frontiers | Frontiers in Language Sciences

TYPE Original Research
PUBLISHED 20 November 2024
DOI 10.3389/flang.2024.1487987

OPEN ACCESS

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RECEIVED 29 August 2024
ACCEPTED 25 October 2024
PUBLISHED 20 November 2024

CITATION
Ishikawa K (2024) Effects of second language learning conditions along the implicit/explicit continuum: an extension of Ishikawa (2019). *Front. Lang. Sci.* 3:1487987. doi: 10.3389/flang.2024.1487987

Effects of second language learning conditions along the implicit/explicit continuum: an extension of Ishikawa (2019)

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This study investigated the effects of learning the morphological rules of a second language under various learning conditions along the implicit/explicit continuum. It compared outcomes between learners under the attentional (required to attend to targets) and intentional (required to search for rules) conditions and under the incidental and explicit conditions immediately after exposure and after 1 week. The study also assessed the nature of acquired knowledge using subjective measures of awareness during the testing phases and post-experimental verbal reports. The results demonstrated similar learning effects across the four groups of learners immediately after the learning phase, whereas only intentional learners outperformed incidental learners after one week. The participants developed conscious and unconscious knowledge irrespective of being attentive or intentional during the learning phase. The outcomes of oral production tasks illustrated that knowledge acquired through exposure did not manifest as productive knowledge. The study discussed the results in terms of learning conditions along the continuum of implicitness and explicitness.

KEYWORDS

derivational morphology, implicit/explicit continuum, attentional learning, intentional learning, implicit knowledge

1 Introduction

A hallmark of human language competence is its open-ended nature of creation: the capacity to generate an infinite number of expressions from a finite set of elements and rules (Hauser et al., 2002; Pinker and Jackendoff, 2005). The generalization of patterns from linguistic input, which is evident in morphological learning (Tamminen et al., 2012, 2015), renders this feat possible. How do humans generalize and learn morphological rules? This study aims to investigate the learning and knowledge retention of derivational morphology in terms of type of learning (differing degrees of implicitness or explicitness), nature of knowledge, and its potential transfer to production.

1.1 Degree of implicitness or explicitness in learning grammatical rules

The literature acknowledges that children typically learn grammatical rules in an unconscious manner (DeKeyser et al., 2010; Ullman, 2001). In contrast, adults engage in the conscious and unconscious processes of linguistic input (Andringa and Rebuschat, 2015; Ellis, 2005; Hulstijn, 2005; Rebuschat and Williams, 2012; Rogers et al., 2016; Williams, 2005). Scholars have long been interested in the

effectiveness of conscious/explicit learning vs. unconscious/implicit learning and their interface (for a review, see Rebuschat, 2015). Recent studies have experimentally compared the relative effects of two types of learning, namely, incidental and explicit or intentional learning (Denhovska and Serratrice, 2017; Gao and Ma, 2021; Ishikawa, 2019; Rivera et al., 2023; Robinson, 1996, 1997; Tagarelli et al., 2016).

For example, Robinson (1996) compared the learning of English grammar rules related to the position of location and time phrases in sentences under four training conditions, namely, implicit (as a memory test), incidental (as an exercise in reading for meaning), rule search (as an exercise in finding rules), or explicit (termed *instructed* in Robinson's study; participants were given the rules). The results of grammaticality judgment tests (GJTs; e.g., "Across the street raced Tom" is considered grammatical but not "On Saturday night danced Charlie") indicated that explicit learners outperformed other groups, although Robinson (1996) study did not include a control group.

Following Robinson (1997), Rivera et al. (2023) used dative alternation rules in English (e.g., both "Marta gives Antonio her key" and "Marta gives her key to Antonio" are correct) as materials in comparing incidental, intentional, and explicit learning conditions. Incidental conditions refer to the learning phase in which participants listen to (or read) a sentence and understand its meaning without disclosure of the rules applied to the sentence. Intentional conditions denote the learning phase in which participants determine the rules applied to a learning sentence. Lastly, explicit conditions pertain to the learning phase in which participants are given metalinguistic explanations of the rules applied to the learning sentence (also in Leow, 2019). The results of the GJTs demonstrated that the rates of accuracy of the intentional and explicit condition groups were higher than that of the incidental condition group, presumably because verbs and prepositions in the learning sentences were highlighted under the intentional condition.

Tagarelli et al. (2016) and Gao and Ma (2021) tasked native English and Chinese speakers, respectively, with learning semiartificial language comprised of sentences with German syntax and English words (e.g., "Yesterday scribbled David a long letter to his family") with varying degrees of linguistic complexity. These studies compared incidental and explicit conditions. The authors found the superiority of explicit conditions for less complex sentences, but little difference between the two with the increase in complexity. However, these studies did not include control groups, which may have displayed certain learning effects even in the absence of the learning phase.

Those studies have not investigated the delayed effects of different learning types, focusing only on the immediate effects. In contrast, Morgan-Short et al. (2012) used an artificial language paradigm to examine longitudinally how explicit and implicit types of language training differentially affect electrophysiological and behavioral measures of L2 syntactic processing. The participants in both groups in their study received extensive training over 1–5 days. Their outcomes revealed that only the implicit-type learners achieved more native-like brain responses, while the two groups did not differ in the behavioral measures. Ishikawa (2019) investigated both the immediate and delayed effects of the incidental and explicit learning of derivational morphology embedded in a semiartificial lexicon (e.g., "He shows his bɔdisnəs in the library") by Japanese learners of English who had a brief exposure to linguistic input, compared to a control group. The results indicated that both learning conditions produced the same levels of accuracy on immediate testing, but only explicit learners retained knowledge after 1 week.

The abovementioned studies overlooked the manipulation of attention to target forms in the learning of grammatical rules, because they were interested in whether learners were given instructions (intentional and explicit conditions) or not (incidental). Some psychological work has demonstrated the role of attention in learning even when participants are engaged in automatic or unconscious processes and pointed to the importance of directing or manipulating attention to the relevant feature of the items to be learned (Jiménez and Méndez, 1999; Logan and Etherton, 1994). The SLA literature has also argued that instruction and manipulation of attention to target forms in the input promote L2 development (Doughty, 2003; Gass et al., 2003; Issa and Morgan-Short, 2019; Liu et al., 2024). Most of the literature has operationalized learning while directing attention to target forms in the visual modality with textual enhancement such as underlining (Gass et al., 2003), using red font (Issa and Morgan-Short, 2019), or both capitalizing and underlining (Liu et al., 2024). In the present study, under the auditory modality, directing attention to target forms without explicit target rules was operationalized as attentional learning. Theoretically, Tomlin and Villa (1994) distinguished three levels of attention in SLA from a cognitive science perspective: alertness, which represents an overall readiness to deal with incoming stimuli, orientation, which entails the specific aligning of attention on a stimulus, and detection, which involves the cognitive registration of information that is available for other cognitive processing. Similarly, Schmidt (1990, 2001) proposed two levels of awareness of conscious and unconscious language learning, namely, noticing (learners infer certain aspects of the input) and understanding (learners infer the rules or regularities underlying the structure of the input). At the level of noticing, linguistic forms that receive attention can be learned. Tomlin and Villa's "detection" and Schmidt's "noticing" seem to be closely related in that both direct selective attention to target forms (instead of target rules) but take place before awareness of their regularities. However, no empirical research has been done to investigate the effect of this type of attentional learning in comparison with incidental and explicit or intentional learning conditions.

To date, no studies have examined the effects of different types of learning along the broad continuum of implicitness or explicitness. Thus, the present study added an attentional learning condition to elucidate the effects of learning conditions along the implicit/explicit continuum: incidental, attentional, intentional, and explicit.

1.2 Nature and measurement of acquired knowledge

One widely-accepted method for measuring whether acquired knowledge is implicit or explicit is the subjective measure of

awareness (Dienes and Scott, 2005; Rebuschat, 2013). This measure can identify the construct of awareness that is not verbalized. Two approaches have been used in measuring subjective awareness. The first is confidence ratings in which participants indicate their level of confidence (e.g., *no confidence*, *somewhat confident*, *very confident*, or *absolutely certain*) for each decision during the testing phrase. The second is source attributions in which participants identify the source of judgment (e.g., *guess*, *intuition*, *memory*, or *rule knowledge*). Knowledge can be considered unconscious if the confidence of participants is unrelated to accuracy (zero-correlation criterion), or if a negative correlation is observed between confidence and accuracy, which provides evidence for better performance without conscious knowledge (Rebuschat, 2013). Knowledge can also be considered implicit if participants believe that they are guessing when their classification performance is significantly above chance (guessing criterion). The intuition and guess attributions are considered to correspond to unconscious knowledge.

For instance, Rogers et al. (2016) used the two types of subjective measures and found that learners developed implicit and explicit knowledge through incidental exposure. Tagarelli et al. (2016) used this measure to examine the knowledge acquired by incidental and explicit learners. The authors found that learners in the incidental and explicit groups relied more on implicit and explicit knowledge, respectively. Producing results similar to those of Tagarelli et al. (2016), Ishikawa (2019) found that part of the explicit knowledge acquired by explicit learners becomes implicit after 1 week. The current study also examined the potential shift in knowledge between immediate and one-week delayed testing.

1.3 Productive knowledge

The issue whether or not knowledge gained through exposure to input is transferrable to productive knowledge remains under-investigated. Studies such as de Jong (2005) and DeKeyser (1997), using long-term practice paradigms (2 weeks and 8 weeks, respectively), have shown that practice effects are skill-specific. Thus far, only a few studies have experimentally examined this issue with a focus on implicit/explicit learning using a brief exposure to input.

For instance, in the following three studies, learners were given 15–45 min of exposure on a single day. Participants in Denhovska and Serratrice (2017), who received 15 min of training, were grouped under the incidental and explicit conditions and completed a GJT and a written production task (fill-in-the-blank test). The results demonstrated that learners under both conditions produced a similar accuracy in comprehension, but only explicit learners performed at an above-chance level on the production task. After completing the GJT, the participants in Gao and Ma (2021) with 15 min of input exposure wrote as many grammatical sentences as they could with reference to a given list that contained 10 expressions. The results indicated that the explicit group performed better than did the incidental group in the GJT and production tasks (greater proportion of target-like sentences). Bovolenta and Williams (2022) trained participants under the incidental learning condition of form-meaning mappings for 45 min, including cued recall trials; even unaware participants used the acquired knowledge in cued oral recall tests. The current study also examined this understudied issue of knowledge transfer from comprehension to production under attentional and intentional conditions with approximately 15 min of input exposure.

1.4 The present study

The purpose of this study is to extend the findings of Ishikawa (2019) concerning the effects of various learning conditions on the acquisition of L2 derivational morphology. Ishikawa (2019) investigated the acquisition of Japanese learners of English of L2 derivational rules that were auditorily presented in semiartificial language sentences. The author compared the learning effects and resultant knowledge under three learning conditions, namely, incidental, explicit, and control (20 participants for each group). Incidental learners listened to 48 grammatical sentences twice (96 sentences in total). Afterward, they were requested to select one of the two pictures on a computer screen that they deemed to match the content of the sentence. A chime or a beep indicated whether their choice was correct or not, respectively. Explicit learners received an explanation in Japanese (using PowerPoint slides) that English has three types of suffixes used to form nouns, adjectives, and verbs. The participants then listened to auditory examples of 12 suffixes and sentences, including suffixes (three grammatical categories × four suffixes) with explanations written on the PowerPoint slides. The learning phase was not applied to the control group. The results of the GJT and subjective measures of awareness immediately after exposure demonstrated that both experimental groups exhibited the same learning effects. However, after 1 week, only explicit learners maintained the effects. Incidental learners acquired primarily unconscious knowledge, whereas explicit learners principally relied on conscious knowledge, some of which eventually became unconscious.

The present study extended that of Ishikawa (2019) in two ways, namely, by adding the attentional and intentional conditions and introducing a production task. The two studies were identical in other aspects such as stimuli and procedure with different learning phrases and participants with the same background and language proficiency. Therefore, the present results of the learning effects will be combined with those of Ishikawa (2019) to elucidate the effects of varying learning conditions (on the continuum of incidental, attentional, intentional, and explicit conditions in order of explicitness), which will be reported in the Result and Discussion sections. The current study intends to address the following research questions:

RQ1: To what extent do adult learners learn (immediate tests) and retain (delayed tests) L2 derivational morphology under the different learning conditions along the implicit/explicit continuum?

RQ2: What is the nature of acquired knowledge: implicit or explicit?

RQ3: To what extent is knowledge acquired through a brief auditory exposure transferrable to productive knowledge?

2 Method

2.1 Participants

A total of forty Japanese university students aged 18–21 years were recruited for the study. They were native speakers of Japanese and studied English as a foreign language for at least 6 years. Their scores in English proficiency tests were 440–600 for TOEIC L&R or Eiken Grade Pre-2 and Grade 2 (corresponding approximately to the A2/B1 level of the Common European Framework of Reference for Languages).

The participants received compensation for their participation. They signed the consent form on the first day (Day 1) and were reminded that they needed to participate again after 1 week (Day 8). In the consent form, the researcher also explained that the task was to perform an action after listening to a sentence (via headphones connected to the computer) and that participants were free to withdraw at any time during the research. It provided no information about the objective of the study. The participants were randomly assigned to two groups, namely, attentional and intentional learning groups, with 20 participants in each group.

2.2 Stimuli

The stimuli were 144 sentences, including nonwords with 12 suffixes based on real English suffixes that form three grammatical categories [noun: -mənt, -nəs, -ʃən (ʒən), and -əti; adjective: -fəl, -ɪʃ, -əl, and -ɪk; verb: -eɪt, -ən, -aɪz, and -ɪfaɪ]. The suffixes were selected from 32 major English suffixes listed in Harwood and Wright (1956). The stems of the nonwords consisted of two syllables: consonant plus vowel plus consonant (CVC) plus /ɪ/, /i/, /ɪs/, /ɪz/, /is/, /iz/, or /əs/. The CVC parts of the nonwords were constructed with reference to Noble (1961), which ensures a variation of vowels and consonants. These nonwords were inserted into sentence frames designed for the three word classes. The noun frames were "She shows some __ at home," "He shows his __ in the library," "The teacher likes his __ at school," and "The doctor likes to show his __". The adjective frames were "She is very __ at home," "He is very __ in the library," "The teacher is very __ at school," and "The doctor is a very __ person". The verb frames were "She tries to __ her friend at home," "He wants to __ his book," "The teacher tries to __ at school," and "The doctor wants to __ his patient". These sentence frames were considered to be appropriate for intermediate learners of English to understand while listening without written forms. Appendix A presents all stimuli. Table 1 presents examples of sentences under the three grammatical categories.

Forty-eight out of the 144 sentences were used to create an exposure list. Another 48 sentences were used as grammatical sentences for the testing phase. The remaining 48 sentences were rendered ungrammatical by inserting the nonwords into inappropriate categories in the sentences (e.g., "The doctor is a very bəfɪsnəs person"). Two versions of the sentence lists (each with 48 sentences) were prepared for the two testing phases (Days 1 and 8), which were counterbalanced across participants.

These stimulus sentences were converted into audio files using text-to-speech software (Globalvoice English 3, HOYA). Half of them were created with an American male voice, and the other half with a British female voice and were counterbalanced across grammatical categories for each learning and testing set.

TABLE 1 Example sentences under the three grammatical categories.

Grammatical category	Examples
Noun	She shows some mezəsmənt at home.
	The teacher likes his dəfɪʒən at school.
Adjective	She is very bæpisfəl at home.
	The doctor is a very fəmɪsɪk person.
Verb	She tries to nebəsaɪz her friend at home.
	The doctor wants to vədɪsɪfaɪ his patient.

2.3 Procedure

The experiment consisted of two phases, namely, learning and testing. In the learning phase, the attentional and intentional learning groups listened to 48 grammatical sentences twice (a total of 96 sentences). The attentional group was requested to select the word class of a nonword by pressing the number indicated below (1: noun, 2: adjective, and 3: verb). This instruction presumably encouraged the participants to pay attention to the target nonwords, which included suffixes, without explicit target rules. A chime or a beep signaled whether the choice was correct or not, respectively. The intentional group was required to try to identify the rules of how nouns, adjectives, and verbs are made and to indicate whether or not they have done so by pressing the number indicated below (1: Yes and 2: No). This instruction presumably prompted them to intentionally search for target rules without being given the rules explicitly. A chime or a beep indicated their selection of "1: yes" or "2: no." The instructions for both groups were also explained in Japanese. The order of the presentation of the sentences was randomized for each participant, and the learning period lasted for approximately 15 min. SuperLab 6.0 with a response pad (RB-740) controlled the stimulus presentation (Cedrus Corporation).

Testing phase: The two groups took the GJT at two time points, namely, immediately after the learning phase (Day 1) and after 1 week (Day 8). Different stimulus sentences were used on Days 1 and 8. The participants listened to one of the two versions of 48 sentences, including new nonwords with the suffixes, and determined whether each sentence was grammatically correct or incorrect as quickly and accurately as possible by pressing the designated buttons on the response pad. The sentences were presented in randomized order for each participant. Half of the sentences were grammatically correct (e.g., "The doctor likes to show his bəfɪzmənt") and the other half were grammatically incorrect (e.g., "The teacher tries to səfɪsɪk at school"). No feedback was provided in the testing phase.

After each trial, the participants indicated the degree of confidence in their decision using a four-point scale (1 = *no confidence*, 2 = *somewhat confident*, 3 = *very confident*, or 4

= *absolutely certain*) and the basis of their judgment (i.e., 1 = *guess*, 2 = *intuition*, 3 = *memory*, or 4 = *rule*). Explanations of the definitions of the English terms in the four-point scale were provided also in Japanese.

The production task followed the testing phase. In this task, the participants listened to a phrase (auditory stimuli produced by the same software used to create the learning stimuli as reported in the Stimuli section) and uttered the next word to complete a sentence. They were also told that they could utter an English word (or words) or nonword(s) that they could think of. With their permission, their voices were recorded for later analysis. The sample phrases for noun, adjective, and verb were as follows: The child shows some ( )./The student is very ( )./The writer wants to ( ). For example, a participant heard "The girl shows some …" and uttered "ideas" to complete a sentence. Appendix B presents the materials for the production task.

After the testing phases on Day 8, a debriefing written questionnaire and an oral follow-up interview were administered. The participants were asked if they observed any rules or patterns in the sentences they heard, and if so, when they noted them (during the training, the first testing phase, or the second testing phase).

3 Results

3.1 GJT

The study reports the results together with those of Ishikawa (2019), who investigated incidental, explicit, and control groups to compare among five groups along the implicit/explicit continuum. Performance on the GJT was assessed using A-prime (A′) scores given the low overall performance following Ishikawa (2019) and Rogers et al. (2016). The A′ scores were calculated based on the proportions of hits (correct acceptance of grammatical sentences) and false alarms (incorrect acceptance of ungrammatical sentences). A′ scores provide a more sophisticated measure compared with a simple report of accuracy scores for the GJT according to the signal detection theory (Grier, 1971; Linebarger et al., 1983; Macmillan and Creelman, 2005; Snodgrass et al., 1985). An A′ score of 0.50 denoted a chance performance. Table 2, Figure 1 present A′ scores for the five groups on Days 1 and 8.

The study performed two-way ANOVA using anovakun (version 4.8.9; Iseki, 2023) in R (version 4.3.2; R Core Team, 2023) with Day as a within-subject factor and Group as a between factor. Mendoza's multisample sphericity test revealed that the sphericity assumption was satisfied ($p = 0.827$ >0.05). ANOVA revealed the main effects of Group only [$F_{(4,95)} = 6.72$, $p < 0.001$, $\eta^2p = 0.126$]. *Post-hoc* multiple comparison with Holm's sequentially rejective Bonferroni procedure found the following differences. The intentional group performed significantly better than did the control ($t = 4.65$, $df = 95$, adjusted $p = 0.0001$, $d = 1.11$) and incidental ($t = 2.82$, $df = 95$, adjusted $p = 0.0404$, $d = 0.59$) groups; moreover, the attentional ($t = 3.31$, $df = 95$, adjusted $p = 0.0105$, $d = 0.80$) and explicit ($t = 3.79$, $df = 95$, adjusted $p = 0.0023$, $d = 0.93$) groups performed better than did the control group.

To identify group differences at each day (immediately and after 1 week) in detail, one-way ANOVA was performed separately for Days 1 and 8. The assumption of equality of variance was tested using Levene's test, which indicated that the assumption was met (Day 1: $p = 0.290$ >0.05; Day 8: $p = 0.521$, >0.05). For Day 1, the main effect of Group was significant [$F_{(4,95)} = 3.81$, $p < 0.01$, $\eta^2p = 0.138$]. A multiple comparison with Holm's sequentially rejective Bonferroni procedure revealed that the incidental ($t = 2.86$, $df = 95$, adjusted $p = 0.0412$, $d = 0.79$), attentional ($t = 2.76$, $df = 95$, adjusted $p = 0.0486$, $d = 0.95$), intentional ($t = 3.41$, $df = 95$, adjusted $p = 0.0096$, $d = 0.98$), and explicit ($t = 3.11$, $df = 95$, adjusted $p = 0.0223$, $d = 0.98$) groups outperformed the control group. For Day 8, the main effect of Group was significant [$F_{(4,95)} = 3.81$, $p < 0.01$, $\eta^2p = 0.162$]. Multiple comparison with Holm's sequentially rejective Bonferroni procedure indicated that only the intentional group performed significantly better than the control ($t = 3.33$, $df = 95$, adjusted $p = 0.0112$, $d = 1.24$) and incidental ($t = 3.38$, $df = 95$, adjusted $p = 0.0105$, $d = 1.05$) groups, while the attentional group did not significantly outperform either the control ($t = 2.07$, $df = 95$, adjusted $p = 0.0219$, $d = 0.66$) or incidental ($t = 2.12$, $df = 95$, adjusted $p = 0.219$, $d = 0.59$) groups. Note that the direct comparisons between the intentional and attentional groups as one of the above multiple comparisons did not show significant differences either for Day 1 (t =0.65, df = 95, adjusted $p = 1.00$, $d = 0.45$) or Day 8 ($t = 1.26$, $df = 95$, adjusted $p = 0.8435$, $d = 0.38$).

3.2 Subjective measures of awareness and retrospective verbal reports

The study assessed the nature of knowledge acquired by the attentional and intentional groups using two types of subjective measure of awareness, namely, confidence ratings and source attributions. Binominal tests were performed to determine whether or not performance was above chance (Marsden et al., 2013; Jackson, 2019; Ishikawa, 2019). Tables 3, 4 include the results of the control group in Ishikawa (2019) for comparison with the case of no-learning effects.

Regarding confidence ratings, Table 3 demonstrates that the attentional learners performed significantly above chance when they reported to have no confidence and be absolutely certain on Day 1 and when they were somewhat confident, very confident, and absolutely certain on Day 8. The intentional learners performed significantly above chance when they had no confidence and were somewhat confident on Day 1 and when they were somewhat confident, very confident, and absolutely certain on Day 8. Moreover, the study employed the logit mixed-effects model to compare the relationship between accuracy and confidence for four cases (i.e., Days 1 and 8 for the two groups) after regrouping the confidence ratings into two categories, namely, less confidence (1 and 2) and more confidence (3 and 4; Rogers, 2017; Ishikawa, 2019). The study specified accuracy as a binary outcome with confidence level as a fixed effect. The results indicated that for the attentional and intentional groups on Day 8 and Days 1/8, respectively, confidence is unrelated to accuracy, which satisfied the zero-correlation criterion. For the attentional group on Day 1, confidence and accuracy were negatively related ($p < 0.001$), which indicates better performance with unconscious knowledge (Rebuschat, 2013).

TABLE 2 A′ scores for the five groups on Days 1 and 8.

Group	Day 1			Day 8		
	M	95% CI	SD	M	95% CI	SD
Control	0.527	[0.479, 0.574]	0.102	0.539	[0.502, 0.577]	0.080
Incidental	0.609	[0.559, 0.659]	0.107	0.537	[0.484, 0.591]	0.115
Attentional	0.606	[0.578, 0.634]	0.059	0.606	[0.550, 0.661]	0.119
Intentional	0.625	[0.578, 0.671]	0.099	0.646	[0.603, 0.690]	0.093
Explicit	0.616	[0.579, 0.653]	0.080	0.617	[0.571, 0.663]	0.099

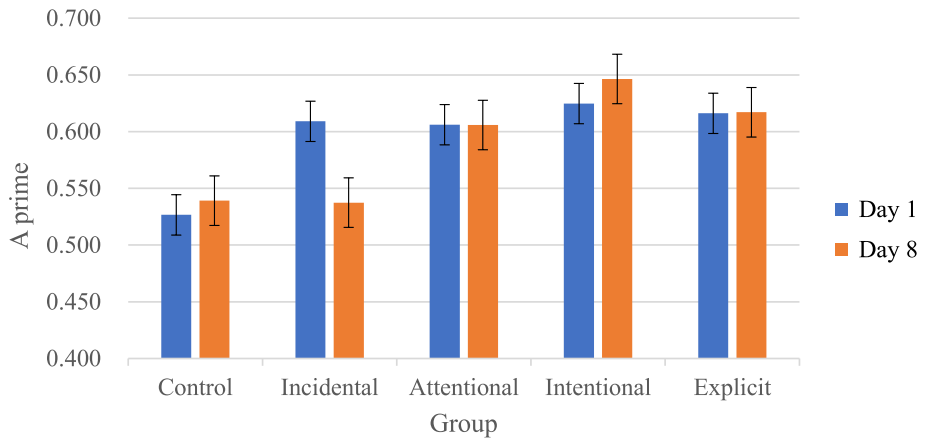

FIGURE 1
A′ scores for the five groups on Days 1 and 8. Error bars denote standard errors.

TABLE 3 Accuracy (%) and number of responses across confidence ratings for the attentional and intentional groups on Days 1 and 8.

Group	Day 1			Day 8		
	Accuracy	Number	*p*	Accuracy	Number	*p*
Attentional						
No confidence	56.1	360	<0.001	50.8	323	0.369
Somewhat confident	52.8	439	0.107	57.2	456	<0.001
Very confident	57.1	112	0.054	61.4	140	0.003
Absolutely certain	65.3	49	0.011	68.3	41	0.006
Intentional						
No confidence	59.1	198	<0.001	51.3	187	0.331
Somewhat confident	55.5	488	<0.001	56.0	529	0.003
Very confident	55.2	183	0.070	58.3	180	0.010
Absolutely certain	54.9	91	0.147	67.2	64	0.002
Control						
No confidence	52.5	427	0.144	53.5	449	0.066
Somewhat confident	49.9	393	0.500	52.7	389	0.132
Very confident	51.8	83	0.330	45.1	71	0.762
Absolutely certain	50.0	44	0.440	53.1	32	0.298

For source attributions, Table 4 indicates that the attentional learners performed significantly above chance when their decisions were based on guessing and rule on Day 1 and on memory and rule on Day 8. The intentional learners performed significantly above chance when their decisions were based on intuition and rule on Day 1 and on intuition, memory, and rule on Day

TABLE 4 Accuracy (%) and number of responses across source attributions for the attentional and intentional groups on Days 1 and 8.

Group	Day 1			Day 8		
	Accuracy	Number	*p*	Accuracy	Number	*p*
Attentional						
Guess	58.8	187	0.006	54.7	247	0.063
Intuition	52.0	369	0.203	53.8	366	0.065
Memory	53.6	151	0.164	63.2	87	0.005
Rule	57.3	253	0.008	58.1	260	0.004
Intentional						
Guess	53.5	170	0.159	46.1	178	0.835
Intuition	54.3	359	0.046	56.4	399	0.005
Memory	54.5	112	0.149	66.3	104	<0.001
Rule	60.2	319	<0.001	58.8	277	0.001
Control						
Guess	49.9	427	0.459	53.4	449	0.084
Intuition	52.0	393	0.209	51.5	389	0.258
Memory	52.2	83	0.288	53.3	71	0.208
Rule	53.2	44	0.209	54.0	32	0.240

8. An above-chance performance when selecting *guess* met the guessing criterion for implicit knowledge, which indicates that the attentional learners developed a certain degree of unconscious knowledge at least immediately after exposure. The above-chance performance of the intentional learners based on intuition on Days 1 and 8 implies that they developed a certain degree of implicit knowledge (Dienes and Scott, 2005; Rebuschat, 2013).

With respect to retrospective verbal reports, no learner in the attentional group could describe the target derivational rules, but 10 out of the 20 participants mentioned that they paid attention to the ending of words and nonwords in the sentences. In addition, one participant cited that the word ending *-ment* indicated that the word was a noun, and two pointed to the relationship between word endings and classes. Similarly, none of the intentional learners could verbalize the target derivational rules, and 8 out of 20 pointed out that they paid attention to the endings of words and nonwords in the sentences. Furthermore, one participant emphasized that the word-endings *-fy* indicated a verb, *-ness* denotes a noun, and *-tic* and *-ful* signal adjectives. Another participant mentioned that word- endings such as *-ment* pertain to nouns, and *-te* and *-fy* refer to verbs. Although learners in both groups tended to pay attention to word endings, they were unable to identify or determine the target rules due to their general lack of confidence, as evident in the abovementioned confidence ratings.

3.3 Production task

The study conducted analyses of the recorded responses of the participants and observed no responses that contained the suffixes as target rules. None of those under the attentional and intentional conditions uttered the words or nonwords with suffixes learned during the learning phases. They completed the phrases they heard with words such as *ideas*, *pictures*, and *books* as nouns, *cute*, *tall*, and *kind* as adjectives, and *play*, *eat*, and *go shopping* as verbs.

4 Discussion

The current study investigated the effects of attentional and intentional learning conditions along with incidental and explicit conditions (cited from Ishikawa, 2019) of the English derivational system by Japanese learners of English. Moreover, it examined the nature of acquired knowledge immediately after learning and after 1 week. The subsequent sections discuss the findings with regard to the three research questions.

4.1 RQ1: to what extent do adult learners learn (immediate tests) and retain (delayed tests) L2 derivational morphology under the different leaning conditions along the implicit/explicit continuum?

All experimental groups (i.e., incidental, attentional, intentional, and explicit) performed significantly better than did the control group, although the incidental group did not retain the learning effects after 1 week. In summary, among the four learning groups, the intentional learners, who were prompted to identify the rules, performed best in that they were superior to the incidental learners, although the study found no significant differences among the intentional, attentional, and explicit learners.

The lack of a significant difference between the intentional and explicit learners was consistent with Rivera et al. (2023). The

authors highlighted target words for intentional learners using red boxes, which may have confounded the effects of the instruction to search for rules. The present study, which used auditorily presented stimuli without highlighting devices, directly demonstrated the impact of the intentional search for rules.

The superiority of the explicit condition reported by Robinson (1996) is in contrast with the present findings. In Robinson, the participants in the rule-search group needed to pay attention to the positions of the location and time phrases in the sentences. In contrast, in the current study, those in the intentional group only needed to pay attention to the words, particularly word endings. This difference in the length of the range within which the learners needed to search for rules may have led to the contrasting results of the effects of intentional learning.

The findings that the learning effects under the attentional condition, which was newly added to the current study, were parallel to the intentional and explicit conditions imply that prompting attention to target features creates nearly the same learning condition as when the relevant rules were explicitly provided. It supports the claim that attention plays a crucial role in promoting L2 development (Doughty, 2003; Gass et al., 2003; Schmidt, 1990, 2001).

In the current work, only the intentional learners performed significantly better than did the incidental and control groups after 1 week. The efficacy demonstrated by the intentional learners may be due to the fact that only this group was aware that the sentences exhibited certain rules prior to the learning phase, which led to the relatively efficient discovery of the rules. The crucial role of awareness was also suggested by the report that only learners who were aware of the L2 syntactic rules, as opposed to the unaware learners, prior to sleep benefitted from sleep-dependent consolidation (Kim and Fenn, 2020).

At the same time, following the instruction to identify such rules is relatively easy and cognitively undemanding, which does not create *desirable difficulties* (Bjork, 1994; Serfaty and Serrano, 2022; Zepeda et al., 2020) believed to produce more effective and long-term learning effects. Providing desirable difficulties in terms of instruction or learning environment could lead to higher levels of performance. From a different perspective, the use of auditory input in the present study seems to create a kind of desirable difficulty. This is because, due to the fleeting nature of speech, the processing of auditory input is more likely than visual input to require cognitive effort and generate time pressure that diminishes working memory processing capacity (Kim and Godfroid, 2019; Suzuki et al., 2019). Therefore, within the framework of desirable difficulty (Bjork, 1994; Suzuki et al., 2019), low-accuracy knowledge in the initial phase of auditory learning may potentially become stable and available with higher accuracy over time through the required cognitive effort.

4.2 RQ2: what is the nature of acquired knowledge: implicit or explicit?

Analyses of confidence ratings demonstrated that the attentional and intentional learners met the zero-correlation criterion on Days 1 and 8. In a relatively puzzling manner, this finding implied that acquired knowledge was mainly unconscious, although the instructions encouraged attention and rule searching. However, another subjective measure of awareness, that is, source attributions, demonstrated that the participants developed conscious knowledge, as evidenced by their reliance on rule on Day 1 and on memory and rule on Day 8 along with unconscious knowledge based on guessing and intuition (the guessing criterion) on Day 1 for the attentional and intentional learners, respectively, and on intuition on Day 8 for the intentional learners.

A comparison of these results with those of Ishikawa (2019) by the explicit learners provides an interesting contrast. In the current study, the attentional and intentional learners relied on guessing and intuition immediately after exposure, whereas the explicit learners did not. Instructing participants to attend to targets or to search for rules without a metalinguistic explanation appears to contribute to the development of knowledge of which they are unaware immediately after exposure.

The difference between the attentional and intentional learners was that the latter performed above chance based on intuition on Day 8 in addition to memory and rule. This aspect may explain the reason that underlies the superiority of intentional learning after one week. Presumably they were capable of using a certain degree of unconscious knowledge developed through the intentionally initiated search for rules. Hamrick and Rebuschat (2012) also reported form-meaning mappings in which intentional learners, who were instructed to learn the meanings of words, developed unconscious knowledge, as evidenced by their above-chance reliance on guessing and intuition.

Analyses of retrospective verbal reports illustrated that none of the participants in either group could describe the target rules, although approximately half of them noticed the endings of the target nonwords. This finding indicated that they remained at the level of noticing or detection and did not reach the level of understanding (Schmidt, 1990, 2001; Tomlin and Villa, 1994). Taken together, the subjective measures of awareness and retrospective verbal reports indicate that people develop conscious and unconscious knowledge despite being attentive and intentional in learning second language grammar.

4.3 RQ3: to what extent is knowledge acquired through an auditory brief exposure transferrable to productive knowledge?

None of the learners under the attentional and intentional conditions demonstrated knowledge in the production tasks. The lack of potential transfer to productive knowledge is inconsistent with the prior findings of Denhovska and Serratrice (2017), Gao and Ma (2021), and Bovolenta and Williams (2022). The difference between the current work and those of Denhovska and Serratrice (2017) and Gao and Ma (2021) was that the former required oral tasks, while the latter two used written tasks. In general, oral tasks force participants to respond quickly (although the current study did not require this aspect), which may encourage them to act intuitively without relying on the metalinguistic knowledge required to construct relevant words and phrases. Likewise,

listening to the frame sentence (e.g., The child shows some...), rather than reading it, may have placed an additional cognitive load on participants, orienting them toward simple English words rather than complex suffixed word (e.g., *curiosity, childish, clarify*) or even nonwords (e.g., *tɪsmənt, nemɪsɪk, bæpəsaɪz*). Although Bovolenta and Williams (2022) used oral tasks, such tasks included pictures as cues to recall the sentences heard by the participants along with the pictures in the training phase. This process may have assisted participants in demonstrating productive knowledge. Without the aid of the written mode and other cues, the participants in the present study were presumably unable to deploy knowledge acquired during the learning phase to productive knowledge. Knowledge acquired through brief auditory exposure alone may be weak and fragmentary (Bovolenta and Williams, 2022), which points to a difficulty in production in the initial stages of language learning. Moreover, the findings may be compatible with the notions of skill specificity and transfer-appropriate processing, which typically argue that comprehension and production are separate skills and, thus, require separate practice (de Jong, 2005; DeKeyser, 1997; Lightbown, 2008).

5 Conclusion

The present study demonstrated that L2 derivational morphology can be auditorily acquired by attentional and intentional learners as well as learners without instruction or with metalinguistic explanation. However, only the intentional learners performed better than did the incidental learners after 1 week. Learners under the attentional and intentional conditions developed implicit and explicit knowledge, whereas the study observed no apparent transfer of knowledge to production.

The learning effects reflected the ability of the learners to generalize acquired knowledge to new items they encountered, because the learning items were not used in the tests. The effects were small, however, because the generalization of newly learned grammatical knowledge develops slowly across a period of time (Tamminen et al., 2012, 2015).

The identified efficacy of intentional or attentional learning appeared to contradict the manner in which children acquire languages. Children are better than adults at implicitly and effortlessly learning languages (Newport, 1990; Smalle and Möttönen, 2023). Given that children are unlikely to be instructed to attend to particular forms or to determine certain rules, inferring that intentional learning is specifically designed for adult language learners is rational due to their limited capacity to implement implicit learning.

The study has several limitations. First, it did not control for individual differences, such as working memory, including executive function (Rivera et al., 2023) and nonacademic populations (Kim et al., 2023), which arguably exert a potential impact on different types of learning. Second, the length of the learning phase (15 min) was brief, which may partially explain the reason for the low overall performance of the learners. A longer duration of the learning phase could potentially lead to higher levels of performance or different results regarding the effects of learning conditions. However, this alternative may increase awareness of the rules. Lastly, it focused only on one aspect of grammatical features, that is, derivational morphology. Thus, caution is warranted in generalizing the findings to other grammatical properties such as word order and form-meaning connections (Bovolenta and Williams, 2022; Gao and Ma, 2021).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because the institution requires this only for life-science and medical research. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

KI: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This research was supported by a grant from the Japan Society for the Promotion of Science (No. 20K00878).

Acknowledgments

The author would like to thank Associate Editor, Dr. Irina Elgort and the two reviewers for their helpful comments and feedback. This work received a grant from the Japan Society for the Promotion of Science (No. 20K00878).

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/flang.2024.1487987/full#supplementary-material

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