Fish—Television |
| Poivron—Hache | Pepper—Axe |
| Pomme—Canard | Apple—Duck |
| Poubelle—Valise | Garbage Can—Suitcase |
| Poulet—Banc | Chicken—Bench |
| Poumons—Balance | Lungs—Scale |
| Pyramide—Râteau | Pyramid—Rake |
| Raisin—Lacet | Grapes—Shoelace |
| Rat—Esquimau | Rat—Choc-Ice |
| Reine—Balai | Queen—Broom |
| Renard—Ski | Fox—Ski |
| Requin—Tank | Shark—Tank |
| Robe—Barbecue | Dress—Grill |
| Sabot—Rose | Clog—Rose |
| Scie—Paon | Saw—Peacock |
| Scorpion—Croissant | Scorpion—French Croissant |
| Sein—Lime | Breast—Nail File |
| Selle—Dinosaure | Saddle—Dinosaur |
| Serpent—Portefeuille | Snake—Wallet |
| Souris—Ampoule | Mouse—Light Bulb |
| Spaghetti—Pot | Spaghetti—Jar |
| Tableau—Libellule | Board—Dragonfly |
| Tambour—Chenille | Drum—Caterpillar |
| Tampon—Usine | Stamp—Factory |
| Tente—Crabe | Tent—Crab |
| Thermomètre—Diamant | Thermometer—Diamond |
| Toilette—Voiture | Lavatory—Car |
| Toit—Bouée | Roof—Lifebuoy |
| Tondeuse—Vélo | Lawnmower—Bicycle |
| Torchon—Pipe | Dish Cloth—Pipe |
| Tournevis—Crayon | Screwdriver—Pencil |
| Tracteur—Conduite | Tractor—Pipe |
| Trèfle—Carrosse | Clover—State-Coach |
| Trombone—Briquet | Paper-Clip—Lighter |
| Tronc—Vase | Trunk—Vase |
| Tunnel—Ongle | Tunnel—Nail |
| Urne—Poule | Urn—Chicken |
| Vis—Pont | Screw—Bridge |
| Voile—Chèvre | Sail—Goat |