Training pattern recognition of skin lesion morphology, configuration, and distribution

Lauren Rimoin, MD,[a] Lisa Altieri, BA,[b] Noah Craft, MD, PhD,[c,d,e,f]
Sally Krasne, PhD,[g] and Philip J. Kellman, PhD[h,i]
Atlanta, Georgia; and Los Angeles, Torrance, and Santa Monica, California

Background: The ability to reliably recognize and classify a range of skin signs and symptoms remains a necessary skill across most clinical disciplines but one that is traditionally mastered via nonsystematic experience over long periods.

Objective: We investigated whether online Perceptual and Adaptive Learning Modules (PALMs) could efficiently train preclerkship medical students to identify and discriminate primary skin lesion morphologies, configurations, and anatomic distributions.

Methods: Medical students completed an online skin lesion morphology PALM voluntarily in year 1 and by requirement, along with configuration and anatomic distribution PALMs, in year 2. In controlled before-and-after studies, multiple-choice pretests and posttests using previously unused images, assessed PALM-induced learning. In prospective cohort studies, differences in year-2 performance between students who had and had not completed the morphology PALM in year 1 were also assessed.

Results: Multiple-choice tests, used to evaluate PALM effectiveness, demonstrated large (effect sizes of 1.1 [±0.1 SE] to 2.2 [±0.1 SE]) and statistically significant ($P < .0001$) improvements after PALM training, with learning retention when tested after 1 year.

Limitations: Results are from self-selected groups and a single class at 1 institution.

Conclusion: PALMs are a useful tool for efficient development of the core clinical skills of pattern recognition and classification of skin lesion characteristics. (J Am Acad Dermatol 2015;72:489-95.)

Key words: adaptive learning; dermatology; diagnosis; experiential learning; lesion configuration; lesion distribution; lesion morphology; pattern recognition; perceptual learning; skin lesions.

Accurate diagnosis of any skin problem hinges on the ability of the clinician to reliably classify the skin lesion characteristics, develop a thorough differential diagnosis, and refine the differential diagnosis based on additional queries or tests. Although accurate characterization of skin lesions is the critical first step in developing a differential diagnosis, it is also required for effective use of various visually based diagnostic clinical decision support tools (eg, VisualDx, Rochester,

From the Department of Dermatology, Emory University School of Medicine, Atlanta[a]; David Geffen School of Medicine, University of California, Los Angeles[b]; Los Angeles Biomedical Research Institute at Harbor-UCLA Medical Center, Torrance[c]; Olive View-UCLA Medical Center, Sylmar[d]; Science 37, Inc, Los Angeles[e]; Departments of Medicine[f] and Physiology,[g] David Geffen School of Medicine, University of California, Los Angeles; Department of Psychology, University of California, Los Angeles[h]; and Insight Learning Technology Inc, Santa Monica.[i]

Dr Rimoin and Ms Altieri contributed equally to this article.

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Disclosure: Dr Craft is a consultant to Logical Images Inc, Rochester, NY, the makers of VisualDx.com and learnderm.org, with approved and pending patents on the use of images and visual knowledge to assist in the diagnostic process. Dr Kellman is the president of Insight Learning Technology Inc, with approved and pending patents on adaptive and perceptual learning technologies. Dr Rimoin, Ms Altieri, and Dr Krasne have no conflicts of interest to declare.

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Correspondence to: Sally Krasne, PhD, Department of Physiology, David Geffen School of Medicine, University of California, Los Angeles, CA 90095-1751. E-mail: skrasne@mednet.ucla.edu.

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NY) and remains a vital and necessary core skill across almost all clinical disciplines.

Currently, the only route to improving proficiency in diagnosing even the most common skin diseases requires repeated clinical exposure, over many years, to patients with skin problems. Compared with expert clinicians, novice trainees tend to engage in more feature-based "analytical" processes rather than more rapid pattern recognition,[1] which relies in part on the experience-based process of perceptual learning (a form of "implicit learning").[2-6] Considerable progress in understanding the conditions that facilitate perceptual learning[7-9] has opened the door to the development of perceptual learning technology, which can accelerate the growth of expert pattern recognition in medical and other domains.[3,10,11]

CAPSULE SUMMARY

- Perceptual and Adaptive Learning Modules effectively and efficiently teach pattern recognition.
- Dermatology Perceptual and Adaptive Learning Modules induced large improvements in the ability to identify primary skin lesion morphologies, configurations, and distributions.
- Use of Perceptual and Adaptive Learning Modules throughout training may facilitate use of advanced diagnostic tools and improve diagnostic accuracy in practice.

Our approach is grounded in perceptual and adaptive learning technology of Kellman et al[3,10,11] that combines interactive learning methods that advance perceptual learning with embedded adaptive learning methods. This technology has been shown to increase dramatically both the rate and retention of learning for simple facts and complex cognitive, symbolic tasks.[3,8,10-13] We designed dermatology-specific Perceptual and Adaptive Learning Modules (PALMs) to enhance pattern recognition of primary skin lesion morphologies, configurations, and anatomic distributions. We then tested them on preclerkship medical students. This online interactive program presents examples of various categories of skin lesions (Fig 1) as a series of multiple-choice questions. To the learner, the PALM appears as a series of online flash cards. However, the underlying algorithm dynamically adjusts the sequence and spacing of category presentation based on the learner's accuracy and response time in identifying the previous example from each category, an adaptive approach that has been shown to produce improved efficiency and retention in factual learning[13,14] and in the learning of perceptual classifications.[9]

The objective of this research was to determine if dermatology-specific PALMs might be efficient and effective tools that enable students to achieve a high level of competency in skin lesion pattern recognition. We also tested the degree to which this improved competency was maintained over time.

METHODS

PALM development

Three dermatology PALMs address important dimensions of dermatologic lesion classification: primary morphology, configurations, and anatomic distribution. The individual categories within each PALM are commonly used distinctions in dermatology and are listed in Table I. Each dermatology PALM consists of a series of images accompanied by 4 answer choices describing the morphology, configuration, or anatomic distribution of the image, according to the particular PALM. Images were selected from the database that powers the Logical Images' VisualDx diagnostic decision support system. Lesion morphologies, configurations, and anatomic distributions were confirmed by at least 2 board-certified dermatologists for use in the PALMs. After each clinical image is shown to the student and an answer is selected, the learner is given immediate feedback on the correct answer. Examples of an image from each PALM, along with the feedback, are shown in Fig 2.

Learner accuracy and response time were used to gauge mastery. Instances of categories were sequenced and spaced adaptively, according to the learner's performance, instances from categories from previously wrong or accurate but slow categories occurring sooner than those from previous accurate responses with short response times. Individual categories were retired once the learner made 3 consecutive correct identifications of items in a given category, each within a designated target response time of 6 seconds, allowing enrichment of trials in those categories that the learner had not yet mastered. The designation of a particular target response time is not meant to imply that pattern recognition and deliberate, conscious analysis occur over dichotomous time periods; however, shorter times suggest greater pattern recognition, the actual range of times depending on the complexity of the pattern to be discriminated. After 12 seconds spent on a given trial, a time-out message was displayed,