MIT Press • Open Encyclopedia of Cognitive Science

Braille

Robert Englebretson[1]

[1]**Rice University**

MIT Press

Published on: Jul 16, 2026

URL: https://oecs.mit.edu/pub/2rs0uioi

Braille is a tactile writing system that serves as the primary means of literacy for many individuals who are blind or visually impaired. It enables active engagement with written language and is used for all of the same purposes for which sighted readers use print. Braille systems exist for over 130 languages, for mathematics and science, for music, and even for the notation of hobbies such as chess and knitting. The basic unit of the script is a six-dot unit ⠿ called a braille cell, in which each dot is either raised or not, giving a total of 2^6 combinations—63 characters plus the space. Braille cells have a standard size, with prescribed dimensions for dot height, dot spacing, and the distance between characters. Braille is relevant to several areas within the cognitive sciences, including the relationship between orthography and sublexical structure, tactile perception, and neuroplasticity.

History

In 1829, Louis Braille (1809–1852) published the first edition of the writing system that now bears his name (see Campsie, 2021; Lorimer, 2002). It is notable that Louis Braille and his schoolmates were blind; they developed braille for their own use, in opposition to the raised-print systems taught by sighted teachers. Although the lines and curves of print letters are well suited for easy recognition by the visual system, tracing embossed print with the fingertips proved slow and laborious, and blind people had no way of embossing print themselves. Braille solved these problems with the six-dot cell, which fits under a single finger pad, is better suited to the affordances of tactile perception, and which the students could easily emboss themselves using a frame and punch (now called a slate and stylus). Louis Braille mapped the French alphabet to configurations of the six-dot cell as illustrated in Table 1.

Table 1.

The French Braille Alphabet

Table 1									
⠁	⠃	⠉	⠙	⠑	⠋	⠛	⠓	⠊	⠚
a	b	c	d	e	f	g	h	i	j
⠅	⠇	⠍	⠝	⠕	⠏	⠟	⠗	⠎	⠞
k	l	m	n	o	p	q	r	s	t
⠥	⠧	⠭	⠽	⠵	⠯	⠿	⠷	⠮	⠾
u	v	x	y	z	ç	é	à	è	ù
⠡	⠣	⠩	⠹	⠱	⠫	⠻	⠳	⠪	⠺
â	ê	î	ô	û	ë	ï	ü	œ	w

Note. Scroll to the right to view additional columns.

During the 19th century, braille spread throughout Europe and the United States and was eventually adopted worldwide.

Languages written in the Latin alphabet typically use the same configurations as French for the letters a to z. Braille alphabets have been developed for Cyrillic, Greek, Hebrew, and others. Languages with character-based print writing systems, on the other hand, typically use braille systems that closely align with the spoken language. For example, Japanese uses a braille abugida based in kana, in which each cell represents a single mora, and Mainland Chinese braille uses a semi-syllabary similar to Zhùyīn Fúhào ("bopomofo"), in which each syllable is represented by two cells—one for the syllable initial and the second for the syllable final. For a reference guide to braille systems in 133 of the world's languages, see *World Braille Usage* (Perkins School for the Blind, 2013).

Core concepts

Multiplicity, contractions, and sublexical structure

This section focuses on three aspects of braille orthography in order to highlight some of the unique characteristics of braille as a writing system that may be new to sighted print readers. First, because braille has only 63 possible dot configurations, the identity of an individual braille character is language specific and highly variable. For example, in languages that use the French-based Latin braille alphabet, ⠓ represents the lowercase letter <h>. In Japanese braille, however, ⠓ represents the mora /ri/ composed of ⠃ for the vowel /i/ plus ⠐ for the consonant /r/. However, in music braille notation (the only fully international braille system), ⠓ represents an eighth-note g.

Even within a single braille system, character identity is context dependent because of indicators that shift the meaning of the following cell. For example, in Unified English Braille, ⠠ shifts the identity of the next cell to a capital letter (or to a series of capital letters if doubled), and ⠼ shifts the letters a to j into the digits 1 to 0 (e.g., ⠓ <h>, ⠠⠓ <H>, ⠼⠓ <8>, ⠁⠃⠉ <abc>, ⠠⠠⠁⠃⠉ <ABC>, ⠼⠁⠃⠉ <123>). Punctuation and type-form indicators likewise differ across languages. And, even for closely related languages such as English and German, there are formal differences as to whether sentence boundaries are indicated by the use of capital letter indicators—English braille follows print capitalization and marks sentence-initial capital letters with ⠠, whereas German braille typically does not.

Second, in many languages, reading and writing braille is not simply a matter of transliterating between the print and braille alphabets; rather, braille has its own orthographic structure. The braille systems of many languages include a set of standardized conventions called *contractions*—one or more braille cells that represent whole words or strings of letters. Unified English braille, the braille system officially used in most English-speaking countries, has 180 contractions (e.g., ⠻ ER, ⠫ ED, ⠬ ING, ⠂ EA, ⠯ AND, ⠮ THE, ⠸⠍ MANY, ⠐⠑ EVER, etc.). Individual letters, when not part of larger strings, represent whole words (e.g.,

⠃ but, ⠓ have, ⠽ you, ⠵ as, etc.). Usage rules are highly prescribed and promulgated by the braille authority designated for a given country or language (for Unified English Braille, see Horspool, 2024).

Contractions are standardized and language specific. For example, although ⠭ <x> is the contraction for the word “it” in Unified English Braille, in German contracted Braille, ⠭ has any of five possible identities, depending on its positional context: “ex-” (word-initially), “-nis” (word-finally), <mm> (word-medially), “immer” (when standing alone), or <x> when preceded by the German braille letter sign ⠠.

Thirdly, contracted braille often obscures the sublexical structure of words [see Morphology]. For example, in the English word ⠝⠑⠫ “neED,” the digraph <ee> is not present because ⠫ ED has subsumed the second <e> of the digraph and the following <d> into a single symbol. Similarly, the morphemes in the English word ⠗⠫⠗⠁⠺ “rEDraw” are not recognizable in braille because ⠫ ED subsumes the final <e> of the prefix “re-” together with the initial <d> of the stem “draw” into a single symbol (see Englebretson et al., 2024 for details and discussion).

In sum, the characteristics of braille orthography discussed in this section highlight some of the key differences between braille and print. Braille characters are formally underspecified; that is, their identities are completely dependent on which language is being represented, the presence or absence of indicators that shift the meaning of the symbol, whether the symbol is read as a contraction, and even the contextual position within a word. The consequences of all of this for the neurocognitive underpinnings of braille reading and writing, and the cognitive flexibility of those who use multiple braille systems, are areas of research that are only beginning to be explored.

Perception, hand movement, and proficiency

In all languages, braille is read from left to right by scanning the finger pads across lines of text embossed on paper or on an electronic braille display. Reading typically takes place while the fingers are in motion, utilizing processes of active touch [see Touch]. Because only one or two cells can fit under a single finger pad, the perceptual window is considerably smaller than for eye fixation in print reading, and for this reason, braille reading tends to take place in a more serial manner. Evidence suggests that unlike with print, in which the visual system focuses on character shape, the fluent recognition of braille utilizes the tactile system’s facility with extended dot shear patterns based on texture (cf. Millar, 1997). For example, although visual form constancy enables sighted print readers to recognize letters regardless of size or font variation, this is not true for braille readers. When keeping braille character shape constant, even slight variation in size, dot position, or spacing between dots of a braille cell may slow recognition or hinder it altogether, and braille readers are slow to recognize braille characters when traced as solid outline shapes instead of configurations of dots.

Braille readers show considerable variation in hand and finger usage (Wright et al., 2009). On one end of the continuum are readers who use only one finger (typically the index finger) on one hand. On the other end of the continuum are readers who use multiple fingers on both hands. The most efficient hand movement pattern (cf. Wright et al., 2009 and references therein) is the scissors pattern, in which both hands are always in motion. In this pattern, the left hand begins reading at the start of the line. The right hand meets it in the middle and takes over reading to the end of the line while the left hand backtracks to the beginning of the next line and starts reading. This pattern continues down the page, trading off the activities of reading (the hand that is moving rightwards) and tracking (the hand that is moving leftwards) between the two hands for roughly half of each line. See https://www.ruf.rice.edu/~reng/reading2.mov for a video example. The efficiency of this pattern lies in the fact that one of the hands is always reading while the other hand is tracking, so reading is continuous and uninterrupted. In contrast, for readers who read with a single hand, reading is discontinuous and is interrupted at the end of each line when the hand moves leftward to reach the next line.

Braille readers (similar to print readers) also show considerable variation in speed and proficiency. The multiple factors that contribute to this, and the way these factors interact, are not yet well understood. Some of the factors believed to influence braille reading speed and proficiency include the age at which the individual began to learn braille; the quality and amount of braille instruction the individual received, especially in the early grades of school; whether or not the individual was previously a print reader before learning braille; tactile acuity; the co-occurrence of disabilities in addition to blindness; positive attitudes toward braille and blindness; the support of family and peers; socioemotional factors related to adjustment to blindness; availability of braille materials; time spent reading braille; and others.

Neuroplasticity

In the mid 1990s, neuroscientists discovered that braille readers who are congenitally blind showed activation in the primary visual cortex while reading braille (Sadato et al., 1996). This finding challenged earlier theories of strict localization of function and generated considerable interest in neuroplasticity and the role of experience in shaping the brain (see Bedny & MacSweeney, 2019 for an overview) [see Neuroplasticity]. In addition, braille readers who are congenitally blind also show activation in the visual word form area (Büchel et al., 1998; Reich et al., 2011), and this finding contributes to ongoing debates about the nature and function of this brain region [see Visual Cognitive Neuroscience]. There is also evidence of parietal cortex engagement in braille reading (e.g., Burton et al., 2002; Liu et al., 2023) and expansion of reading finger representations in the somatosensory cortex of proficient braille readers (Pascual-Leone & Torres, 1993).

Questions, controversies, and new developments

Most areas of braille have been only sparsely researched and would benefit from additional focused work. Much of the research on braille in the cognitive sciences to date has tended to take a sight-centric perspective—comparing braille against the normative backdrop of print, using braille as a test case to support or refute theories of print reading, assuming blindness as "deficit," and failing to take into account the wider social contexts in which braille is taught, learned, read, and written (cf. Englebretson et al., 2023). The field would benefit from additional work that centers on the experiences and perspectives of braille readers and work that approaches braille as a writing system in its own right—equal to print and not dependent on it. In addition, the vast majority of research has tended to focus on English braille; widening the scope to a larger variety of the 130-plus languages with braille systems is crucial. Finally, most work on braille has privileged braille readers who are congenitally, totally blind. However, blindness is a spectrum and not a binary, and a wider focus would lead to a better understanding of how braille is read by a vast section of the braille-reading population—those who learn braille after having been print readers as well as dual media readers who regularly use both print and braille.

Broader connections

Braille connects directly with numerous areas within the cognitive sciences and beyond. Braille reading relies on the brain, of course, but also the physiology and kinematics of the hands and fingers. Because braille is a writing system, all areas of language structure are relevant. The science of reading, which has tended to exclude braille, is generally relevant—and findings from braille research are likewise relevant to the science of reading [see Literacy].

Acknowledgments

The author would like to thank Simon Fischer-Baum, Cay Holbrook, and Marina Bedny for discussion and comments.

Further reading

- Bedny, M., & MacSweeney, M. (2019). Insights into the neurobiology of language from individuals born blind or deaf. In P. Hagoort (Ed.), *Human language: From genes and brains to behavior* (pp. 509–525). MIT Press.
- Englebretson, R., Holbrook, M. C., & Fischer-Baum, S. (2023). A position paper on researching braille in the cognitive sciences: De-centering the sighted norm. *Journal of Applied Psycholinguistics, 44*(3), 400–415. https://doi.org/10.1017/S0142716423000061
- Millar, S. (1997). *Reading by touch*. Routledge.

References

- Bedny, M., & MacSweeney, M. (2019). Insights into the neurobiology of language from individuals born blind or deaf. In P. Hagoort (Ed.), *Human language: From genes and brains to behavior* (pp. 509–525). MIT Press.

  ↩
- Büchel, C., Price, C., & Friston, K. (1998). A multimodal language region in the ventral visual pathway. *Nature*, *394*, 274–277. https://doi.org/10.1038/28389

  ↩

- Burton, H., Snyder, A. Z., Conturo, T. E., Akbudak, E., Ollinger, J. M., & Raichle, M. E. (2002). Adaptive changes in early and late blind: A fMRI study of braille reading. *Journal of Neurophysiology*, *87*(1), 589–607. https://www.doi.org/10.1152/jn.00285.2001

↩

- Campsie, P. (2021). Charles Barbier: A hidden story. *Disability Studies Quarterly, 41*(2). https://doi.org/10.18061/dsq.v41i2.7499

↩

- Englebretson, R., Holbrook, M. C., & Fischer-Baum, S. (2023). A position paper on researching braille in the cognitive sciences: De-centering the sighted norm. *Journal of Applied Psycholinguistics*, *44*(3), 400–415. https://doi.org/10.1017/S0142716423000061

↩

- Englebretson, R., Holbrook, M. C., Treiman, R., & Fischer-Baum, S. (2024). The primacy of morphology in English braille spelling: An analysis of bridging contractions. *Morphology*, *34*(2), 125–150. https://doi.org/10.1007/s11525-023-09413-8

↩

- Horspool, M. (Ed.). (2024). *The rules of Unified English Braille* (3rd ed.). International Council on English Braille.

↩

- Liu, Y. F., Rapp, B., & Bedny, M. (2023). Reading braille by touch recruits posterior parietal cortex. *Journal of Cognitive Neuroscience*, *35*(10), 1593–1616. https://doi.org/10.1162/jocn_a_02041

↩

- Lorimer, P. (2002). *Reading by touch: Trials, battles, and discoveries.* National Federation of the Blind.

↩

- Millar, S. (1997). *Reading by touch.* Routledge.

↩

- Pascual-Leone, A., & Torres, F. (1993). Plasticity of the sensorimotor cortex representation of the reading finger in braille readers. *Brain*, *116*(1), 39–52. https://doi.org/10.1093/brain/116.1.39

↩

- Perkins School for the Blind. (2013). *World braille usage* (3rd ed.). Library of Congress.

↩

- Reich, L., Szwed, M., Cohen, L., & Amedi, A. (2011). A ventral visual stream reading center independent of visual experience. *Current Biology*, *21*(5), 363–368. https://www.doi.org/10.1016/j.cub.2011.01.040

  ↩
- Sadato, N., Pascual-Leone, A., Grafman, J., Ibañez, V., Deiber, M. P., Dold, G., & Hallett, M. (1996). Activation of the primary visual cortex by braille reading in blind subjects. *Nature*, *380*(6574), 526–528. https://doi.org/10.1038/380526a0

  ↩
- Wright, T., Wormsley, D. P., & Kamei-Hannan, C. (2009). Hand movements and braille reading efficiency: Data from the Alphabetic Braille and Contracted Braille Study. *Journal of Visual Impairment & Blindness*, *103*(10), 649–661. https://doi.org/10.1177/0145482X0910301008

  ↩