

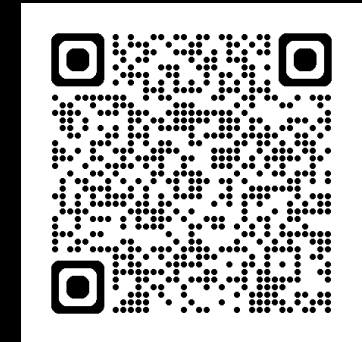
Ollscoil Chathair
Bhaile Átha Cliath
Dublin City University

Graphematic representation in Japanese braille and print

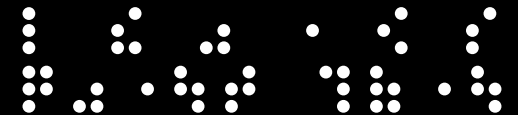
Implications for grapholinguistics

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AWLL 15 – “Written words: From graphematic forms to meaning”
Institute for Computational Linguistics, “Antonio Zampolli”, Pisa, Italy
29-31 October 2025



日本語の
点字と墨字



Introduction

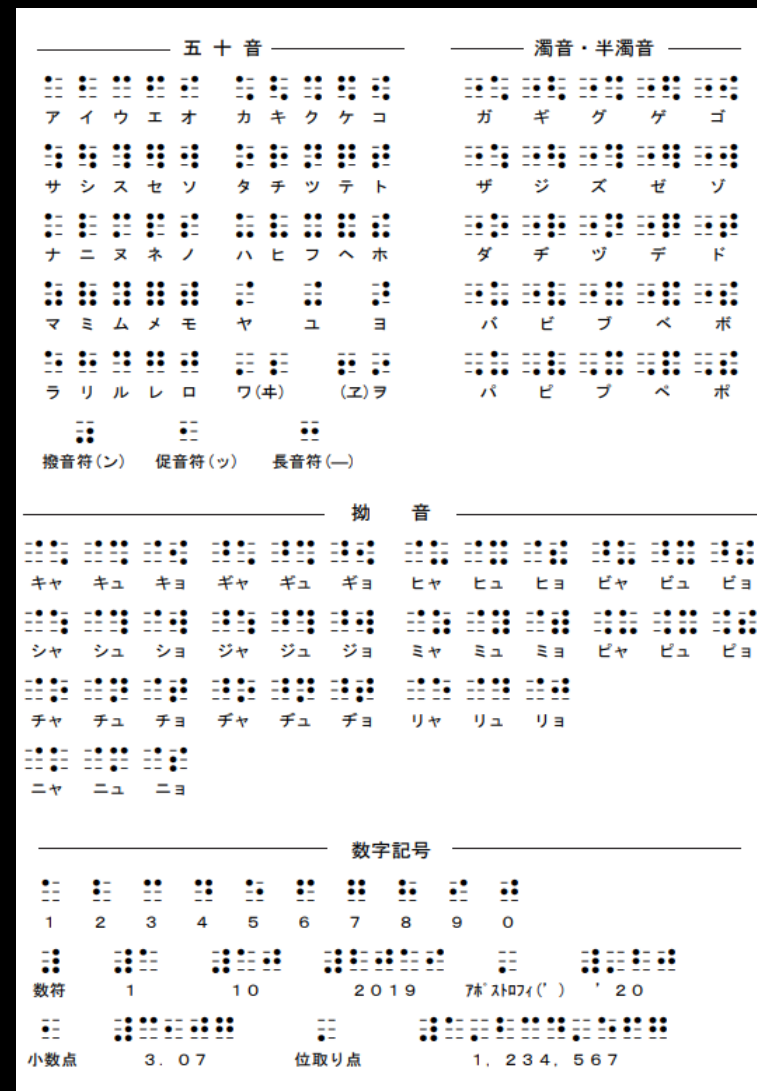
My research interests

- ❖ Grapholinguistics
- ❖ Linguistic analysis of JP writing system
- ❖ Description, comparison, typology

JP braille & print

- ❖ Same language, different principles
- ❖ Both uniquely complex
- ❖ Lack of research

→ Contributions in both directions



Introduction

Goals of this presentation

- ❖ Part 1: Significance of braille for grapholinguistics
- ❖ Part 2: Comparative analysis of JP braille and print
- ❖ Part 3: Typological category of JP braille

Notational conventions

WS (ISO CODES)	ja-Brai	ja-Jpan	en-Brai	en-Latn
GRAPHEMATIC				
<TRANSCRIPT>	<te.n.VOI.shi>	<SUMI.JI>	<b.r.l.>	<p.r.i.n.t>
/PHONEMIC/	/tenji/	/sumiji/	/bʁeɪl/	/pɹɪnt/
'SEMANTIC'	'braille'	'print'	'braille'	'print'

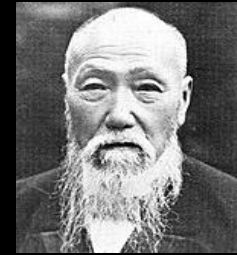
Part 3. Typological category of JP braille

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History (NTI 2019; Guthrie 2024; MLB 2025)



Louis Braille
(1809–1852)



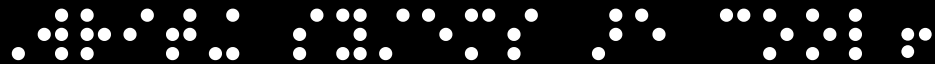
Kuraji Ishikawa
(1859–1944)

1785 Institute for Blind Youth
1815 C. Barbier's 'night writing'
1829 First book on braille (*Procédé*)
1837 First book in braille (*Précis*)
Use spread in Europe & US

1886 Introduction of braille to Japan
1887 N. Konishi's JP braille romanisation
Ishikawa et al. begin JP adaptation
1890 Ishikawa's 6-dot braille for JP
1894 First book in JP braille (*Taikon*)

→ Literacy for the blind & visually impaired (BVI) individuals & communities

Key features (Daniels 1996; Hosokawa 2001)

Example	 <CAP.W.r.i.t.ing s.y.st.e.m.s ar.e c.o.o.l!>	Writing systems are cool!
Modality	Tactile (+ visual)	Visual (+ tactile)
Graph	3D dots in 3x2 matrices*	2D strokes in various config.
Script	63 graphs + 1 blank	12 ~ 5,000+ graphs
Sign	Various types (e.g. ⠠ <t>, ⠢ <ing>, ⠠ <!>)	Various types (e.g. <t>, <oo>, <!>)
Signary	Phonographic (e.g. en-Brai vs zh-Brai)	Phono- / morphographic (e.g. en-Latn vs zh-Hani)
Orthogr.	Different from print	Different from braille

*8-dot braille (256 graphs) is also used in digital encoding and technical texts.

Key features (Daniels 1996; Hosokawa 2001)

Example


<CAP.w.r.i.t.i.n.g s.y.s.t.e.m.s a.r.e c.o.o.l!>

Writing systems are cool!

Modality

Tactile (+ visual)

Visual (+ tactile)

Graph

3D dots in 3x2 matrices*

2D strokes in various config.

Script

63 graphs + 1 blank

12 ~ 5,000+ graphs

Sign

Various types

Various types

(e.g. ⠠ <t>, ⠠ <ing>, ⠠ <!>)

(e.g. <t>, <oo>, <!>)

Signary

Phonographic

Phono- / morphographic

(e.g. en-Brai vs zh-Brai)

(e.g. en-Latn vs zh-Hani)

Orthogr.

Different from print

Different from braille

*8-dot braille (256 graphs) is also used in digital encoding and technical texts.

Literacy pedagogy (Hamp et al. 1995)

- ▶ Lack of a thorough, abstract internal analysis of braille
- ▶ Tendency to approach braille from the viewpoint of print

Cog. Sci. of reading (Englebretson et al. 2023)

- ▶ “Erasure” in the literature due to braille readers being a minority
- ▶ “Adequation” of braille reading to print reading due to erasure

“ [B]raille as a writing system worthy of study in its own right
| and on its own terms. (Englebretson et al. 2023: 400)

Grapholinguistics

- ▶ “In the blind spot” (Klein & Spitzmüller 2022)
- ▶ Braille as a writing system (Daniels 1996; Meletis 2020; Iyengar 2024)
 - ▶ WS = Language + Script
 - ▶ Lang. X + Print script
 - ▶ Lang. X + Braille script
- ▶ Braille as a writing system distinct from print
 - ▶ Not transliteration (Daniels 1996)
 - ▶ Differences in structure & usage: English (Hamp et al. 1995), Arabic (Fetnaci et al. 2022), Urdu & other (Iyengar 2024)

Grapholinguistics & Japanese braille

▶ JP braille

- ▶ Accounts in JP (Hosokawa 2001; NTI 2019) & EN (Unger 1984; Kunert 2024)
- ▶ Formal & functional differences from print (Honda 2021)
- ▶ “Best example” of braille’s typological diversity (Iyengar 2024)

▶ Questions

- ▶ Differences from print?
- ▶ Typological category? (Iyengar 2024)

→ **Comparative analysis (Part 2) + typological discussion (Part 3)**

Part 1. Significance of braille for grapholinguistics

Part 2. Comparative analysis of JP braille and print*

Part 3. Typological category of JP braille

* JP braille representations are based on the conventions of NTI (2018).

五十音										濁音・半濁音									
ア	イ	ウ	エ	オ	カ	キ	ク	ケ	コ	ガ	ギ	グ	ゲ	ゴ					
サ	シ	ス	セ	ソ	タ	チ	ツ	テ	ト	ザ	ジ	ズ	ゼ	ゾ					
ナ	ニ	ヌ	ネ	ノ	ハ	ヒ	フ	ヘ	ホ	ダ	ヂ	ヅ	デ	ド					
マ	ミ	ム	メ	モ	ヤ	ユ	ヨ			バ	ビ	ブ	ベ	ボ					
ラ	リ	ル	レ	ロ	ワ(中)			(エ)ヲ		パ	ピ	プ	ペ	ポ					
撥音符(ン)										促音符(ッ)									
										長音符(ー)									
拗音																			
キャ	キュ	キョ	ギャ	ギユ	ギョ	ヒャ	ヒュ	ヒョ	ビャ	ビュ	ビョ								
シャ	シュ	ショ	ジャ	ジュ	ジョ	ミャ	ミュ	ミョ	ピャ	ピュ	ピョ								
チャ	チュ	チョ	ヂャ	ヂュ	ヂョ	リャ	リュ	リョ											
ニャ	ニユ	ニョ																	
数字記号																			
1	2	3	4	5	6	7	8	9	0										
数符	1		10		20	19		7年	20										
小数点	3.	0	7		位取り点			1,	2	3	4,	5	6	7					

Graphematic representation on different levels

Level	Example	Gloss
Syntactic	⠠⠠⠨ ⠠⠠⠠⠨ ⠠⠠⠠ ⠠⠠⠠⠠⠠ ⠠⠠⠠⠠⠠⠠ ⠠⠠ /tenji no chichi buraiyu/ 'Braille, the father of braille script' 点字の父ブライユ	
Lexical	⠠⠠⠨ ⠠⠠⠠⠨ 点字の	/tenji=no/ 'braille=GEN'
(Sub)syl.	⠠⠠⠨ てん	/ten/
(Sub)seg.	⠠⠠⠨ じ	/ji/

Single script vs multiple scripts

- ▶ Braille: Braille graphs + word spacing
- ▶ Print: Kanji, hiragana & katakana graphs + no spacing

(1) /tenji no chichi buraiyu/ 'Braille, the father of braille script'

Braille

Print

<te.n.VOI.shi.no chi.chi VOI.fu.ra.i.yu>

点字の父ブライユ

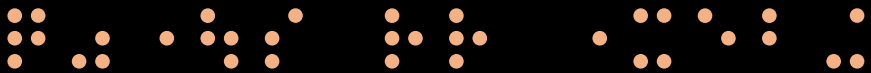
<TEN.JI.no.CHICHI.fu-vol.ra.i.yu>

Single script vs multiple scripts

- ▶ Braille: Braille graphs + word spacing
- ▶ Print: Kanji, hiragana & katakana graphs + no spacing

(1) /tenji no chichi buraiyu/ 'Braille, the father of braille script'

Braille


<te.n.VOI.shi.no chi.chi VOI.fu.ra.i.yu>

Print

点字の父ブライユ
<TEN.JI.no.CHICHI.fu-VOI.ra.i.yu>

Phonographic vs morpho-phonographic

- ▶ Braille: Phonograms + some morphograms (no contractions)
- ▶ Print: Kanji morphograms
Hiragana & katakana phonograms

(2) /tenji=no/ 'braille=GEN' ~ 'exhibition=GEN'

Braille

⠠⠠ ⠠⠠ ⠠⠠ ⠠⠠
<te.n.VOI.shi.no>

Print

点字の
<TEN.JI.no>
'braille=GEN'

展示の
<TEN.JI.no>
'exhibition=GEN'

Phonographic vs morpho-phonographic

- ▶ Braille: Phonograms + some morphograms (no contractions)
- ▶ Print: Kanji morphograms
Hiragana & katakana phonograms

(2) /tenji=no/ 'braille=GEN' ~ 'exhibition=GEN'

Braille

⠠⠠ ⠠⠠ ⠠⠠ ⠠⠠ ⠠⠠
<te.n.VOI.shi.no>

Print

点字の
<TEN.JI.no>
'braille=GEN'

展示の
<TEN.JI.no>
'exhibition=GEN'

(Sub)syllabic level

2. Comparative analysis

Segmental analysis + non-segmental analysis

- ▶ Braille: Segment + mora (typological category? → Part 3)
- ▶ Hr/Kt: Mora (Honda 2011) / CV core syllable (Buckley 2018)

(3) /ten/

Braille

⠠⠠⠠⠠⠠⠠
<te.n>

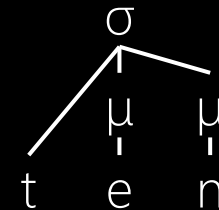
Hiragana

てん
<te.n>

Katakana

テン
<te.n>

Mora theory



Hayes (1989)

CV theory



(Lowenstamm 1996)

(Sub)syllabic level

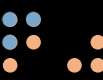
2. Comparative analysis

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- ▶ Braille: Segment + mora (typological category? → Part 3)
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(3) /ten/

Braille


<te.n>

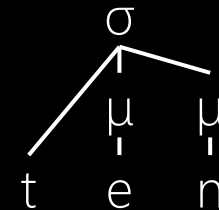
Hiragana

てん
<te.n>

Katakana

テン
<te.n>

Mora theory



Hayes (1989)

CV theory



(Lowenstamm 1996)

Linear featurality vs non-linear featurality (Roberts 2024)

- ▶ Braille: Preposed graph for voice & palatality
- ▶ Hr/Kt: Diacritic for voice; digraph for palatality

(4) /ji/, /shi/, /sha/, /sa/

Braille

⠠⠠⠠

<VOI.shi>

⠠⠠

<shi>

⠠⠠⠠

<PALATAL.sa>

⠠⠠

<sa>

Hiragana

じ

<shi-VOI>

し

<shi>

しゃ

<shi.ya>

さ

<sa>

Linear featurality vs non-linear featurality (Roberts 2024)

- ▶ Braille: Preposed graph for voice & palatality
- ▶ Hr/Kt: Diacritic for voice; digraph for palatality

(4) /ji/, /shi/, /sha/, /sa/

Braille

<VOI.shi>

<shi>

<PALATAL.sa>

<sa>

Hiragana

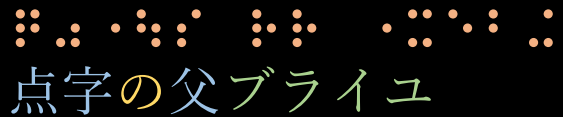
<shi-VOI>

<shi>

<shi.ya>

<sa>

Summary & possible explanation

Level	Example	Description	Explanation
Syntactic	 点字の父ブライユ	Single script + spacing Multi scripts + no spacing	History + parsability
Lexical	 点字の	Phonographic Morpho-phonographic	History + script size
(Sub)syl.	 てん	Segmental analysis Non-segmental analysis	Phon. simplicity + script size
(Sub)seg.	 じ	Linear featurality Non-linear featurality	Linear structure + script size

Part 1. Significance of braille for grapholinguistics

Part 2. Comparative analysis of JP braille and print

Part 3. Typological category of JP braille*

* Limited to representational mapping.
See Joyce & Meletis (2021).

五十音										濁音・半濁音									
ア	イ	ウ	エ	オ	カ	キ	ク	ケ	コ	ガ	ギ	グ	ゲ	ゴ					
サ	シ	ス	セ	ソ	タ	チ	ツ	テ	ト	ザ	ジ	ズ	ゼ	ゾ					
ナ	ニ	ヌ	ネ	ノ	ハ	ヒ	フ	ヘ	ホ	ダ	ヂ	ヅ	デ	ド					
マ	ミ	ム	メ	モ	ヤ	ユ	ヨ			バ	ビ	ブ	ベ	ボ					
ラ	リ	ル	レ	ロ	ワ(中)			(エ)ヲ		パ	ピ	プ	ペ	ポ					
撥音符(ン)		促音符(ッ)		長音符(ー)															
拗音																			
キャ	キュ	キョ	ギャ	ギユ	ギョ	ヒャ	ヒュ	ヒョ	ビャ	ビュ	ビョ								
シャ	シュ	ショ	ジャ	ジュ	ジョ	ミャ	ミュ	ミョ	ピャ	ピュ	ピョ								
チャ	チュ	チョ	ヂャ	ヂュ	ヂョ	リャ	リュ	リョ											
ニャ	ニュ	ニョ																	
数字記号																			
1	2	3	4	5	6	7	8	9	0										
数符	1		10		20	19	7年	2019	7年	2019	7年	2019	7年	2019	7年	2019	7年	2019	7年
小数点	3.	07								位取り点	1,	2	3	4,	5	6	7		

JP braille vs Korean Hangul

3. Typological category

Similarity (Iyengar 2024)

- ▶ ja-Brai: C & V in a block “like in Hangul”
- ▶ ko-Hang: C & V in a block

(5) CV /te/, /ta/, /to/

ja-Brai

⠠⠠⠠

<t-e>

⠠⠠

<t-a>

⠠⠠⠠

<t-o>

⠠⠠

<k-e>

⠠⠠

<k-a>

⠠⠠⠠

<k-o>

ko-Hang

테

<t-e>

타

<t-a>

토

<t-o>

게

<k-e>

가

<k-a>

고

<k-o>

JP braille vs Korean Hangul

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(5) CV /te/, /ta/, /to/

ja-Brai



<t-e>



<t-a>



<t-o>



<k-e>



<k-a>



<k-o>

ko-Hang



<t-e>



<t-a>



<t-o>



<k-e>



<k-a>

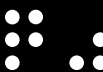
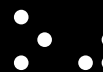
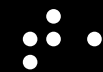


<k-o>

Difference

- ▶ ja-Brai: Final C in another block, like hiragana & katakana
- ▶ ko-Hang: Final C in the same block

(6) CVC /ten/, /tan/, /toʈʰ/

ja-Brai			ja-Hira			ko-Hang		
								
<t-e.n>	<t-a.n>	<t-o.tʰ>	<t-e.n>	<t-a.n>	<t-o.tʰ>	<t-e.n>	<t-a.n>	<t-o.tʰ>

JP braille vs Korean Hangul

3. Typological category

Difference

- ▶ ja-Brai: Final C in another block, like hiragana & katakana
- ▶ ko-Hang: Final C in the same block

(6) CVC /ten/, /tan/, /toʈʰ/

ja-Brai			ja-Hira			ko-Hang		
<t-e.n>	<t-a.n>	<t-o.t̚ʰ>	<t-e.n>	<t-a.n>	<t-o.t̚ʰ>	<t-e.n>	<t-a.n>	<t-o.t̚ʰ>
<C-V.C>			<CV.C>			<C-V-C>		
segmentally encoded, morally grouped			morally encoded			segmentally encoded, syllabically grouped		

JP braille vs Canadian syllabics

3. Typological category

<C-V.C> as a typological category? (OpenAI 2025)

- ▶ ja-Brai: C & V in a block, final C in another
- ▶ cr-Cans: C (shape) & V (orientation), final C separate (Nichols 1996)

(7) /ten/, /tan/, /tot^(ʔ)/

ja-Brai

cr-Cans

⠠⠠⠠⠠⠠⠠

⠠⠠⠠⠠⠠⠠

⠠⠠⠠⠠⠠⠠

U³

C³

⠠⠠⠠⠠⠠⠠

<t-e.n>

<t-a.n>

<t-o.t^ʔ>

<t-e.n>

<t-a.n>

<t-o.t>

Hitherto unrecognised type of segmentary?
(cf. Gnanadesikan 2017; Osterkamp & Schreiber 2023)

JP braille vs Canadian syllabics

3. Typological category

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(7) /ten/, /tan/, /tot^(ʔ)/

ja-Brai

cr-Cans

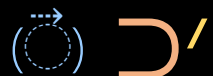

<t-e.n>


<t-a.n>


<t-o.t̚>


<t-e.n>


<t-a.n>


<t-o.t̚>

Hitherto unrecognised type of segmentary?
(cf. Gnanadesikan 2017; Osterkamp & Schreiber 2023)

JP braille vs other segmentaries

3. Typological category

<C-V.C> structure & mapping

- ▶ Free graph: $\langle C \rangle, \langle V \rangle$
- ▶ Bound graph: $\langle c \rangle, \langle v \rangle$
- ▶ Other: $\langle C_i \rangle = C + \text{inherent } V; \langle *v \rangle = V \text{ cancellation}$

(8) /ten/

ja-Brai	cr-Cans	ar-Arab (voc.)	en-Latn	dv-Thaa	sa-Deva
⠏⠞⠎	Uᵑ	تِن	ten	ٲُئْ	तेन्
<t-e.n>	<t-e.n>	<t-i.n>	<t.e.n>	<t-e.n-*v>	<ta-e.na-*v>
<c-v.C>	<c-v.C>	<C-v.C>	<C.V.C>	<C-v.C-*v>	<C _j -v.C _j -*v>

(Based on Gnanadesikan 2017 & Osterkamp & Schreiber 2023)

JP braille vs other segmentaries

3. Typological category

<C-V.C> structure & mapping

- ▶ Free graph: $\langle C \rangle, \langle V \rangle$
- ▶ Bound graph: $\langle c \rangle, \langle v \rangle$
- ▶ Other: $\langle C_i \rangle = C + \text{inherent } V; \langle *v \rangle = V \text{ cancellation}$

(8) /ten/

ja-Brai	cr-Cans	ar-Arab (voc.)	en-Latn	dv-Thaa	sa-Deva
			ten		
<t-e.n>	<t-e.n>	<t-i.n>	<t.e.n>	<t-e.n-*v>	<ta-e.na-*v>
<c-v.C>	<c-v.C>	<C-v.C>	<C.V.C>	<C-v.C-*v>	<C _j -v.C _j -*v>

(Based on Gnanadesikan 2017 & Osterkamp & Schreiber 2023)

Part 1. Significance of braille for grapholinguistics

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五十音										濁音・半濁音									
ア	イ	ウ	エ	オ	カ	キ	ク	ケ	コ	ガ	ギ	グ	ゲ	ゴ					
サ	シ	ス	セ	ソ	タ	チ	ツ	テ	ト	ザ	ジ	ズ	ゼ	ゾ					
ナ	ニ	ヌ	ネ	ノ	ハ	ヒ	フ	ヘ	ホ	ダ	ヂ	ヅ	デ	ド					
マ	ミ	ム	メ	モ	ヤ	ユ	ヨ			バ	ビ	ブ	ベ	ボ					
ラ	リ	ル	レ	ロ	ワ(中)			(工)ヲ		パ	ピ	プ	ペ	ポ					
撥音符(ン)		促音符(ッ)		長音符(ー)															
拗音										拗音									
キャ	キュ	キョ	ギャ	ギユ	ギョ	ヒャ	ヒュ	ヒョ	ビャ	ビュ	ビョ								
シャ	シュ	ショ	ジャ	ジュ	ジョ	ミャ	ミュ	ミョ	ピャ	ピュ	ピョ								
チャ	チュ	チョ	ヂャ	ヂュ	ヂョ	リャ	リュ	リョ											
ニャ	ニユ	ニョ																	
数字記号										数字記号									
1	2	3	4	5	6	7	8	9	0										
数符	1		10		20	19	7分	10分	1分										
小数点	3.	0	7		位取り点		1,	2	3	4,	5	6	7						

Goals of this study

- ❖ Significance of braille for grapholinguistics (Iyengar 2024)
 - Need for overcoming 'erasure' & 'adequation'
 - Possibilities for better understanding of writing systems
- ❖ Comparative analysis of JP braille and print
 - Writing systems with different formal & functional features
- ❖ Typological category of JP braille
 - <C-V.C> as a new typological category?

References

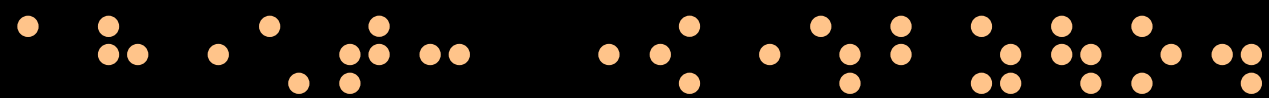
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ありがとうございました。

/arigatō gozaimashita/

'Thank you.'

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