Oops, I learned music : the power of incidental learning

Claudia IORIO

Lead – CNRS UMR 5022, Université Bourgogne Europe, Dijon

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Abstract: This work focuses on the research exploring incidental learning within the realm of music. This chapter presents research that investigated humans' ability to capture the relationship between two events in the environment, aiming to investigate whether or not this human ability can be applied to skills normally considered hard to acquire, such as sight-reading and pitch discrimination. The potential use of incidental learning applied to sight-reading and pitch identification skills is discussed and some experimental works are presented. Overall, this work offers fresh experimental insights into leveraging incidental learning techniques to acquire music information.

Keywords: music – learning – sight-reading – pitch identification – contingency learning

Oups, j'ai appris la musique : le pouvoir de l'apprentissage incident

Résumé : Ce travail se concentre sur la recherche explorant l'apprentissage incident dans le domaine de la musique. Ce chapitre présente des recherches qui ont examiné la capacité des humains à percevoir la relation entre deux événements dans l'environnement, visant à déterminer si cette aptitude peut être appliquée à des compétences généralement considérées comme difficiles à acquérir, telles que la lecture à vue et la discrimination des hauteurs. L'utilisation potentielle de l'apprentissage incident pour ces compétences est discutée et quelques travaux expérimentaux sont présentés. Globalement, ce travail offre de nouvelles perspectives expérimentales sur l'utilisation des techniques d'apprentissage incident pour acquérir des informations musicales.

Mots-clés : musique – apprentissage – lecture à vue – identification de la hauteur – apprentissage par contingence

1 Introduction

Imagine yourself driving down the road, lost in thought, when suddenly a familiar jingle begins playing on the radio. It's the jingle of your favorite supermarket, the one you visit regularly for groceries. Almost instantly, your mind shifts gears, and you start thinking about the store, the items you need to buy, and perhaps even recalling your last shopping trip. You might even feel an urge to stop by, even if

you hadn't originally planned to. What's fascinating is that you likely never made a conscious effort to associate this particular song with the supermarket. You didn't sit down and decide that this melody would remind you of grocery shopping. However, through repeated exposure, that is, hearing the jingle each time you walked into the store, played over speakers while you browsed the aisles, or in advertisements you encountered, the connection has formed automatically. Without realizing it, the music has become a mental cue, effortlessly triggering thoughts about the store and the act of shopping itself.

This is a powerful example of how incidental learning works in our everyday lives, demonstrating how our brains link sensory stimuli, such as music, to experiences, places, and behaviors without any deliberate effort on our part. Humans are able to make associations between different stimuli and easily learn these associations even when we do not intend to do so. As for instance, in the case of the association between the song and the groceries store. Even more remarkably, our brains have an innate ability to incidentally acquire new information and apply it to different cognitive tasks, including complex processes such as language acquisition (see Aslin et alii 1998 ; Saffran/Newport et alii 1996). For example, studies on artificial grammar learning demonstrate that after just a few minutes of exposure to sequences of pseudowords, nonsense words constructed using specific grammatical rules, we can begin to detect patterns without realizing it. These pseudowords follow hidden linguistic structures, such as rules determining which letters or syllables can appear together. Surprisingly, even when participants are not explicitly told that there is a grammatical system at play, they can later identify new pseudowords that conform to the learned rules with a notable degree of accuracy (Pothos 2007 ; Reber 1967). This artificial grammar learning occurs even though learning is incidental, meaning that participants are not informed that there is a grammar to learn, and they are often unaware that they have learned anything. Similarly, in a simple stimulus identification task where participants are unaware that the responses follow a predictable repeating pattern, they will incidentally learn the sequence in much the same way. (Nissen/Bullemer 1987 ; Turk-Browne et alii 2005). Although there are many incidental learning procedures (for a review, see Pothos 2007), that produce a rapid learning effect in a manner of minutes from the start of the task, the following work focused specifically in one particular methodological approach to incidentally learn new information : a contingency learning task.

Contingency learning refers to the human ability to detect regularities between events in the environment, one of the primary ways to study this phenomenon is through contingency learning tasks, where individuals are exposed to specific event pairings and asked to respond to certain stimuli in a controlled environment (e.g., Event B tends to follow Event A, making Event A a predictive cue for Event B ; for reviews, see MacLeod 2019 ; Schmidt 2021). These tasks serve as an effective method for examining how quickly people can learn regularities between different events, often without conscious awareness. In a typical contingency learning procedure, participants are instructed to respond to a relevant stimulus or target (e.g., a color). In the meantime, an irrelevant stimulus or cue (e.g., a word, as in Schmidt et alii 2007) is introduced and consistently paired with the target stimulus. The important feature here is that the

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neutral stimulus or cue is not directly tied to the participant's primary task but instead acts as a predictor or signal of the target stimulus. Importantly, participants are never explicitly told to learn the association between the cue and the target ; rather, they simply experience repeated exposure to the regularity. Over time, participants begin to form associations between the cue and the target, such that when the cue is presented, they can predict the occurrence of the target. This learning manifests in the form of faster and more accurate responses to stimuli that conform to the learned regularity. Conversely, when the associations deviate from the established pattern, responses tend to be slower and less accurate (Perruchet 2019 ; Thiessen et alii 2013). Research has shown that this process is not limited to a specific type of stimulus. The cues and targets used in these tasks can vary widely, from simple visual shapes to words, nonwords, or positive/negatively-valenced words (Forrin/MacLeod 2017 ; Levin/Tzelgov 2016 ; Schmidt/De Houwer 2012b and 2012a). Regardless of the specific stimuli, however, the results consistently demonstrate that participants are able to learn regularities. In fact, people show faster reaction times for the more predictable and frequently occurring pairings, suggesting that they are able to differentiate between events that are likely to occur together and those that are more unpredictable or inconsistent.

Interestingly, different findings indicated that music-related information is mostly acquired implicitly through mere exposure (Rohrmeier/Rebuschat 2012). For instance, we are able to implicitly acquired different melodies, harmony, timbre and temporal sequences (e.g., Saffran et alii 1999 and 2000 ; Rohrmeier/Cross 2009 ; Bigand et alii 1998 ; Tillmann et alii 2011). In a series of studies, Saffran et alii (2000) examined whether infants could recognize familiar music they had been previously exposed to. The results indicated that, despite only being passively exposed to the music, the infants were able to learn the musical segments, showing a clear preference for the familiar pieces over unfamiliar ones.

Previous research has primarily focused on listeners' perceptual processes, exploring how individuals process various aspects of musical information. These studies often examined how we perceive rhythm, melody, harmony, and other musical elements. In contrast, the studies discussed in the following sections take a distinct approach by shifting the focus to music performance. Instead of investigating how listeners process music, they explore how musical information can be incidentally acquired to support learning to play an instrument.

One of the first difficulties encountered when starting to learn how to play an instrument is the automatization of subskills useful to play : initially, managing all the elements-such as bowing techniques, positioning your left-hand fingers on the fingerboard, reading musical notes, and producing precise motor responses, feels overwhelmingly difficult. However, with consistent practice, some of these individual skills begin to require less conscious effort and become more automatic. For instance, you may notice that your brain starts to interpret and process the musical notes on the sheet music effortlessly, much like the ease of reading words in a book.

Skill acquisition usually follows three phases (Anderson 1982 ; Fitts/Posner 1967 ; Schneider/Shiffrin 1977). At first, the task is new, and it is characterized by controlled

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cognitive processes. That is, we engage in intentional and conscious strategies to achieve the instructed task. The second phase of the process involves a combination between controlled and automatic processes. Control is still being exerted to master the task, but through experience the appropriate actions to the stimuli presented to us become gradually automatized. For example, a stimulus triggers the appropriate response in an unconscious and effortless manner. In the last step, the skill has been acquired and it is completely automatic, that is, cognitive control is no longer required.

The following studies suggest that employing an incidental learning procedure can enhance the process of automatizing essential subskills involved in music performance. Specifically, they highlight how this approach can improve two critical abilities : sight-reading and pitch identification.

2 Incidental learning and sight-reading

Sight-reading is the ability to read a musical score and instantly translate it into performance on an instrument (Waters et alii 1997 ; Wolf 1976). This complex skill requires the integration of multiple cognitive and motor processes, including the rapid decoding of visual information, the preparation and execution of motor responses, and the coordination of visual and motor elements (Gudmundsdottir 2010 ; Kopiez/In Lee 2006 and 2008 ; Lehmann/Kopiez 2009). Traditionally, sight-reading is taught through explicit instruction (Ericsson/Harwell 2019 ; Mills/McPherson 2006 ; Mishra 2014). Students spend extensive practice time engaging in structured exercises such as naming and singing aloud the notes on a musical score to reinforce their recognition and execution skills. Despite these dedicated efforts, however, sight-reading remains a particularly challenging skill to develop. Even after many hours of practice, many musicians struggle to achieve proficiency, suggesting that traditional teaching methods may not be sufficient on their own (Hargreaves 1986 ; Mills/McPherson 2006 ; Scripp 1995).

On the other hand, experienced musicians are able to read and interpret musical notation effortlessly and automatically. Evidence for this comes from studies utilizing the *Music Stroop* procedure, a variation of the classic Stroop paradigm, which measures automaticity in music reading (e.g., Grégoire et alii 2013 ; Stewart 2005 ; for musical Stroop procedures).

Similar to the classic Stroop procedure (MacLeod 1991 ; MacLeod/MacDonald 2000, for nonmusical Stroop procedure), in musical Stroop tasks, participants are asked to identify the note name (often by reading it aloud) written inside of a note presented in either a congruent position (vertical location) on the music staff (e.g., “fa” written inside of the note for “fa”) or in an incongruent position (e.g., “fa” written inside the note for “re”). The results from these types of tasks showed a significant difference between congruent and incongruent trials in Reaction Times (RT) for musicians, but not for nonmusicians. Specifically, musicians responded much faster to congruent than to incongruent trials, suggesting that they automatically processed the note-position, and this had an impact on note-name reading. In other words, they automatically “read” the note position, which can aid in responding when the note name matches the position or slow down responding when the note name indicates

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a different, conflicting response. This effect, commonly known as the Musical Stroop Effect (MSE), is consistently observed in musicians. As expected, nonmusicians do not exhibit this effect, indicating that they can read the note names without being affected by the note positions. Since nonmusicians are unfamiliar with the meanings of musical symbols, they are not influenced by the incongruence between the note name and its position and cannot translate the note position into a meaningful interpretation. The aim of the research presented below is to show that a similar MSE can be found in nonmusicians after a short acquisition phase using an incidental contingency learning procedure. The presence of the MSE in nonmusicians would suggest that a complex subskill such as sight-reading can be easily and quickly automatized thanks to the rapid acquisition of the note name/note position associations through the incidental contingency learning task.

3 Contingency learning and sight-reading : experimental works

In a series of studies Iorio et alii (2022 ; Schmidt et alii 2023) explored the potential of an *incidental contingency learning procedure* as a method for training nonmusicians in acquiring key sight-reading subskills. Sight-reading is a complex skill that relies heavily on the ability to process and interpret visual information efficiently. A fundamental aspect of this process is the ability to decode the spatial positioning of notes on the musical staff, a crucial step in associating written notation with corresponding instrumental actions.

One of the primary challenges in teaching sight-reading is helping students develop an automatic and rapid translation of musical notes from the page to the appropriate movements on their instrument. Achieving this level of fluency typically requires extensive practice with a vast array of new materials, such as different musical scores, to reinforce these associations effectively (Hardy 1998).

Iorio et alii (2022 ; Schmidt et alii 2023) created a musical contingency-learning procedure merging together the above-mentioned musical Stroop and the color-word contingency learning procedures. The task suggested in their articles follows the same structure of the musical Stroop task of Grégoire et alii (2013), in which a note is presented on a musical staff, which we will refer to as the note-position or simply the note. Written inside the note is the name of a note (e.g., “mi”), or note-name. Critically, the note-name can be either congruent with the position of the note (e.g., “ré” written inside the note for “ré”) or incongruent (e.g., “mi” written inside of the note for “la”). However, to induce the learning of the note-name/note-position associations, the task followed the same logic as the color-word contingency learning procedure of Schmidt et alii (2007). That is, each note was presented much more frequently with the congruent note-name (18 of 24 presentations, or 75 %) than with any of the incongruent note-names (6 of 24 presentations, or 25 %). For instance, the note-position for “do” was presented much more often with the note-name “do” than with the note-names “ré”, “mi”, and so on. Participants simply respond as quickly and accurately as possible to the task-relevant stimulus (note-name) while ignoring the task-irrelevant stimulus or cue (note-position).

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In the initial experiment of this series, nonmusicians successfully acquired the associations between note names and their corresponding positions after just a 15-minute exposure to the contingencies. Some might argue, however, that this result could stem from prior familiarity with reading musical notation. Even though the study specifically recruited nonmusicians, most individuals have some degree of exposure to music notation, such as during school music lessons. To examine whether prior musical knowledge might influence the results, the researchers conducted a second experiment. Interestingly, in this follow-up study, participants were predominantly exposed to incongruent trials rather than congruent ones, in other words, they frequently encountered "incorrect" associations (e.g., the note name "do" appearing in the position typically associated with "mi"). Despite this, the findings still revealed a significant contingency effect, indicating that participants were able to learn the given associations regardless of any prior musical knowledge. Prior knowledge of sight-reading could not have been responsible for the observed contingency learning effect. In fact, any existing familiarity with musical notation would likely have interfered with, rather than facilitated, this learning process, given that the congruent pairings were presented far less than incongruent pairings.

Interestingly, in Experiment 2, the authors also observed a congruency effect, with participants responding more quickly to congruent trials than to control trials. One possible explanation for this finding is that the Experiment 2 may have involved an inherent spatial compatibility between the vertical arrangement of note positions (from bottom to top) and the horizontal layout of the response keys (from left to right). Rusconi et alii (2006) demonstrated the existence of the SMARC (Spatial–Musical Association of Response Codes) effect, which they described as a variation of the well-known orthogonal stimulus-response compatibility effect. Specifically, they found a tendency for lower-pitched stimuli to be preferentially associated with left-side responses and higher-pitched stimuli with right-side responses. According to their interpretation, the SMARC effect reflects an automatic spatial representation of pitch, where higher tones are mentally mapped to the right and lower tones to the left. More recently, Ariga and Saito (2019) provided further evidence of the SMARC effect, even in the absence of actual pitch perception. In their study/auditory stimuli were presented ; instead, the effect was triggered purely by written pitch names, influencing both trained musicians and individuals without formal musical training. These findings collectively support the idea that the human cognitive system encodes pitch in spatial terms.

Considering the existence of this SMARC effect, the congruency effect found in Experiment 2 could be due to an inherent tendency to associate pitches with spatial positions. Indeed, the lowest note position (fa) aligned with the leftmost response key (Z), while the highest note position (mi) corresponded to the rightmost response key (I). This suggests that participants may have responded more quickly to the congruent pairings not due to an understanding of the note positions but rather because of the spatial alignment between the stimuli and response locations. To investigate this possibility further, the authors conducted a third experiment. In the third experiment, participants were exposed to different trials, that is : *congruent trials*, in which the note name (e.g., "do") was written in the congruent note position (e.g., "do"), *com-*

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patible trials, where the note name was spatially compatible with the order of the key mapping (e.g., the leftmost note name "do" written in the bottommost note position "fa"), and *control trials*, which were neither congruent nor spatially compatible (e.g., the leftmost note name "do" written in the topmost position "si"). The results showed no differences in responses times between the different trails, suggesting no influence of the SMARC effect for performance task. The above-mentioned studies clearly showed that nonmusicians were able to learn the associations between the note name and the note position just because they were exposed to it during a very short learning phase. These findings suggest that an incidental contingency learning procedure can actually help in developing automatization for subskills useful for reading music notation.

4 Incidental learning and pitch identification

Pitch identification is a fascinating and unique cognitive process within music perception. Unlike visual perception, where most people can effortlessly and automatically name a color upon seeing it, the same level of automaticity does not apply to pitch recognition. Even among highly trained musicians, the ability to instantly and accurately name a musical pitch upon hearing it is not a universal skill.

Most musicians rely on a Relative Pitch (RP) strategy when identifying pitches. This approach requires them to compare a heard pitch to a known reference tone in order to determine its identity. For example, if a musician knows that a given note is "C" (do), they can determine that another note is "E" (mi) by recognizing that the interval between the two is a major third, meaning "E" is four semitones above "C". This process, while highly effective, requires conscious effort and a reference point, making it a learned and deliberate skill rather than an automatic one.

By contrast, a small percentage of musicians possess Absolute Pitch (AP), a rare ability that allows them to recognize and name a musical note instantly and effortlessly, without any external reference. Individuals with AP can hear a tone in isolation and immediately identify it, much like one would name a color upon seeing it. This ability is considered highly specialized and is often thought to be a combination of early musical training and genetic predisposition develop early in life (see Deutsch 2013 for a review).

While the precise mechanisms behind AP are still not fully understood, its existence suggests that the process of pitch identification can, in principle, become automatic, much like other perceptual skills that develop through exposure and experience.

In a recent review Schmidt (2025) suggested that incidental (i.e., non-intentional) learning may be particularly effective in training this difficult-to-acquire skill. In particular, in his review, Schmidt suggested that the primary challenge for listeners may not lie in their ability to perceive or even reproduce AP, but rather in the process of assigning the correct verbal labels to these pitches (e.g., Hsieh/Saberi 2008 ; Vanzella/Schellenberg 2010). This difficulty could stem from the fact that individuals are extensively exposed to specific pitches within familiar musical or auditory contexts, yet they receive far less practice in explicitly associating those pitches with corresponding verbal designations.

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Accordingly, for instance, Levitin and Rogers (2005) proposed that whereas absolute pitch memory is relatively widespread, the ability to assign verbal labels to pitches is far less common. That is, pitch labelling may rely on the existence of a pitch template that connects linguistic labels (such as note names) to specific pitches. This template is believed to be acquired only by individuals with AP. Once established, it enables the automatic retrieval of pitch labels upon hearing musical notes.

Since the primary distinction between AP and non-AP possessors may lie in pitch labeling rather than in recognizing pitches within implicit absolute pitch memory, it is reasonable to hypothesize that non-AP possessors can also learn pitch-label associations.

Accordingly, some research proposed that adults can learn AP. In a study (Van Hedger et alii 2019) non-AP possessors were trained with an eight-weeks long program. During the training sessions participants completed three training programs in four days every week and they were tested on the fifth day of the same week. For instance, in the first program, called "Simple Speed", participants saw a target note name presented on the screen while hearing the sung version of its label. Afterwards participants heard a string of 16 notes, in which the target note was randomly mixed with non-target notes and they had to press the spacebar as quickly as possible whenever they heard the target note established at the beginning of the trial. The programs were designed by adding more and more complexity in order to improve accuracy and response speed across different timbres and octaves. Overall, at the end of the program, most participants showed improvements and retained this knowledge for at least four months after training. However, only a couple of participants achieved AP-level performance at the end of the training.

In three separate experiments (Wong/Lui et alii 2020), adults participated in a computerized, gamified, and customized training program designed to teach them pitch naming. The training lasted between 12 and 40 hours, with the number of pitches progressively expanding from three to twelve. Throughout the experiments, the training incorporated variations in octave range, timbre, and setting, taking place both within and outside the laboratory. Again, although overall results suggested improvements in participants' performance, only a few participants were able to name the twelve pitches at 90 % or above accuracy, comparable to AP possessors' performance as defined in the literature. In a follow-up study (Wong/Ngan et alii 2020) attempted to replicate the previously mentioned findings with adults who spoke non-tonal languages. In their initial study, participants were native speakers of tonal languages, which may have facilitated AP acquisition due to early exposure to tonal distinctions in childhood. In the new experiment, participants underwent a 20-hour, computerized, and personalized AP training program. Overall, the researchers successfully reproduced the earlier results, showing that most participants improved their performance. However, only a small percentage achieved accuracy levels comparable to those of AP possessors.

Although the research presented above supported the hypothesis that even adults are able to learn AP, they mostly used extended practice, on the contrary the studies presented below investigated whether, using an incidental contingency learning pro-

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cedure, it is possible to strengthen and automatize the link between the pitch and its label.

5 Contingency learning and pitch identification : experimental works

In a set of studies Iorio et alii (2024) explored an entirely new approach to training pitch identification skills and to determine whether nonmusicians with no pitch detection abilities can easily and rapidly learn pitch-label associations, improving their pitch detection.

Similar to visual Stroop tasks (see Grégoire et alii 2013 for a musical version ; see Schmidt et alii 2007 for the color-word paradigm), auditory musical Stroop procedures are one way to easily assess the automaticity of pitch processing (Akiva-Kabiri/Henik 2012 ; Hamers/Lambert 1972 ; Leboe/Mondor 2007). Generally, in these procedures participants are asked to respond to a relevant stimulus while ignoring an irrelevant stimulus that is either congruent (e.g., the word "high" presented in a high-pitched voice) or incongruent (e.g., the word "high" presented in a low-pitched voice). Faster RTs for congruent trials compared to incongruent trials indicates that pitch processing is automatic. That is, although participants are asked to respond to the words, they cannot avoid processing the pitch, resulting in slower RTs when the association between the stimuli is incongruent. In one experiment, Akiva-Kabiri and Henik (2012) compared performance in a tone naming task and note naming task between AP and non-AP possessors. In the tone naming task, participants were asked to respond to the tone while ignoring the note name. In the note naming task, participants were asked to do the reverse (i.e., to respond to the note name while ignoring the tone). They found a congruency effect for AP possessors only in the note naming task and a congruency effect in the tone naming task for non-AP possessors, suggesting that only AP possessors are automatically biased by pitches when identifying note names. This is not surprising when considering that only AP possessors seem to rely on an automatic retrieval of the pitch-label association from memory.

Iorio et alii (2024) conducted a series of studies that combined the auditory musical Stroop procedure with the contingency learning procedure previously outlined by Schmidt et alii (2007) to investigate the automaticity of pitch processing in both nonmusicians and musicians.

In their first experiment, the authors focused on studying the acquisition of pitch-label associations in nonmusicians. Participants were asked to respond to the note name (target) that appeared in association with a specific tone (cue). The note name could either be congruent with the tone (e.g., the name "do" with the tone for "do") or incongruent (e.g., the name "mi" with the tone for "do"). The experiment was structured so that participants first heard a tone before the presentation of each note name. The tone was typically presented with the congruent note name, and only occasionally paired with an incongruent one. This design mimicked a contingency learning procedure, where the majority of the associations were congruent, allowing participants to form strong connections between the tone and the correct note label. The results demonstrated that nonmusicians learned the pitch-label associations easily and quickly, suggesting that even individuals without formal musical training can

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rapidly form accurate associations between auditory pitches and their corresponding names.

In follow-up experiments, Iorio et alii (2024) used the same auditory contingency learning procedure to measure improvements in pitch identification skills among musicians. These experiments showed that musicians also benefited from the procedure, with their pitch identification abilities improving significantly after the training. Furthermore, the authors found that the learning effect persisted in participants' memory even one week after they had learned the specific pitch-label associations. This finding suggests that the procedure not only helps musicians and nonmusicians alike to develop their pitch recognition skills, but also has long-term effects on their ability to recall and use those associations.

Recently Henry et alii (2024), using a similar contingency learning procedure showed that pitch-label associations can be generalized to different timbres and it is not purely instrument-specific. Specifically, compared to Iorio et alii (2024), the authors added all 12 semitones of an octave, participants were asked to read the note names and not responding using a keypress and the notes presented were always congruent with their corresponding note labels. Post-test results showed significant improvements in explicit pitch identification accuracy and response times compared to pre-test performance. This improvement was evident across different accuracy measures, including strictly correct responses, accuracy allowing for semitone deviations, and the mean absolute deviation between the actual and guessed notes. Notably, even after a surprise retest one week later, accuracy remained elevated, mirroring the findings of Iorio et alii (2024) but extending to all 12 pitches within an octave.

6 Conclusion

Can nonmusicians with no prior familiarity acquire musical knowledge ? The experimental work presented above (Henry/Schmidt 2024 ; Iorio et alii 2022 and 2024 ; Schmidt et alii 2023) provides compelling evidence that they can. Despite using a very brief learning phase, which took approximately 15 minutes, the studies showed that nonmusicians were able to produce a robust contingency effect during both the learning process and the subsequent test phase. This result strongly suggests that, even without prior exposure to music or formal training, participants were able to form and retain associations between note names and note positions, as well as the corresponding pitch-label associations.

The primary objective of the experimental work outlined above was to apply insights from human contingency learning research to the field of music. Specifically, the authors set out to test the hypothesis that an incidental contingency learning procedure could facilitate the acquisition and automatization of key musical subskills, which are essential for learning how to play an instrument. The results of the experiments demonstrated that both in the visual domain (e.g., learning to read music) and in the auditory domain (e.g., learning to identify pitches), it is indeed possible to apply contingency learning rules to the music domain.

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One of the most striking findings was that nonmusicians were able to easily and rapidly learn associations between cues and their corresponding targets. For instance, they were able to link note names with their corresponding note positions on the staff, or match specific tones to the correct note name. Moreover, participants were able to successfully apply these learned associations in both performance and explicit judgment tasks. This suggests that even individuals without prior musical training can acquire fundamental musical knowledge and skills quickly when exposed to the right kind of learning procedure.

While deliberate practice is undeniably effective for achieving high levels of expertise (e.g., Ericsson & Harwell 2019), it does have its limitations, particularly when it comes to automatizing skills like sight-reading or pitch identification. Deliberate practice often requires substantial amounts of time and effort, and it does not always allow for a high frequency of repetitions in certain tasks, such as quickly recognizing and reproducing individual notes. In contrast, incidental learning procedures, like the one used in the studies mentioned, offer a significant advantage. The rapid learning observed in these experiments can likely be attributed to the nature of the task. The participants were able to extensively practice the stimulus-response pairings in a relatively short period of time. This frequent and concentrated exposure allowed them to internalize the associations quickly. In contrast, more traditional and deliberate learning methods often require much longer periods of time to achieve similar results (Logan/Klapp 1991).

The research presented (Henry/Schmidt 2024 ; Iorio et alii 2022 and 2024 ; Schmidt et alii 2023) represents the first significant investigation into how contingency learning procedures can be applied to the domain of music acquisition. These studies have yielded promising results, suggesting that nonmusicians can rapidly and effectively learn musical associations, such as linking note names with their corresponding pitch positions. Despite the positive findings, it is important to recognize that these studies may have certain limitations.

One such limitation is the potential for an alternative interpretation of the results. It is possible, for instance, that the participants were simply forming associations between note names and a specific set of auditory stimuli, such as the limited range of 7 or 12 tones used in a given experiment, rather than genuinely developing a true AP ability. This interpretation would suggest that the participants are engaging in item-specific learning, where they are memorizing particular tones associated with particular labels, rather than acquiring a broader, generalized ability to identify any pitch. True AP, on the other hand, transcends familiarity with specific stimuli. Genuine AP allows a person to identify a note accurately regardless of its timbre, octave, or register. While some individuals with AP may find pitch identification easier within certain timbres or registers (Lockhead/Byrd 1981 ; Marvin/Brinkman 2000 ; Miyazaki 1989 ; Schlemmer et alii 2005), genuine AP operates at the level of pitch class, meaning that a true possessor of AP can identify any tone within a specific pitch category, regardless of variation in sound quality. Furthermore, some musicians may possess a more restricted form of AP tied to a specific instrument (referred to as instrument-specific AP, see Reymore/Hansen 2020).

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To fully understand the potential of incidental learning for acquiring musical knowledge, further research is needed. Specifically, future studies should examine the conditions under which incidental learning is most effective, and explore the types of musical information, such as pitch recognition, rhythm perception, or notation reading, that can be most successfully learned using this approach. Additionally, more research is necessary to determine the long-term retention of the knowledge acquired through incidental learning, and how it compares to more explicit forms of musical training. Future studies should also explore how incidental learning can be applied to other aspects of music education, including areas that typically require deliberate practice, and compare its effectiveness with traditional methods of instruction.

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