# Contrasting explicit and implicit instruction for grammatical categorization

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## Language Learning

Grammar is one of the most difficult tasks in learning language (Birdsong, 1999). That difficulty stems from the complexity of the system and the lack of transparency in the correspondence between form and meaning (e.g., DeKeyser, 2005).

Domain-general categorization models (e.g., Posner & Keele, 1970) predict that variables that affect category representation will likewise affect generalization performance.

Here, we manipulate the explicitness of the category representation and the strength of one example of each category to see the effect on learning a *language [grammar] task.*

What is the capability of **adult** naïve subjects to learn a grammar categorization task, and what are the effects of explicit instruction on their performance? Are those effects moderated by the presence of a more frequent [available] exemplar?

Our goal is to use explicit instruction of a grammatical structure with beginning French students.

## Relevant Learning Questions

Can explicitly taught cues to French grammatical gender be effectively learned by novices? Does implicit learning render an advantage in delayed recall?

Are cues that are less reliable indicators (e.g., conflict with other cues) more difficult to learn, and can we quantitatively predict that difficulty?

Does emphasizing the cue by using a more frequent, salient "prototype" word improve learning over equal frequency varied exemplars?

## French Grammatical Gender

Binary categorization system: *masculine (e.g., le fromage)* and *feminine (e.g., la sortie)*

Native speakers show consistency in their gender assignments to nonce words ➔ patterns in the gender of even inanimate nouns (Carroll, 1999); *e.g.*, words that end in *-age* tend to be masculine

For this intervention, we teach 24 cues to grammatical gender (all orthographic cues, some with morphological meaning).

## Specific Hypotheses

We hypothesized that students would learn the cues over time, as indicated by increased accuracy and decreased response latency, and that this learning would extend to a generalization task [post-tests] and a retention interval [delayed post-test].

In the prototype manipulation, we predicted that the prototype word itself would experience a large benefit in performance (from saliency and repetition). If that benefit generalized to other exemplars of that same rule, we expected an increase in accuracy and corresponding decrease in latency for the other exemplars, as well.

Further, we speculated that the effect of the increased transparency would be mediated by some measure of the cohesiveness of the category; the more self-similar the category members are, the stronger the effect should be.

## Design & Procedure

N = 40 undergraduate & graduate students at CMU with no prior French experience.
Students used a tutor (Fig. 1) based on prior classroom studies, but in a lab setting with *controlled within-subjects manipulations* (described in Fig. 2):


Fig. 1. Tutor screenshot.

1)Within subjects, half (12) of the cues to gender were taught with **one highly frequent example**, or "prototype", presented 50% of the time, and 7 other **equally frequent exemplars**, presented in total 50% of the time. The other half were taught with **14 equally frequent exemplars**; condition assignment was randomized for each rule for each participant.
2)Also within subjects, half of each session gave feedback with explicit instruction (e.g., *age -> M*). The same cues were taught explicitly across sessions, but cues were randomized for each user.

### Timeline

As shown in Fig. 2, the learner completed a pre-test followed by a training session the same day. Training sessions 2 & 3 were 1 week apart, with an immediate post-test after session 3. After 2-3 weeks, the learner returned for a delayed post-test.

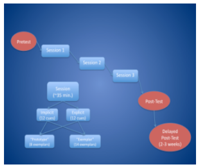


Fig. 2. Study timeline.

### Variables

The independent within-subjects variables were the explicit or implicit instruction conditions and the "prototype" vs. equal frequency examples.

Dependent measures were accuracy and latency of correct response on both the post-tests and the training trials.

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## Results

Accuracy and latency improved significantly with training on both of the generalization post-tests ($F(1, 39) = 176.2$, $p < .0001$ $d = .84$). This increase was maintained with slight decay to the delayed post-test, shown in Table 1.

| | Accuracy | Latency |
|---|---|---|
| Pretest | 0.621 (.014) | 1979 (111.6) |
| Session 1 | 0.858 (.014) | 1106 (49.3) |
| Session 2 | 0.908 (.011) | 872 (47.4) |
| Session 3 | 0.933 (.010) | 776.1 (42.5) |
| Posttest | 0.89 (.018) | 1106.5 (74.2) |
| Delayed Posttest | 0.848 (.018) | 1143 (69.4) |

Table 1. Mean accuracy & latency by session.

Cues taught with a "prototype" were more accurate *and faster* on the post-tests ($F(1,39) = 3.15$, $p = .08$); however, this interacts with test time such that the difference narrows over time.

Explicitly instructed cues were approximately equal at immediate post-test to inductive learning, but by the delayed post-test the explicit cues were (shown in Fig. 3) more accurate ($F(1,39) = 3.44$, $p < .05$) though not faster ($F < 1$). Overall, though, explicit instruction led to faster response time ($F(1,39) = 4.9$, $p < .05$).

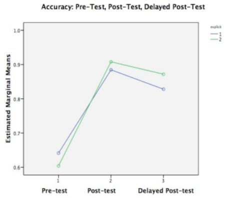


Fig. 3. Implicit (blue line) vs. Explicit (green line) across tests.

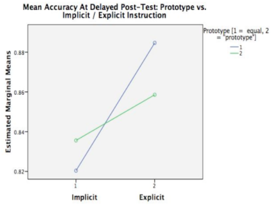


Fig. 4. Prototype x Explicitness in delayed post-test.

## Discussion

Fig. 4 shows the interaction between the explicit instruction and example frequency: *The prototype only helps in the implicit learning condition, even considering delay / robustness. Gains from explicit prompts are larger than those from a salient example.*

Learning was robust to delay and generalization, even under explicit instruction. Explicit instruction showed performance advantages, though implicitly learned cues were helped by the presence of a frequent, salient example ["prototype"].

This is consistent with what we know about categorization, and represents the first step in what we see as the application of domain-general principles to the language-learning problem.

Future work will bring this test to a French classrooom and expand on the predictions tested here with more precise models of the task. Also, we must consider more realistic language tasks for more complete analysis.