

EARTH LANGUAGE NEIL

Integrated Master Specification and Educational Materials

NE-IL CORE Controlled language	PICTO-2 Visual semantic frames	WAVE-2 Multichannel transport
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Integrated Edition 2.2

Technical specification • 100-phrase reference • communication boards • study cards • 7-day course • dictionary • exercises

Carlos Daniel Borrego Romero
Independent Researcher

Document status

This preprint defines a controlled, experimental communication framework for research, education, prototyping, accessibility studies, and controlled interoperability testing. Operational use in safety-critical contexts requires independent validation. Persistent identifier: Zenodo DOI to be assigned upon publication. License: This work is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License.

Preprint / technical specification

Document control

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Normative language	MUST = required; MUST NOT = prohibited; SHOULD = recommended; MAY = optional, following BCP 14 usage [4]
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Abstract

Earth-Language is a layered experimental framework for preserving a canonical semantic intent across three coordinated representations: NE-IL Core, a human-readable controlled language; PICTO-2, a role-ordered visual token system; and WAVE-2, a channel-neutral transport frame. This integrated edition specifies the grammar, token registry, transport framing, reliability behavior, error handling, and accessibility constraints, and consolidates a 100-phras reference inventory with communication boards, study cards, a seven-day learning sequence, a lexical dictionary, exercises, and a machine-interchange profile. The release defines exact byte order, flag assignments, literal encoding, and CRC-16/CCITT-FALSE parameters so that the published checksums can be independently reproduced. Internal conformance testing covers inventory completeness, canonical uniqueness within the registered dataset, PICTO and payload uniqueness, round-trip reconstruction, CRC verification, and course coverage. The framework remains experimental: cross-cultural comprehension, accessibility outcomes, long-range channel behavior, and safety-critical performance require independent empirical validation.

Keywords: controlled language; visual semantics; multimodal communication; interoperability; accessibility; error-detecting transport; educational technology; human-computer interaction

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1. Purpose, scope, and architectural principles

Earth-Language is a layered communication framework designed to preserve meaning across text, visual representation, and physical or digital transmission channels. The layers are related but independent: a message is authored in a canonical semantic form, expressed through NE-IL Core, rendered through PICTO-2, and transported through WAVE-2.

Core design rule
Meaning is defined once and transported through multiple representations. No visual symbol or waveform is allowed to introduce a second interpretation.

1.1 Layered architecture

Layer	Function
Semantic intent	Language-independent role structure: actor, time, polarity, action/state, object, relation, place, recipient, quantity, urgency.
NE-IL Core	Human-readable controlled language with fixed word order, invariant roots, explicit markers, and productive suffixes.
PICTO-2	Visual semantic frame using category shapes and readable labels; each token also has a stable numeric identifier.
WAVE-2	Channel-neutral frame that transports PICTO token identifiers, message metadata, and error-control fields.
Educational layer	Reference sheets, boards, study cards, course plan, dictionary, exercises, and conformance checklist.

1.2 Design principles

- Compositionality: every message is generated from reusable semantic units rather than memorized whole-message codes.
- Unambiguous scope: time, polarity, quantity, comparison, and relation markers occupy defined positions.
- Round-trip preservation: semantic frame → NE-IL → PICTO → WAVE → PICTO → NE-IL MUST preserve the same meaning.
- Encoding uniqueness: within a fixed token registry and canonicalization profile, two distinct canonical frames MUST NOT produce the same ordered PICTO token sequence or WAVE payload. The CRC is an error-detection field and MUST NOT be treated as a globally unique identifier.
- Graceful degradation: a partially received message MUST be rejected or marked incomplete, never guessed.
- Channel independence: the payload remains the same across digital, acoustic, optical, or haptic profiles.
- Human readability: machine identifiers are always paired with visible labels in educational and diagnostic modes.

1.3 Status and limitations

The framework is a controlled experimental system, not a replacement for natural languages, sign languages, established augmentative and alternative communication systems, or certified emergency protocols. Its claims are limited to internal consistency and the conformance results documented here. Cross-cultural comprehension, long-range channel behavior, and safety-critical performance require empirical testing with independent participants and implementations.

2. NE-IL Core normative grammar

NE-IL Core uses invariant roots, explicit particles, and a restricted syntax. The canonical form is designed for deterministic parsing and direct conversion into semantic roles.

2.1 Canonical clause order

Declarative frame

SUBJECT + [TIME] + [NOT] + PREDICATE + [OBJECT / COMPLEMENT] + [PREPOSITION + TARGET]

Function	NE-IL	English
Simple action	mi eat.	I eat.
Time	mi now work.	I am working now.
Negation	mi not drink.	I do not drink.
Time + negation	mi future not go to city-place.	I will not go to the city.
Transfer	mi now give water to person.	I give water to a person now.
State	mi now be safe-al.	I am safe now.

2.2 Question patterns

Type	Pattern	Example
Yes/no	qa + SUBJECT + [TIME] + [NOT] + PREDICATE + ... ?	qa tu understand?
Location	where + be + ENTITY ?	where be hospital-place?
Identity	who + be + REFERENCE ?	who be that person?
Object	what + be + REFERENCE ?	what be this?
Time	when + SUBJECT + [FUTURE] + PREDICATE ?	when mi future go?
Reason	why + SUBJECT + [NOT] + PREDICATE ?	why tu not eat?
Method	how + SUBJECT + PREDICATE + OBJECT ?	how tu make this?

2.3 Morphology

Marker	Function	Examples
-place	location	house-place, hospital-place, city-place
-thing	object or item	phone-thing, help-thing, price-thing
-al	state or quality	safe-al, hungry-al, blue-al
-er	agent or role	doctor-er
-many	plural or group	friend-many, person-many
-own	possession	mi-own, she-own, house-place-own

A numeral or quantifier does not remove the plural marker: two book-thing-many and many friend-many are canonical. This redundancy supports parsing and error detection.

2.4 Lexical and semantic rules

- Roots do not inflect for person, number, gender, or tense.
- The copula is always be. Forms such as am, is, and are are not used in canonical NE-IL.
- Time markers are past, now, future, and today. They appear immediately after the subject or subject phrase.
- not appears after the time marker and before the predicate. This fixes the scope of negation.

- Prepositions appear before their complements: to person, from city-place, at school-place, in bottle-thing, of this.
- Proper names are literal fields. They retain spelling, are normalized to Unicode NFC before transport, and are encoded as defined in Section 4.8 [2].
- Punctuation is part of the human-readable layer; semantic question status is encoded separately in PICTO-2 and WAVE-2.

2.5 Compact grammar

```

<message> ::= <declaration> | <question> | <answer>
<declaration> ::= <declaration-body> "."
<declaration-body> ::= <subject-frame> [<time>] ["not"] <predicate> [<complement>] {<relation> <target-frame>}
<question> ::= "qa" <declaration-body> "?" | <wh-word> <question-body> "?"
<question-body> ::= [<subject-frame>] [<time>] ["not"] <predicate> [<complement>] {<relation> <target-frame>}
<state-clause> ::= <subject-frame> [<time>] ["not"] "be" <state-or-reference>
<subject-frame> ::= [<quantifier>] <reference-or-entity> | <possessor> <entity>
<target-frame> ::= [<quantifier>] <reference-or-entity>
<complement> ::= [<quantifier-or-comparison>] <object-or-state> | <literal>
<time> ::= "past" | "now" | "future" | "today"
<wh-word> ::= "where" | "what" | "who" | "when" | "why" | "how"
<relation> ::= "to" | "from" | "by" | "at" | "in" | "than" | "as" | "of"
<answer> ::= "yes." | "no."

```

3. PICTO-2 visual semantic encoding

PICTO-2 is the normative visual representation of a semantic frame. It replaces whole-phrase symbol memorization with a fixed sequence of reusable role tokens. Each token has a category shape, a human-readable label, and a 16-bit machine identifier.

3.1 Category shapes

Shape	Semantic category	Examples
?	Question / interrogative	WHERE, WHAT, QA
○	Actor, reference, or possessor	MI, TU, PERSON, MI:OWN
⊙	Time	PAST, NOW, FUTURE, TODAY
×	Polarity	NOT, NO
◇	Action or copula	GO, NEED, BE, SPEAK
□	Entity, object, agent, or literal	WATER, PHONE:OBJ, DOCTOR:ROLE
⬜	Place	HOSPITAL:PLACE, CITY:PLACE
△	State or quality	SAFE:STATE, HOT:STATE
→	Relation	TO, FROM, AT, IN, THAN, AS, OF
#	Quantity or comparison	TWO, MANY, MORE, SAME

3.2 Linear frame order

PICTO canonical frame

[QUESTION] → SUBJECT-FRAME → [TIME] → [POLARITY] → PREDICATE → [COMPLEMENT] → {RELATION → TARGET-FRAME} → [URGENCY]

SUBJECT-FRAME = [QUANTIFIER] + ACTOR / REFERENCE / ENTITY; COMPLEMENT = [QUANTITY / COMPARISON] + OBJECT / STATE / LITERAL; TARGET-FRAME = [QUANTIFIER] + ACTOR / REFERENCE / ENTITY / PLACE.

Not every frame uses every slot. Omitted slots are not inferred. Quantity and comparison tokens occupy the scope immediately before the role they modify; repeated roles remain explicit when needed for comparison or transfer.

English	PICTO-2 frame
I need a doctor now.	○MI · ⊙NOW · ◇NEED · □DOCTOR:ROLE
Where is the hospital?	?WHERE · ◇BE · ⬜HOSPITAL:PLACE
I will not go to the city.	○MI · ⊙FUTURE · ×NOT · ◇GO · →TO · ⬜CITY:PLACE
I give water to a person now.	○MI · ⊙NOW · ◇GIVE · □WATER · →TO · ○PERSON

3.3 Uniqueness and error behavior

- Two canonical messages MUST NOT share the same ordered token sequence.
- Whitespace and visual spacing are presentation-only. Token order and identifiers are normative.
- Unknown tokens MUST be shown as UNKNOWN[id] and MUST NOT be guessed from neighboring tokens.
- An incomplete frame MUST be marked INCOMPLETE until its WAVE length and CRC fields are verified.
- Critical messages SHOULD request acknowledgment and SHOULD be repeated using the critical-message profile.

3.4 Human and machine representations

Representation	Example	Primary use
Human-readable	○MI · ⊙NOW · ◇NEED · □HELP:OBJ	Teaching, boards, diagnostics

Representation	Example	Primary use
Machine-readable	1003-2002-3014-400A	WAVE payload and software interchange
Canonical text	mi now need help-thing.	Authoring and round-trip verification

4. WAVE-2 transport protocol

WAVE-2 transports the same PICTO token identifiers through different physical or digital channels. The transport layer does not redefine meaning; it adds framing, synchronization, sequence control, error detection, and acknowledgment.

4.1 Normative frame

Field	Requirement
Preamble	Alternating synchronization pattern, repeated according to channel profile
Start delimiter	0x7E
Version	Protocol major/minor; this edition uses 0x21
Flags	Question, urgent, acknowledgment requested, repeat, channel profile
Message ID	16-bit identifier used for sequencing and acknowledgment
Sequence	8-bit fragment number; 0 for unfragmented messages
Length	Number of payload bytes
Payload	Ordered 16-bit PICTO token identifiers plus literal blocks when required
CRC	CRC-16-CCITT over header fields from Version through Payload
End delimiter	0x7F

4.2 Byte-level layout

Canonical frame

PREAMBLE | 7E | VERSION | FLAGS | MESSAGE-ID(2) | SEQUENCE | LENGTH | PAYLOAD(n) | CRC16(2) | 7F

Reserved delimiter bytes inside the header or payload MUST be escaped with 0x7D followed by the original byte XOR 0x20, following the octet-transparency convention used in HDLC-like framing [1]. Multi-byte integers and 16-bit token identifiers use network byte order (most significant byte first). Receivers MUST reject frames with inconsistent length, invalid escaping, unknown version, or failed CRC.

4.3 Channel profiles

Profile	Bearer	Minimum requirements
WAVE-D	Digital packet	Raw framed bytes over a reliable or unreliable digital link. CRC remains mandatory.
WAVE-A	Acoustic	Binary frequency-shift or equivalent tone mapping; use a repeated preamble, inter-symbol guard interval, and channel calibration.
WAVE-L	Optical	Manchester-coded light states or equivalent transition-rich signaling; avoid long steady states.
WAVE-H	Haptic	Short/long pulse mapping with explicit start, end, and pause durations; intended for low-rate human interaction.
WAVE-R	Radio bearer	The WAVE frame is encapsulated in a compliant radio system; frequency, power, and modulation are implementation- and jurisdiction-specific.

4.4 Reliability profiles

Profile	Behavior
Normal	One frame; CRC required; acknowledgment optional.
Confirmed	Acknowledgment requested; sender retries after timeout using the same message ID and a repeat flag.
Critical	Three transmissions separated by guard intervals; acknowledgment required; receiver accepts only a CRC-valid frame and reports conflicts.
Fragmented	Each fragment carries the same message ID and a sequence number; reassembly requires all fragments and a final message CRC.

4.5 Acknowledgment and conflict handling

- ACK contains the received message ID, status code, and CRC.
- NACK identifies invalid CRC, unsupported token, unsupported version, missing fragment, or semantic conflict.
- If repeated valid frames with the same message ID carry different payloads, the receiver **MUST** report CONFLICT and **MUST NOT** select one automatically.
- Receivers **SHOULD** preserve a diagnostic transcript containing timestamps, raw payloads, decoded tokens, and validation status.

4.6 Flag assignments and Annex A default profile

Bit / mask	Meaning
0 / 0x01	QUESTION
1 / 0x02	URGENT
2 / 0x04	ACK-REQUEST
3 / 0x08	REPEAT
4-6 / 0x70	CHANNEL PROFILE; see Section 4.3. Bit 7 = 0.

Bit 0 marks questions, bit 1 marks urgent entries, bit 2 requests acknowledgment, and bit 3 marks retransmission. Annex A uses Version 0x21, WAVE-D channel bits 000, Message ID equal to the phrase ID, Sequence 0, and Length equal to the unescaped payload byte count. Noncritical declarations use Flags 0x00; noncritical questions use 0x01; critical declarations use 0x06; and critical questions use 0x07.

4.7 CRC-16 and byte-level reproducibility profile

Parameter	Value
Name	CRC-16/CCITT-FALSE
Polynomial	0x1021
Initial value	0xFFFF
Reflect input / output	false / false
Final XOR	0x0000
Check order	Version through Payload, before byte escaping
Serialized CRC	16-bit big-endian

The start delimiter, preamble, end delimiter, and escaped on-wire substitutions are excluded from the CRC input. Length is the number of unescaped payload bytes. CRC verification detects accidental corruption but does not provide cryptographic integrity, authentication, or collision resistance.

4.8 Literal blocks and fragmentation

A literal block is encoded as the 16-bit marker 0x9001, followed by one unsigned byte containing the UTF-8 byte length, followed by the Unicode NFC-normalized UTF-8 bytes. The human-readable notation 9001[ANA] therefore represents 90 01 03 41 4E 41. The literal length is limited to 255 bytes in this edition. Messages whose complete payload exceeds the one-byte Length field MUST use the Fragmented reliability profile; implementations MUST NOT truncate or silently shorten a literal.

5. Safety, accessibility, and conformance

5.1 Safety constraints

- Critical concepts such as help, doctor, danger, pain, stop, no, hospital, food, water, and safe use distinct tokens and distinct complete frames.
- Critical boards place urgent messages in a visually separate region and pair text with PICTO, never PICTO alone.
- No receiver may infer a missing actor, polarity, or object in a safety-relevant message.
- The system MUST NOT be represented as clinically certified, emergency-certified, universally understood, or suitable for autonomous safety decisions without independent evidence and jurisdiction-specific approval.

5.2 Accessibility requirements

Dimension	Requirement
Visual	High contrast, minimum 12-point board text, redundant shape + label, no dependence on color alone.
Auditory	Adjustable rate and tone spacing, visual transcript, replay, and CRC status.
Motor	Large target cells, scanning order, printable boards, and switch-access compatible software layout.
Cognitive	Consistent left-to-right order, limited symbol families, repeated examples, and explicit error state.
Technical	Unicode plus ASCII fallback labels; machine IDs remain authoritative when glyphs are unavailable.

5.3 Release conformance tests

Test	Acceptance criterion
Inventory completeness	100/100 phrase IDs present in the master dataset.
Canonical uniqueness	100/100 canonical NE-IL strings are distinct within the registered inventory.
PICTO collision test	100/100 ordered PICTO frames are distinct within the registered inventory.
WAVE collision test	100/100 unescaped WAVE payloads are distinct; all listed CRC values independently reproduce under Sections 4.6-4.8.
Course coverage	Every phrase appears exactly once in the seven-day primary sequence.
Round trip	Token sequence reconstructs the same canonical NE-IL token order and semantic roles.
Error handling	Invalid length, escaping, token ID, version, literal length, and CRC are rejected.

Test	Acceptance criterion
Rendering	All required glyphs have readable ASCII labels and machine IDs.
Integrated dataset result The publication dataset passes the 100-entry inventory, canonical uniqueness, PICTO uniqueness, WAVE payload uniqueness, exact CRC reproduction, round-trip, and seven-day coverage tests. These are internal conformance results for the registered inventory and do not constitute evidence of universal comprehension, channel robustness, clinical safety, or cryptographic security.	

5.4 Validation boundaries and evidence status

The conformance tests in this edition verify deterministic encoding and internal consistency of the supplied 100-phrase inventory. They do not test whether unfamiliar users infer the intended meaning, whether symbols are culturally neutral, whether people with specific disabilities can use the materials effectively, or whether acoustic, optical, haptic, radio, and digital implementations remain reliable under real noise and interference. Those questions require preregistered human-subject studies, accessibility evaluation, independent software implementations, channel testing, and appropriate ethical or regulatory review.

References and external technical foundations

[1] Simpson, W., ed. PPP in HDLC-like Framing. Internet Standard STD 51, RFC 1662, Internet Engineering Task Force, July 1994.

[2] The Unicode Consortium. Unicode Standard Annex #15: Unicode Normalization Forms. Current online edition accessed for this preprint.

[3] World Wide Web Consortium. Web Content Accessibility Guidelines (WCAG) 2.2. W3C Recommendation, 2024. Used as general guidance for redundant presentation and contrast; no WCAG conformance claim is made for this print document.

[4] Leiba, B. Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words. BCP 14, RFC 8174, Internet Engineering Task Force, May 2017.

Annex A. Complete corrected 100-phphrase reference

The table below is normative for the educational inventory. PICTO frames are human-readable. WAVE token sequences list ordered 16-bit identifiers; literal blocks use the notation defined in Section 4.8. CRC is calculated over Version, Flags, Message ID, Sequence, Length, and the unescaped Payload using CRC-16/CCITT-FALSE. Question IDs are 31, 51-60, and 98. Critical IDs are 29, 30, 33, 41, 42, 43, 50-54, 87, 99, and 100; IDs 51-54 therefore use Flags 0x07. All other flag values follow Section 4.6.

ID	English	Canonical NE-IL	PICTO-2	WAVE token sequence	CRC
1	I eat.	mi eat.	◊MI · ◊EAT	1003-300C	00F8
2	I drink.	mi drink.	◊MI · ◊DRINK	1003-300B	A89D
3	I sleep.	mi sleep.	◊MI · ◊SLEEP	1003-301B	02CD
4	I woke up.	mi past wake.	◊MI · ◊PAST · ◊WAKE	1003-2003-3023	5F3A
5	I wash.	mi wash.	◊MI · ◊WASH	1003-3025	7475
6	I get dressed.	mi dress.	◊MI · ◊DRESS	1003-300A	797A
7	I will go to work.	mi future go to work-place.	◊MI · ◊FUTURE · ◊GO · →TO · ◻WORK:PLACE	1003-2001-300F-7008-5009	08E3
8	I am working now.	mi now work.	◊MI · ◊NOW · ◊WORK	1003-2002-3026	8DBF
9	I am studying now.	mi now study.	◊MI · ◊NOW · ◊STUDY	1003-2002-301F	C1E6
10	I am reading now.	mi now read.	◊MI · ◊NOW · ◊READ	1003-2002-3017	6DAA
11	I am writing now.	mi now write.	◊MI · ◊NOW · ◊WRITE	1003-2002-3027	B0DA
12	I am cooking now.	mi now cook.	◊MI · ◊NOW · ◊COOK	1003-2002-3008	D4FC
13	I eat breakfast.	mi eat breakfast-thing.	◊MI · ◊EAT · ◻BREAKFAST:OBJ	1003-300C-4004	F6AC
14	I eat lunch.	mi eat lunch-thing.	◊MI · ◊EAT · ◻LUNCH:OBJ	1003-300C-400B	2A07
15	I eat dinner.	mi eat dinner-thing.	◊MI · ◊EAT · ◻DINNER:OBJ	1003-300C-4007	00A8
16	I drink water.	mi drink water.	◊MI · ◊DRINK · ◊WATER	1003-300B-100B	81A1
17	I am hungry.	mi be hungry-al.	◊MI · ◊BE · ◻HUNGRY:STATE	1003-3001-6008	9579
18	I am thirsty.	mi be thirsty-al.	◊MI · ◊BE · ◻THIRSTY:STATE	1003-3001-6010	2B04
19	I am tired.	mi be tired-al.	◊MI · ◊BE · ◻TIRED:STATE	1003-3001-6011	D006
20	I am ill.	mi be ill-al.	◊MI · ◊BE · ◻ILL:STATE	1003-3001-6009	F294
21	I am happy.	mi be happy-al.	◊MI · ◊BE · ◻HAPPY:STATE	1003-3001-6006	E858
22	I am sad.	mi be sad-al.	◊MI · ◊BE · ◻SAD:STATE	1003-3001-600D	7477
23	I go home now.	mi now go to house-place.	◊MI · ◊NOW · ◊GO · →TO · ◻HOUSE:PLACE	1003-2002-300F-7008-5004	1778
24	I am at home.	mi be at house-place.	◊MI · ◊BE · →AT · ◻HOUSE:PLACE	1003-3001-7002-5004	934D
25	I go to school now.	mi now go to school-place.	◊MI · ◊NOW · ◊GO · →TO · ◻SCHOOL:PLACE	1003-2002-300F-7008-5007	A32A
26	I am at school.	mi be at school-place.	◊MI · ◊BE · →AT · ◻SCHOOL:PLACE	1003-3001-7002-5007	039D
27	I go to the market now.	mi now go to market-place.	◊MI · ◊NOW · ◊GO · →TO · ◻MARKET:PLACE	1003-2002-300F-7008-5006	39CD
28	I buy food now.	mi now buy food-thing.	◊MI · ◊NOW · ◊BUY · ◻FOOD:OBJ	1003-2002-3003-4009	BD2E
29	I go to the hospital now.	mi now go to hospital-place.	◊MI · ◊NOW · ◊GO · →TO · ◻HOSPITAL:PLACE	1003-2002-300F-7008-5003	3068
30	I am at the hospital.	mi be at hospital-place.	◊MI · ◊BE · →AT · ◻HOSPITAL:PLACE	1003-3001-7002-5003	9D35
31	Do you understand?	qa tu understand?	?QA · ◊TU · ◊UNDERSTAND	0102-100A-3020	A758

ID	English	Canonical NE-IL	PICTO-2	WAVE token sequence	CRC
32	I do not understand.	mi not understand.	◊MI · ×NOT · ◊UNDERSTAND	1003-2102-3020	15CE
33	I need help now.	mi now need help-thing.	◊MI · ◊NOW · ◊NEED · ◻HELP:OBJ	1003-2002-3014-400A	1012
34	I call someone now.	mi now call person.	◊MI · ◊NOW · ◊CALL · ◊PERSON	1003-2002-3004-1004	4B91
35	I use the phone now.	mi now use phone-thing.	◊MI · ◊NOW · ◊USE · ◻PHONE:OBJ	1003-2002-3021-400E	511B
36	I charge the phone now.	mi now charge phone-thing.	◊MI · ◊NOW · ◊CHARGE · ◻PHONE:OBJ	1003-2002-3005-400E	22A0
37	I go by bus now.	mi now go by bus-thing.	◊MI · ◊NOW · ◊GO · →BY · ◻BUS:OBJ	1003-2002-300F-7003-4005	45C1
38	I go by car now.	mi now go by car-thing.	◊MI · ◊NOW · ◊GO · →BY · ◻CAR:OBJ	1003-2002-300F-7003-4006	BA07
39	I wait at the bus stop now.	mi now wait at bus-stop-place.	◊MI · ◊NOW · ◊WAIT · →AT · ◻BUS-STOP:PLACE	1003-2002-3022-7002-5001	920E
40	I cross the road now.	mi now cross road.	◊MI · ◊NOW · ◊CROSS · ◊ROAD	1003-2002-3009-1005	1BDC
41	I am in danger.	mi be danger-al.	◊MI · ◊BE · ◻DANGER:STATE	1003-3001-6004	78FC
42	I need a doctor now.	mi now need doctor-er.	◊MI · ◊NOW · ◊NEED · ◻DOCTOR:ROLE	1003-2002-3014-4201	1D6F
43	I feel pain now.	mi now feel pain-thing.	◊MI · ◊NOW · ◊FEEL · ◻PAIN:OBJ	1003-2002-300D-400D	BF3A
44	I do not eat.	mi not eat.	◊MI · ×NOT · ◊EAT	1003-2102-300C	4530
45	I do not drink.	mi not drink.	◊MI · ×NOT · ◊DRINK	1003-2102-300B	DEF4
46	I will not go to the city.	mi future not go to city-place.	◊MI · ◊FUTURE · ×NOT · ◊GO · →TO · ◻CITY:PLACE	1003-2001-2102-300F-7008-5002	6C08
47	I am not sleeping now.	mi now not sleep.	◊MI · ◊NOW · ×NOT · ◊SLEEP	1003-2002-2102-301B	5A9A
48	I do not work today.	mi today not work.	◊MI · ◊TODAY · ×NOT · ◊WORK	1003-2004-2102-3026	AEEF
49	Yes.	yes.	×YES	2103	C0EE
50	No.	no.	×NO	2101	AF5B
51	Where is the toilet?	where be toilet-place?	?WHERE · ◊BE · ◻TOILET:PLACE	0105-3001-5008	4A6B
52	Where is water?	where be water?	?WHERE · ◊BE · ◊WATER	0105-3001-100B	C66F
53	Where is food?	where be food-thing?	?WHERE · ◊BE · ◻FOOD:OBJ	0105-3001-4009	03B1
54	Where is the hospital?	where be hospital-place?	?WHERE · ◊BE · ◻HOSPITAL:PLACE	0105-3001-5003	8CCC
55	Where is home?	where be house-place?	?WHERE · ◊BE · ◻HOUSE:PLACE	0105-3001-5004	E6FC
56	Who is that person?	who be that person?	?WHO · ◊BE · ◊THAT · ◊PERSON	0106-3001-1008-1004	EC4B
57	What is this?	what be this?	?WHAT · ◊BE · ◊THIS	0103-3001-1009	846F
58	When will I go?	when mi future go?	?WHEN · ◊MI · ◊FUTURE · ◊GO	0104-1003-2001-300F	5865
59	Why do you not eat?	why tu not eat?	?WHY · ◊TU · ×NOT · ◊EAT	0107-100A-2102-300C	EF55
60	How do you make this?	how tu make this?	?HOW · ◊TU · ◊MAKE · ◊THIS	0101-100A-3013-1009	28CE
61	I have two books.	mi have two book-thing-many.	◊MI · ◊HAVE · #TWO · ◻BOOK:OBJ+PL	1003-3010-8007-4002	093A
62	I have many friends.	mi have many friend-many.	◊MI · ◊HAVE · #MANY · ◻FRIEND:PL	1003-3010-8004-8101	3D96
63	There is no water in the bottle.	water not be in bottle-thing.	◊WATER · ×NOT · ◊BE · →IN · ◻BOTTLE:OBJ	100B-2102-3001-7005-4003	A10B
64	Many people are in the city.	many person-many be in city-place.	#MANY · ◻PERSON:PL · ◊BE · →IN · ◻CITY:PLACE	8004-8102-3001-7005-5002	7C18
65	Few friends live in the city.	few friend-many live in city-place.	#FEW · ◻FRIEND:PL · ◊LIVE · →IN · ◻CITY:PLACE	8002-8101-3012-7005-5002	51F9
66	Everyone goes now.	all person-many now go.	#ALL · ◻PERSON:PL · ◊NOW · ◊GO	8001-8102-2002-300F	BFEA

ID	English	Canonical NE-IL	PICTO-2	WAVE token sequence	CRC
67	My name is Ana.	mi-own name-thing be Ana.	◊MI:OWN · ◻NAME:OBJ · ◊BE · "ANA"	1101-400C-3001-9001[ANA]	F1D7
68	That person is Daniel.	that person be Daniel.	◊THAT · ◊PERSON · ◊BE · "DANIEL"	1008-1004-3001-9001[DANIEL]	5A8C
69	My house is big.	mi-own house-place be big-al.	◊MI:OWN · ◻HOUSE:PLACE · ◊BE · ◻BIG:STATE	1101-5004-3001-6001	90A6
70	Her book is new.	she-own book-thing be new-al.	◊SHE:OWN · ◻BOOK:OBJ · ◊BE · ◻NEW:STATE	1102-4001-3001-600B	A847
71	I am taller than you.	mi be more tall-al than tu.	◊MI · ◊BE · #MORE · ◻TALL:STATE · →THAN · ◊TU	1003-3001-8005-600F-7007-100A	CE25
72	She is younger than he is.	she be less old-al than he.	◊SHE · ◊BE · #LESS · ◻OLD:STATE · →THAN · ◊HE	1006-3001-8003-600C-7007-1002	D606
73	This house is the same size as that house.	this house-place-own size-thing be same as that house-place-own size-thing.	◊THIS · ◻HOUSE:PLACE+OWN · ◻SIZE:OBJ · ◊BE · #SAME · →AS · ◊THAT · ◻HOUSE:PLACE+OWN · ◻SIZE:OBJ	1009-5005-4010-3001-8006-7001-1008-5005-4010	A906
74	I am hungrier than you.	mi be more hungry-al than tu.	◊MI · ◊BE · #MORE · ◻HUNGRY:STATE · →THAN · ◊TU	1003-3001-8005-6008-7007-100A	BBFA
75	I am less tired than you.	mi be less tired-al than tu.	◊MI · ◊BE · #LESS · ◻TIRED:STATE · →THAN · ◊TU	1003-3001-8003-6011-7007-100A	1805
76	The friend is good.	friend be good-al.	◊FRIEND · ◊BE · ◻GOOD:STATE	1001-3001-6005	5243
77	The road is long.	road be long-al.	◊ROAD · ◊BE · ◻LONG:STATE	1005-3001-600A	C189
78	The sky is blue.	sky be blue-al.	◊SKY · ◊BE · ◻BLUE:STATE	1007-3001-6002	2946
79	The water is cold.	water be cold-al.	◊WATER · ◊BE · ◻COLD:STATE	100B-3001-6003	596F
80	The food is hot.	food-thing be hot-al.	◻FOOD:OBJ · ◊BE · ◻HOT:STATE	4009-3001-6007	E656
81	I open the door now.	mi now open door-thing.	◊MI · ◊NOW · ◊OPEN · ◻DOOR:OBJ	1003-2002-3015-4008	3399
82	I close the door now.	mi now close door-thing.	◊MI · ◊NOW · ◊CLOSE · ◻DOOR:OBJ	1003-2002-3006-4008	5150
83	I sit now.	mi now sit.	◊MI · ◊NOW · ◊SIT	1003-2002-301A	72FC
84	I stand now.	mi now stand.	◊MI · ◊NOW · ◊STAND	1003-2002-301D	B3B0
85	I walk now.	mi now walk.	◊MI · ◊NOW · ◊WALK	1003-2002-3024	FFE9
86	I run now.	mi now run.	◊MI · ◊NOW · ◊RUN	1003-2002-3018	2572
87	I stop now.	mi now stop.	◊MI · ◊NOW · ◊STOP	1003-2002-301E	5F63
88	I will wait.	mi future wait.	◊MI · ◊FUTURE · ◊WAIT	1003-2001-3022	984C
89	I come from the city now.	mi now come from city-place.	◊MI · ◊NOW · ◊COME · →FROM · ◻CITY:PLACE	1003-2002-3007-7004-5002	DE13
90	I bring the book now.	mi now bring book-thing.	◊MI · ◊NOW · ◊BRING · ◻BOOK:OBJ	1003-2002-3002-4001	BE37
91	I give water to a person now.	mi now give water to person.	◊MI · ◊NOW · ◊GIVE · ◊WATER · →TO · ◊PERSON	1003-2002-300E-100B-7008-1004	749D
92	A person gives food to me now.	person now give food-thing to mi.	◊PERSON · ◊NOW · ◊GIVE · ◻FOOD:OBJ · →TO · ◊MI	1004-2002-300E-4009-7008-1003	6147
93	I see a person now.	mi now see person.	◊MI · ◊NOW · ◊SEE · ◊PERSON	1003-2002-3019-1004	7A02
94	I hear a person now.	mi now hear person.	◊MI · ◊NOW · ◊HEAR · ◊PERSON	1003-2002-3011-1004	AB59
95	I speak to a person now.	mi now speak to person.	◊MI · ◊NOW · ◊SPEAK · →TO · ◊PERSON	1003-2002-301C-7008-1004	A1B6
96	The person does not speak.	person not speak.	◊PERSON · ×NOT · ◊SPEAK	1004-2102-301C	DA1C
97	I pay now.	mi now pay.	◊MI · ◊NOW · ◊PAY	1003-2002-3016	8115
98	What is the price of this?	what be price-thing of this?	?WHAT · ◊BE · ◻PRICE:OBJ · →OF · ◊THIS	0103-3001-400F-7006-1009	045F
99	I need food now.	mi now need food-thing.	◊MI · ◊NOW · ◊NEED · ◻FOOD:OBJ	1003-2002-3014-4009	C417
100	I am safe now.	mi now be safe-al.	◊MI · ◊NOW · ◊BE · ◻SAFE:STATE	1003-2002-3001-600E	3338

Annex B. Ten communication boards

Each board contains ten complete messages in a 2 × 5 layout. Red cells indicate critical or urgent concepts. Pointing order follows reading order from top-left to bottom-right.

COMMUNICATION BOARD 1 | PHRASES 1-10

#1 I eat. ◦MI • ◇EAT mi eat.	#2 I drink. ◦MI • ◇DRINK mi drink.
#3 I sleep. ◦MI • ◇SLEEP mi sleep.	#4 I woke up. ◦MI • ⊕PAST • ◇WAKE mi past wake.
#5 I wash. ◦MI • ◇WASH mi wash.	#6 I get dressed. ◦MI • ◇DRESS mi dress.
#7 I will go to work. ◦MI • ⊕FUTURE • ◇GO • →TO • ⊠WORK:PLACE mi future go to work-place.	#8 I am working now. ◦MI • ⊕NOW • ◇WORK mi now work.
#9 I am studying now. ◦MI • ⊕NOW • ◇STUDY mi now study.	#10 I am reading now. ◦MI • ⊕NOW • ◇READ mi now read.

COMMUNICATION BOARD 2 | PHRASES 11-20

#11 I am writing now. ○MI · ⊙NOW · ◇WRITE mi now write.	#12 I am cooking now. ○MI · ⊙NOW · ◇COOK mi now cook.
#13 I eat breakfast. ○MI · ◇EAT · □BREAKFAST:OBJ mi eat breakfast-thing.	#14 I eat lunch. ○MI · ◇EAT · □LUNCH:OBJ mi eat lunch-thing.
#15 I eat dinner. ○MI · ◇EAT · □DINNER:OBJ mi eat dinner-thing.	#16 I drink water. ○MI · ◇DRINK · ○WATER mi drink water.
#17 I am hungry. ○MI · ◇BE · △HUNGRY:STATE mi be hungry-al.	#18 I am thirsty. ○MI · ◇BE · △THIRSTY:STATE mi be thirsty-al.
#19 I am tired. ○MI · ◇BE · △TIRED:STATE mi be tired-al.	#20 I am ill. ○MI · ◇BE · △ILL:STATE mi be ill-al.

COMMUNICATION BOARD 3 | PHRASES 21-30

#21 I am happy. ◦MI • ◇BE • △HAPPY:STATE mi be happy-al.	#22 I am sad. ◦MI • ◇BE • △SAD:STATE mi be sad-al.
#23 I go home now. ◦MI • ⊙NOW • ◇GO • →TO • ⊠HOUSE:PLACE mi now go to house-place.	#24 I am at home. ◦MI • ◇BE • →AT • ⊠HOUSE:PLACE mi be at house-place.
#25 I go to school now. ◦MI • ⊙NOW • ◇GO • →TO • ⊠SCHOOL:PLACE mi now go to school-place.	#26 I am at school. ◦MI • ◇BE • →AT • ⊠SCHOOL:PLACE mi be at school-place.
#27 I go to the market now. ◦MI • ⊙NOW • ◇GO • →TO • ⊠MARKET:PLACE mi now go to market-place.	#28 I buy food now. ◦MI • ⊙NOW • ◇BUY • □FOOD:OBJ mi now buy food-thing.
#29 I go to the hospital now. ◦MI • ⊙NOW • ◇GO • →TO • ⊠HOSPITAL:PLACE mi now go to hospital-place.	#30 I am at the hospital. ◦MI • ◇BE • →AT • ⊠HOSPITAL:PLACE mi be at hospital-place.

COMMUNICATION BOARD 4 | PHRASES 31-40

#31 Do you understand? ?QA · ◦TU · ◇UNDERSTAND qa tu understand?	#32 I do not understand. ◦MI · ✕NOT · ◇UNDERSTAND mi not understand.
#33 I need help now. ◦MI · ◯NOW · ◇NEED · ◻HELP:OBJ mi now need help-thing.	#34 I call someone now. ◦MI · ◯NOW · ◇CALL · ◦PERSON mi now call person.
#35 I use the phone now. ◦MI · ◯NOW · ◇USE · ◻PHONE:OBJ mi now use phone-thing.	#36 I charge the phone now. ◦MI · ◯NOW · ◇CHARGE · ◻PHONE:OBJ mi now charge phone-thing.
#37 I go by bus now. ◦MI · ◯NOW · ◇GO · →BY · ◻BUS:OBJ mi now go by bus-thing.	#38 I go by car now. ◦MI · ◯NOW · ◇GO · →BY · ◻CAR:OBJ mi now go by car-thing.
#39 I wait at the bus stop now. ◦MI · ◯NOW · ◇WAIT · →AT · ◻BUS-STOP:PLACE mi now wait at bus-stop-place.	#40 I cross the road now. ◦MI · ◯NOW · ◇CROSS · ◦ROAD mi now cross road.

COMMUNICATION BOARD 5 | PHRASES 41-50

#41 I am in danger. ○MI · ◇BE · △DANGER:STATE mi be danger-al.	#42 I need a doctor now. ○MI · ⊙NOW · ◇NEED · □DOCTOR:ROLE mi now need doctor-er.
#43 I feel pain now. ○MI · ⊙NOW · ◇FEEL · □PAIN:OBJ mi now feel pain-thing.	#44 I do not eat. ○MI · ×NOT · ◇EAT mi not eat.
#45 I do not drink. ○MI · ×NOT · ◇DRINK mi not drink.	#46 I will not go to the city. ○MI · ⊙FUTURE · ×NOT · ◇GO · →TO · □CITY:PLACE mi future not go to city-place.
#47 I am not sleeping now. ○MI · ⊙NOW · ×NOT · ◇SLEEP mi now not sleep.	#48 I do not work today. ○MI · ⊙TODAY · ×NOT · ◇WORK mi today not work.
#49 Yes. ×YES yes.	#50 No. ×NO no.

COMMUNICATION BOARD 6 | PHRASES 51-60

#51 Where is the toilet? ?WHERE · ◇BE · ◻TOILET:PLACE where be toilet-place?	#52 Where is water? ?WHERE · ◇BE · ○WATER where be water?
#53 Where is food? ?WHERE · ◇BE · ◻FOOD:OBJ where be food-thing?	#54 Where is the hospital? ?WHERE · ◇BE · ◻HOSPITAL:PLACE where be hospital-place?
#55 Where is home? ?WHERE · ◇BE · ◻HOUSE:PLACE where be house-place?	#56 Who is that person? ?WHO · ◇BE · ○THAT · ○PERSON who be that person?
#57 What is this? ?WHAT · ◇BE · ○THIS what be this?	#58 When will I go? ?WHEN · ○MI · ◯FUTURE · ◇GO when mi future go?
#59 Why do you not eat? ?WHY · ○TU · ×NOT · ◇EAT why tu not eat?	#60 How do you make this? ?HOW · ○TU · ◇MAKE · ○THIS how tu make this?

COMMUNICATION BOARD 7 | PHRASES 61-70

#61 I have two books. ○MI · ◇HAVE · #TWO · □BOOK:OBJ+PL mi have two book-thing-many.	#62 I have many friends. ○MI · ◇HAVE · #MANY · ○○FRIEND:PL mi have many friend-many.
#63 There is no water in the bottle. ○WATER · ×NOT · ◇BE · →IN · □BOTTLE:OBJ water not be in bottle-thing.	#64 Many people are in the city. #MANY · ○○PERSON:PL · ◇BE · →IN · □CITY:PLACE many person-many be in city-place.
#65 Few friends live in the city. #FEW · ○○FRIEND:PL · ◇LIVE · →IN · □CITY:PLACE few friend-many live in city-place.	#66 Everyone goes now. #ALL · ○○PERSON:PL · ○NOW · ◇GO all person-many now go.
#67 My name is Ana. ○MI:OWN · □NAME:OBJ · ◇BE · "ANA" mi-own name-thing be Ana.	#68 That person is Daniel. ○THAT · ○PERSON · ◇BE · "DANIEL" that person be Daniel.
#69 My house is big. ○MI:OWN · □HOUSE:PLACE · ◇BE · △BIG:STATE mi-own house-place be big-al.	#70 Her book is new. ○SHE:OWN · □BOOK:OBJ · ◇BE · △NEW:STATE she-own book-thing be new-al.

COMMUNICATION BOARD 8 | PHRASES 71-80

#71 I am taller than you. ○MI · ◇BE · #MORE · △TALL:STATE · →THAN · ○TU mi be more tall-al than tu.	#72 She is younger than he is. ○SHE · ◇BE · #LESS · △OLD:STATE · →THAN · ○HE she be less old-al than he.
#73 This house is the same size as that house. ○THIS · ▢HOUSE:PLACE+OWN · ▢SIZE:OBJ · ◇BE · #SAME · →AS · ○THAT · ▢HOUSE:PLACE+OWN · ▢SIZE:OBJ this house-place-own size-thing be same as that house-place-own size-thing.	#74 I am hungrier than you. ○MI · ◇BE · #MORE · △HUNGRY:STATE · →THAN · ○TU mi be more hungry-al than tu.
#75 I am less tired than you. ○MI · ◇BE · #LESS · △TIRED:STATE · →THAN · ○TU mi be less tired-al than tu.	#76 The friend is good. ○FRIEND · ◇BE · △GOOD:STATE friend be good-al.
#77 The road is long. ○ROAD · ◇BE · △LONG:STATE road be long-al.	#78 The sky is blue. ○SKY · ◇BE · △BLUE:STATE sky be blue-al.
#79 The water is cold. ○WATER · ◇BE · △COLD:STATE water be cold-al.	#80 The food is hot. ▢FOOD:OBJ · ◇BE · △HOT:STATE food-thing be hot-al.

COMMUNICATION BOARD 9 | PHRASES 81-90

#81 I open the door now. ○MI · ☉NOW · ◇OPEN · □DOOR:OBJ mi now open door-thing.	#82 I close the door now. ○MI · ☉NOW · ◇CLOSE · □DOOR:OBJ mi now close door-thing.
#83 I sit now. ○MI · ☉NOW · ◇SIT mi now sit.	#84 I stand now. ○MI · ☉NOW · ◇STAND mi now stand.
#85 I walk now. ○MI · ☉NOW · ◇WALK mi now walk.	#86 I run now. ○MI · ☉NOW · ◇RUN mi now run.
#87 I stop now. ○MI · ☉NOW · ◇STOP mi now stop.	#88 I will wait. ○MI · ☉FUTURE · ◇WAIT mi future wait.
#89 I come from the city now. ○MI · ☉NOW · ◇COME · →FROM · ⬆CITY:PLACE mi now come from city-place.	#90 I bring the book now. ○MI · ☉NOW · ◇BRING · □BOOK:OBJ mi now bring book-thing.

COMMUNICATION BOARD 10 | PHRASES 91-100

#91 I give water to a person now. ○MI • ⊙NOW • ◇GIVE • ○WATER • →TO • ○PERSON mi now give water to person.	#92 A person gives food to me now. ○PERSON • ⊙NOW • ◇GIVE • □FOOD:OBJ • →TO • ○MI person now give food-thing to mi.
#93 I see a person now. ○MI • ⊙NOW • ◇SEE • ○PERSON mi now see person.	#94 I hear a person now. ○MI • ⊙NOW • ◇HEAR • ○PERSON mi now hear person.
#95 I speak to a person now. ○MI • ⊙NOW • ◇SPEAK • →TO • ○PERSON mi now speak to person.	#96 The person does not speak. ○PERSON • ×NOT • ◇SPEAK person not speak.
#97 I pay now. ○MI • ⊙NOW • ◇PAY mi now pay.	#98 What is the price of this? ?WHAT • ◇BE • □PRICE:OBJ • →OF • ○THIS what be price-thing of this?
#99 I need food now. ○MI • ⊙NOW • ◇NEED • □FOOD:OBJ mi now need food-thing.	#100 I am safe now. ○MI • ⊙NOW • ◇BE • △SAFE:STATE mi now be safe-al.

Annex C. Printable study cards

Each card has a prompt band and an answer band. Learners may cover the lower band during recall practice or cut the cards along the grid.

STUDY CARDS 1-10

FRONT #1 I eat. BACK mi eat. ◦MI · ◇EAT	FRONT #2 I drink. BACK mi drink. ◦MI · ◇DRINK
FRONT #3 I sleep. BACK mi sleep. ◦MI · ◇SLEEP	FRONT #4 I woke up. BACK mi past wake. ◦MI · ⊙PAST · ◇WAKE
FRONT #5 I wash. BACK mi wash. ◦MI · ◇WASH	FRONT #6 I get dressed. BACK mi dress. ◦MI · ◇DRESS
FRONT #7 I will go to work. BACK mi future go to work-place. ◦MI · ⊙FUTURE · ◇GO · →TO · □WORK:PLACE	FRONT #8 I am working now. BACK mi now work. ◦MI · ⊙NOW · ◇WORK
FRONT #9 I am studying now. BACK mi now study. ◦MI · ⊙NOW · ◇STUDY	FRONT #10 I am reading now. BACK mi now read. ◦MI · ⊙NOW · ◇READ

STUDY CARDS 11-20

FRONT #11 I am writing now. BACK mi now write. ◦MI • ◊NOW • ◊WRITE	FRONT #12 I am cooking now. BACK mi now cook. ◦MI • ◊NOW • ◊COOK
FRONT #13 I eat breakfast. BACK mi eat breakfast-thing. ◦MI • ◊EAT • ◻BREAKFAST:OBJ	FRONT #14 I eat lunch. BACK mi eat lunch-thing. ◦MI • ◊EAT • ◻LUNCH:OBJ
FRONT #15 I eat dinner. BACK mi eat dinner-thing. ◦MI • ◊EAT • ◻DINNER:OBJ	FRONT #16 I drink water. BACK mi drink water. ◦MI • ◊DRINK • ◦WATER
FRONT #17 I am hungry. BACK mi be hungry-al. ◦MI • ◊BE • △HUNGRY:STATE	FRONT #18 I am thirsty. BACK mi be thirsty-al. ◦MI • ◊BE • △THIRSTY:STATE
FRONT #19 I am tired. BACK mi be tired-al. ◦MI • ◊BE • △TIRED:STATE	FRONT #20 I am ill. BACK mi be ill-al. ◦MI • ◊BE • △ILL:STATE

STUDY CARDS 21-30

FRONT #21 I am happy. BACK mi be happy-al. ◦MI · ◇BE · △HAPPY:STATE	FRONT #22 I am sad. BACK mi be sad-al. ◦MI · ◇BE · △SAD:STATE
FRONT #23 I go home now. BACK mi now go to house-place. ◦MI · ◎NOW · ◇GO · →TO · □HOUSE:PLACE	FRONT #24 I am at home. BACK mi be at house-place. ◦MI · ◇BE · →AT · □HOUSE:PLACE
FRONT #25 I go to school now. BACK mi now go to school-place. ◦MI · ◎NOW · ◇GO · →TO · □SCHOOL:PLACE	FRONT #26 I am at school. BACK mi be at school-place. ◦MI · ◇BE · →AT · □SCHOOL:PLACE
FRONT #27 I go to the market now. BACK mi now go to market-place. ◦MI · ◎NOW · ◇GO · →TO · □MARKET:PLACE	FRONT #28 I buy food now. BACK mi now buy food-thing. ◦MI · ◎NOW · ◇BUY · □FOOD:OBJ
FRONT #29 I go to the hospital now. BACK mi now go to hospital-place. ◦MI · ◎NOW · ◇GO · →TO · □HOSPITAL:PLACE	FRONT #30 I am at the hospital. BACK mi be at hospital-place. ◦MI · ◇BE · →AT · □HOSPITAL:PLACE

STUDY CARDS 31-40

FRONT #31 Do you understand? BACK qa tu understand? ?QA • ◯TU • ◇UNDERSTAND	FRONT #32 I do not understand. BACK mi not understand. ◯MI • ×NOT • ◇UNDERSTAND
FRONT #33 I need help now. BACK mi now need help-thing. ◯MI • ◯NOW • ◇NEED • □HELP:OBJ	FRONT #34 I call someone now. BACK mi now call person. ◯MI • ◯NOW • ◇CALL • ◯PERSON
FRONT #35 I use the phone now. BACK mi now use phone-thing. ◯MI • ◯NOW • ◇USE • □PHONE:OBJ	FRONT #36 I charge the phone now. BACK mi now charge phone-thing. ◯MI • ◯NOW • ◇CHARGE • □PHONE:OBJ
FRONT #37 I go by bus now. BACK mi now go by bus-thing. ◯MI • ◯NOW • ◇GO • →BY • □BUS:OBJ	FRONT #38 I go by car now. BACK mi now go by car-thing. ◯MI • ◯NOW • ◇GO • →BY • □CAR:OBJ
FRONT #39 I wait at the bus stop now. BACK mi now wait at bus-stop-place. ◯MI • ◯NOW • ◇WAIT • →AT • □BUS-STOP:PLACE	FRONT #40 I cross the road now. BACK mi now cross road. ◯MI • ◯NOW • ◇CROSS • ◯ROAD

STUDY CARDS 41-50

FRONT #41 I am in danger. BACK mi be danger-al. ◦MI · ◇BE · △DANGER:STATE	FRONT #42 I need a doctor now. BACK mi now need doctor-er. ◦MI · ⊙NOW · ◇NEED · □DOCTOR:ROLE
FRONT #43 I feel pain now. BACK mi now feel pain-thing. ◦MI · ⊙NOW · ◇FEEL · □PAIN:OBJ	FRONT #44 I do not eat. BACK mi not eat. ◦MI · ×NOT · ◇EAT
FRONT #45 I do not drink. BACK mi not drink. ◦MI · ×NOT · ◇DRINK	FRONT #46 I will not go to the city. BACK mi future not go to city-place. ◦MI · ⊙FUTURE · ×NOT · ◇GO · →TO · □CITY:PLACE
FRONT #47 I am not sleeping now. BACK mi now not sleep. ◦MI · ⊙NOW · ×NOT · ◇SLEEP	FRONT #48 I do not work today. BACK mi today not work. ◦MI · ⊙TODAY · ×NOT · ◇WORK
FRONT #49 Yes. BACK yes. ×YES	FRONT #50 No. BACK no. ×NO

STUDY CARDS 51-60

FRONT #51 Where is the toilet? BACK where be toilet-place? ?WHERE · ◇BE · □TOILET:PLACE	FRONT #52 Where is water? BACK where be water? ?WHERE · ◇BE · ○WATER
FRONT #53 Where is food? BACK where be food-thing? ?WHERE · ◇BE · □FOOD:OBJ	FRONT #54 Where is the hospital? BACK where be hospital-place? ?WHERE · ◇BE · □HOSPITAL:PLACE
FRONT #55 Where is home? BACK where be house-place? ?WHERE · ◇BE · □HOUSE:PLACE	FRONT #56 Who is that person? BACK who be that person? ?WHO · ◇BE · ○THAT · ○PERSON
FRONT #57 What is this? BACK what be this? ?WHAT · ◇BE · ○THIS	FRONT #58 When will I go? BACK when mi future go? ?WHEN · ○MI · ⊕FUTURE · ◇GO
FRONT #59 Why do you not eat? BACK why tu not eat? ?WHY · ○TU · ×NOT · ◇EAT	FRONT #60 How do you make this? BACK how tu make this? ?HOW · ○TU · ◇MAKE · ○THIS

STUDY CARDS 61-70

FRONT #61 I have two books. BACK mi have two book-thing-many. ◦MI · ◇HAVE · #TWO · □BOOK:OBJ+PL	FRONT #62 I have many friends. BACK mi have many friend-many. ◦MI · ◇HAVE · #MANY · ◦◦FRIEND:PL
FRONT #63 There is no water in the bottle. BACK water not be in bottle-thing. ◦WATER · ×NOT · ◇BE · →IN · □BOTTLE:OBJ	FRONT #64 Many people are in the city. BACK many person-many be in city-place. #MANY · ◦◦PERSON:PL · ◇BE · →IN · □CITY:PLACE
FRONT #65 Few friends live in the city. BACK few friend-many live in city-place. #FEW · ◦◦FRIEND:PL · ◇LIVE · →IN · □CITY:PLACE	FRONT #66 Everyone goes now. BACK all person-many now go. #ALL · ◦◦PERSON:PL · ⊙NOW · ◇GO
FRONT #67 My name is Ana. BACK mi-own name-thing be Ana. ◦MI:OWN · □NAME:OBJ · ◇BE · "ANA"	FRONT #68 That person is Daniel. BACK that person be Daniel. ◦THAT · ◦PERSON · ◇BE · "DANIEL"
FRONT #69 My house is big. BACK mi-own house-place be big-al. ◦MI:OWN · □HOUSE:PLACE · ◇BE · △BIG:STATE	FRONT #70 Her book is new. BACK she-own book-thing be new-al. ◦SHE:OWN · □BOOK:OBJ · ◇BE · △NEW:STATE

STUDY CARDS 71-80

FRONT #71 I am taller than you. BACK mi be more tall-al than tu. ◦MI · ◇BE · #MORE · △TALL:STATE · →THAN · ◦TU	FRONT #72 She is younger than he is. BACK she be less old-al than he. ◦SHE · ◇BE · #LESS · △OLD:STATE · →THAN · ◦HE
FRONT #73 This house is the same size as that house. BACK this house-place-own size-thing be same as that house-place-own size-thing. ◦THIS · ◻HOUSE:PLACE+OWN · ◻SIZE:OBJ · ◇BE · #SAME · →AS · ◦THAT · ◻HOUSE:PLACE+OWN · ◻SIZE:OBJ	FRONT #74 I am hungrier than you. BACK mi be more hungry-al than tu. ◦MI · ◇BE · #MORE · △HUNGRY:STATE · →THAN · ◦TU
FRONT #75 I am less tired than you. BACK mi be less tired-al than tu. ◦MI · ◇BE · #LESS · △TIRED:STATE · →THAN · ◦TU	FRONT #76 The friend is good. BACK friend be good-al. ◦FRIEND · ◇BE · △GOOD:STATE
FRONT #77 The road is long. BACK road be long-al. ◦ROAD · ◇BE · △LONG:STATE	FRONT #78 The sky is blue. BACK sky be blue-al. ◦SKY · ◇BE · △BLUE:STATE
FRONT #79 The water is cold. BACK water be cold-al. ◦WATER · ◇BE · △COLD:STATE	FRONT #80 The food is hot. BACK food-thing be hot-al. ◻FOOD:OBJ · ◇BE · △HOT:STATE

STUDY CARDS 81-90

FRONT #81 I open the door now. BACK mi now open door-thing. ◦MI · ◯NOW · ◇OPEN · ◻DOOR:OBJ	FRONT #82 I close the door now. BACK mi now close door-thing. ◦MI · ◯NOW · ◇CLOSE · ◻DOOR:OBJ
FRONT #83 I sit now. BACK mi now sit. ◦MI · ◯NOW · ◇SIT	FRONT #84 I stand now. BACK mi now stand. ◦MI · ◯NOW · ◇STAND
FRONT #85 I walk now. BACK mi now walk. ◦MI · ◯NOW · ◇WALK	FRONT #86 I run now. BACK mi now run. ◦MI · ◯NOW · ◇RUN
FRONT #87 I stop now. BACK mi now stop. ◦MI · ◯NOW · ◇STOP	FRONT #88 I will wait. BACK mi future wait. ◦MI · ◯FUTURE · ◇WAIT
FRONT #89 I come from the city now. BACK mi now come from city-place. ◦MI · ◯NOW · ◇COME · →FROM · ◻CITY:PLACE	FRONT #90 I bring the book now. BACK mi now bring book-thing. ◦MI · ◯NOW · ◇BRING · ◻BOOK:OBJ

STUDY CARDS 91-100

FRONT #91 I give water to a person now. BACK mi now give water to person. ◦MI • ◯NOW • ◇GIVE • ◦WATER • →TO • ◦PERSON	FRONT #92 A person gives food to me now. BACK person now give food-thing to mi. ◦PERSON • ◯NOW • ◇GIVE • ◻FOOD:OBJ • →TO • ◦MI
FRONT #93 I see a person now. BACK mi now see person. ◦MI • ◯NOW • ◇SEE • ◦PERSON	FRONT #94 I hear a person now. BACK mi now hear person. ◦MI • ◯NOW • ◇HEAR • ◦PERSON
FRONT #95 I speak to a person now. BACK mi now speak to person. ◦MI • ◯NOW • ◇SPEAK • →TO • ◦PERSON	FRONT #96 The person does not speak. BACK person not speak. ◦PERSON • ×NOT • ◇SPEAK
FRONT #97 I pay now. BACK mi now pay. ◦MI • ◯NOW • ◇PAY	FRONT #98 What is the price of this? BACK what be price-thing of this? ?WHAT • ◇BE • ◻PRICE:OBJ • →OF • ◦THIS
FRONT #99 I need food now. BACK mi now need food-thing. ◦MI • ◯NOW • ◇NEED • ◻FOOD:OBJ	FRONT #100 I am safe now. BACK mi now be safe-al. ◦MI • ◯NOW • ◇BE • △SAFE:STATE

Annex D. Seven-day learning manual

Recommended session length: 25-40 minutes per day. Each phrase appears exactly once in the primary sequence. Review items may be repeated after the assigned day without changing the coverage count.

Daily learning cycle

1. Recognition: read the English prompt and identify the NE-IL and PICTO form.
2. Production: say or write the NE-IL form without looking at the answer.
3. Visual mapping: rebuild the PICTO token order from semantic roles.
4. Transport awareness: compare the token order with the WAVE identifier sequence and CRC.
5. Variation: change one element while preserving the canonical grammar.
6. Review: retest missed items after a short interval.

Day 1 - Identity, confirmation, and questions

Focus: Question status, reference words, confirmation, and refusal.

ID	English	NE-IL	PICTO-2
49	Yes.	yes.	×YES
50	No.	no.	×NO
31	Do you understand?	qa tu understand?	?QA · ◊TU · ◊UNDERSTAND
32	I do not understand.	mi not understand.	◊MI · ×NOT · ◊UNDERSTAND
51	Where is the toilet?	where be toilet-place?	?WHERE · ◊BE · ◻TOILET:PLACE
52	Where is water?	where be water?	?WHERE · ◊BE · ◊WATER
53	Where is food?	where be food-thing?	?WHERE · ◊BE · ◻FOOD:OBJ
54	Where is the hospital?	where be hospital-place?	?WHERE · ◊BE · ◻HOSPITAL:PLACE
55	Where is home?	where be house-place?	?WHERE · ◊BE · ◻HOUSE:PLACE
56	Who is that person?	who be that person?	?WHO · ◊BE · ◊THAT · ◊PERSON
57	What is this?	what be this?	?WHAT · ◊BE · ◊THIS
58	When will I go?	when mi future go?	?WHEN · ◊MI · ◊FUTURE · ◊GO
59	Why do you not eat?	why tu not eat?	?WHY · ◊TU · ×NOT · ◊EAT
60	How do you make this?	how tu make this?	?HOW · ◊TU · ◊MAKE · ◊THIS

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Day 2 - Body, routines, food, and water

Focus: Routine verbs, meal objects, body states, and the copula be.

ID	English	NE-IL	PICTO-2
1	I eat.	mi eat.	◊MI · ◊EAT
2	I drink.	mi drink.	◊MI · ◊DRINK
3	I sleep.	mi sleep.	◊MI · ◊SLEEP
4	I woke up.	mi past wake.	◊MI · ◊PAST · ◊WAKE
5	I wash.	mi wash.	◊MI · ◊WASH
6	I get dressed.	mi dress.	◊MI · ◊DRESS
13	I eat breakfast.	mi eat breakfast-thing.	◊MI · ◊EAT · ◻BREAKFAST:OBJ
14	I eat lunch.	mi eat lunch-thing.	◊MI · ◊EAT · ◻LUNCH:OBJ

ID	English	NE-IL	PICTO-2
15	I eat dinner.	mi eat dinner-thing.	◊MI · ◊EAT · ◻DINNER:OBJ
16	I drink water.	mi drink water.	◊MI · ◊DRINK · ◊WATER
17	I am hungry.	mi be hungry-al.	◊MI · ◊BE · ΔHUNGRY:STATE
18	I am thirsty.	mi be thirsty-al.	◊MI · ◊BE · ΔTHIRSTY:STATE
19	I am tired.	mi be tired-al.	◊MI · ◊BE · ΔTIRED:STATE
20	I am ill.	mi be ill-al.	◊MI · ◊BE · ΔILL:STATE

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Day 3 - Work, learning, feelings, and familiar places

Focus: Time particles, work and learning actions, feelings, and common destinations.

ID	English	NE-IL	PICTO-2
7	I will go to work.	mi future go to work-place.	◊MI · ◊FUTURE · ◊GO · →TO · ◻WORK:PLACE
8	I am working now.	mi now work.	◊MI · ◊NOW · ◊WORK
9	I am studying now.	mi now study.	◊MI · ◊NOW · ◊STUDY
10	I am reading now.	mi now read.	◊MI · ◊NOW · ◊READ
11	I am writing now.	mi now write.	◊MI · ◊NOW · ◊WRITE
12	I am cooking now.	mi now cook.	◊MI · ◊NOW · ◊COOK
21	I am happy.	mi be happy-al.	◊MI · ◊BE · ΔHAPPY:STATE
22	I am sad.	mi be sad-al.	◊MI · ◊BE · ΔSAD:STATE
23	I go home now.	mi now go to house-place.	◊MI · ◊NOW · ◊GO · →TO · ◻HOUSE:PLACE
24	I am at home.	mi be at house-place.	◊MI · ◊BE · →AT · ◻HOUSE:PLACE
25	I go to school now.	mi now go to school-place.	◊MI · ◊NOW · ◊GO · →TO · ◻SCHOOL:PLACE
26	I am at school.	mi be at school-place.	◊MI · ◊BE · →AT · ◻SCHOOL:PLACE
27	I go to the market now.	mi now go to market-place.	◊MI · ◊NOW · ◊GO · →TO · ◻MARKET:PLACE
28	I buy food now.	mi now buy food-thing.	◊MI · ◊NOW · ◊BUY · ◻FOOD:OBJ

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Day 4 - Health, safety, needs, and negation

Focus: Critical concepts, negative scope, safety vocabulary, and acknowledgment practice.

ID	English	NE-IL	PICTO-2
29	I go to the hospital now.	mi now go to hospital-place.	◊MI · ◊NOW · ◊GO · →TO · ◻HOSPITAL:PLACE
30	I am at the hospital.	mi be at hospital-place.	◊MI · ◊BE · →AT · ◻HOSPITAL:PLACE
33	I need help now.	mi now need help-thing.	◊MI · ◊NOW · ◊NEED · ◻HELP:OBJ
41	I am in danger.	mi be danger-al.	◊MI · ◊BE · ΔDANGER:STATE
42	I need a doctor now.	mi now need doctor-er.	◊MI · ◊NOW · ◊NEED · ◻DOCTOR:ROLE
43	I feel pain now.	mi now feel pain-thing.	◊MI · ◊NOW · ◊FEEL · ◻PAIN:OBJ
44	I do not eat.	mi not eat.	◊MI · ×NOT · ◊EAT
45	I do not drink.	mi not drink.	◊MI · ×NOT · ◊DRINK

ID	English	NE-IL	PICTO-2
46	I will not go to the city.	mi future not go to city-place.	◊MI · ◊FUTURE · ×NOT · ◊GO · →TO · ◻CITY:PLACE
47	I am not sleeping now.	mi now not sleep.	◊MI · ◊NOW · ×NOT · ◊SLEEP
48	I do not work today.	mi today not work.	◊MI · ◊TODAY · ×NOT · ◊WORK
99	I need food now.	mi now need food-thing.	◊MI · ◊NOW · ◊NEED · ◻FOOD:OBJ
100	I am safe now.	mi now be safe-al.	◊MI · ◊NOW · ◊BE · △SAFE:STATE
87	I stop now.	mi now stop.	◊MI · ◊NOW · ◊STOP

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Day 5 - Movement, tools, doors, and waiting

Focus: Movement, devices, location relations, doors, and action contrasts.

ID	English	NE-IL	PICTO-2
34	I call someone now.	mi now call person.	◊MI · ◊NOW · ◊CALL · ◊PERSON
35	I use the phone now.	mi now use phone-thing.	◊MI · ◊NOW · ◊USE · ◻PHONE:OBJ
36	I charge the phone now.	mi now charge phone-thing.	◊MI · ◊NOW · ◊CHARGE · ◻PHONE:OBJ
37	I go by bus now.	mi now go by bus-thing.	◊MI · ◊NOW · ◊GO · →BY · ◻BUS:OBJ
38	I go by car now.	mi now go by car-thing.	◊MI · ◊NOW · ◊GO · →BY · ◻CAR:OBJ
39	I wait at the bus stop now.	mi now wait at bus-stop-place.	◊MI · ◊NOW · ◊WAIT · →AT · ◻BUS-STOP:PLACE
40	I cross the road now.	mi now cross road.	◊MI · ◊NOW · ◊CROSS · ◊ROAD
81	I open the door now.	mi now open door-thing.	◊MI · ◊NOW · ◊OPEN · ◻DOOR:OBJ
82	I close the door now.	mi now close door-thing.	◊MI · ◊NOW · ◊CLOSE · ◻DOOR:OBJ
83	I sit now.	mi now sit.	◊MI · ◊NOW · ◊SIT
84	I stand now.	mi now stand.	◊MI · ◊NOW · ◊STAND
85	I walk now.	mi now walk.	◊MI · ◊NOW · ◊WALK
86	I run now.	mi now run.	◊MI · ◊NOW · ◊RUN
88	I will wait.	mi future wait.	◊MI · ◊FUTURE · ◊WAIT

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Day 6 - Quantity, identity, possession, and comparison

Focus: Plurality, quantity, possession, proper-name literals, and comparison structures.

ID	English	NE-IL	PICTO-2
61	I have two books.	mi have two book-thing-many.	◊MI · ◊HAVE · #TWO · ◻BOOK:OBJ+PL
62	I have many friends.	mi have many friend-many.	◊MI · ◊HAVE · #MANY · ◊◊FRIEND:PL
63	There is no water in the bottle.	water not be in bottle-thing.	◊WATER · ×NOT · ◊BE · →IN · ◻BOTTLE:OBJ
64	Many people are in the city.	many person-many be in city-place.	#MANY · ◊◊PERSON:PL · ◊BE · →IN · ◻CITY:PLACE
65	Few friends live in the city.	few friend-many live in city-place.	#FEW · ◊◊FRIEND:PL · ◊LIVE · →IN · ◻CITY:PLACE
66	Everyone goes now.	all person-many now go.	#ALL · ◊◊PERSON:PL · ◊NOW · ◊GO
67	My name is Ana.	mi-own name-thing be Ana.	◊MI:OWN · ◻NAME:OBJ · ◊BE · "ANA"
68	That person is Daniel.	that person be Daniel.	◊THAT · ◊PERSON · ◊BE · "DANIEL"

ID	English	NE-IL	PICTO-2
69	My house is big.	mi-own house-place be big-al.	◊MI:OWN · ◊HOUSE:PLACE · ◊BE · ΔBIG:STATE
70	Her book is new.	she-own book-thing be new-al.	◊SHE:OWN · ◊BOOK:OBJ · ◊BE · ΔNEW:STATE
71	I am taller than you.	mi be more tall-al than tu.	◊MI · ◊BE · #MORE · ΔTALL:STATE · →THAN · ◊TU
72	She is younger than he is.	she be less old-al than he.	◊SHE · ◊BE · #LESS · ΔOLD:STATE · →THAN · ◊HE
73	This house is the same size as that house.	this house-place-own size-thing be same as that house-place-own size-thing.	◊THIS · ◊HOUSE:PLACE+OWN · ◊SIZE:OBJ · ◊BE · #SAME · →AS · ◊THAT · ◊HOUSE:PLACE+OWN · ◊SIZE:OBJ
74	I am hungrier than you.	mi be more hungry-al than tu.	◊MI · ◊BE · #MORE · ΔHUNGRY:STATE · →THAN · ◊TU
75	I am less tired than you.	mi be less tired-al than tu.	◊MI · ◊BE · #LESS · ΔTIRED:STATE · →THAN · ◊TU

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Day 7 - Description, transfer, perception, and transactions

Focus: Qualities, transfer roles, perception, speech, payment, and integrated round-trip practice.

ID	English	NE-IL	PICTO-2
76	The friend is good.	friend be good-al.	◊FRIEND · ◊BE · ΔGOOD:STATE
77	The road is long.	road be long-al.	◊ROAD · ◊BE · ΔLONG:STATE
78	The sky is blue.	sky be blue-al.	◊SKY · ◊BE · ΔBLUE:STATE
79	The water is cold.	water be cold-al.	◊WATER · ◊BE · ΔCOLD:STATE
80	The food is hot.	food-thing be hot-al.	◊FOOD:OBJ · ◊BE · ΔHOT:STATE
89	I come from the city now.	mi now come from city-place.	◊MI · ◊NOW · ◊COME · →FROM · ◊CITY:PLACE
90	I bring the book now.	mi now bring book-thing.	◊MI · ◊NOW · ◊BRING · ◊BOOK:OBJ
91	I give water to a person now.	mi now give water to person.	◊MI · ◊NOW · ◊GIVE · ◊WATER · →TO · ◊PERSON
92	A person gives food to me now.	person now give food-thing to mi.	◊PERSON · ◊NOW · ◊GIVE · ◊FOOD:OBJ · →TO · ◊MI
93	I see a person now.	mi now see person.	◊MI · ◊NOW · ◊SEE · ◊PERSON
94	I hear a person now.	mi now hear person.	◊MI · ◊NOW · ◊HEAR · ◊PERSON
95	I speak to a person now.	mi now speak to person.	◊MI · ◊NOW · ◊SPEAK · →TO · ◊PERSON
96	The person does not speak.	person not speak.	◊PERSON · ×NOT · ◊SPEAK
97	I pay now.	mi now pay.	◊MI · ◊NOW · ◊PAY
98	What is the price of this?	what be price-thing of this?	?WHAT · ◊BE · ◊PRICE:OBJ · →OF · ◊THIS

Practice task: create two valid substitutions from the day's vocabulary, then perform a text → PICTO → text round trip. Mark any uncertain token rather than guessing.

Annex E. Visual and lexical dictionary

This dictionary contains every canonical token used by the 100-phrase inventory. The 16-bit identifier is normative for machine interchange; the shape and label are normative for PICTO display.

Questions

PICTO label	NE-IL token	ID	Category
?HOW	how	0101	question
?QA	qa	0102	question
?WHAT	what	0103	question
?WHEN	when	0104	question
?WHERE	where	0105	question
?WHO	who	0106	question
?WHY	why	0107	question

References and entities

PICTO label	NE-IL token	ID	Category
oFRIEND	friend	1001	reference
oHE	he	1002	reference
oMI	mi	1003	reference
oPERSON	person	1004	reference
oROAD	road	1005	reference
oSHE	she	1006	reference
oSKY	sky	1007	reference
oTHAT	that	1008	reference
oTHIS	this	1009	reference
oTU	tu	100A	reference
oWATER	water	100B	reference

Possessors

PICTO label	NE-IL token	ID	Category
oMI:OWN	mi-own	1101	possessor
oSHE:OWN	she-own	1102	possessor

Time

PICTO label	NE-IL token	ID	Category
oFUTURE	future	2001	time
oNOW	now	2002	time
oPAST	past	2003	time
oTODAY	today	2004	time

Polarity and answers

PICTO label	NE-IL token	ID	Category
×NO	no	2101	polarity
×NOT	not	2102	polarity
×YES	yes	2103	polarity

Actions and copula

PICTO label	NE-IL token	ID	Category
◇BE	be	3001	verb
◇BRING	bring	3002	verb
◇BUY	buy	3003	verb
◇CALL	call	3004	verb
◇CHARGE	charge	3005	verb
◇CLOSE	close	3006	verb
◇COME	come	3007	verb
◇COOK	cook	3008	verb
◇CROSS	cross	3009	verb
◇DRESS	dress	300A	verb
◇DRINK	drink	300B	verb
◇EAT	eat	300C	verb
◇FEEL	feel	300D	verb
◇GIVE	give	300E	verb
◇GO	go	300F	verb
◇HAVE	have	3010	verb
◇HEAR	hear	3011	verb
◇LIVE	live	3012	verb
◇MAKE	make	3013	verb
◇NEED	need	3014	verb
◇OPEN	open	3015	verb
◇PAY	pay	3016	verb
◇READ	read	3017	verb
◇RUN	run	3018	verb
◇SEE	see	3019	verb
◇SIT	sit	301A	verb
◇SLEEP	sleep	301B	verb
◇SPEAK	speak	301C	verb
◇STAND	stand	301D	verb
◇STOP	stop	301E	verb
◇STUDY	study	301F	verb
◇UNDERSTAND	understand	3020	verb

PICTO label	NE-IL token	ID	Category
◇USE	use	3021	verb
◇WAIT	wait	3022	verb
◇WAKE	wake	3023	verb
◇WALK	walk	3024	verb
◇WASH	wash	3025	verb
◇WORK	work	3026	verb
◇WRITE	write	3027	verb

Objects

PICTO label	NE-IL token	ID	Category
□BOOK:OBJ	book-thing	4001	object
□BOOK:OBJ+PL	book-thing-many	4002	object
□BOTTLE:OBJ	bottle-thing	4003	object
□BREAKFAST:OBJ	breakfast-thing	4004	object
□BUS:OBJ	bus-thing	4005	object
□CAR:OBJ	car-thing	4006	object
□DINNER:OBJ	dinner-thing	4007	object
□DOOR:OBJ	door-thing	4008	object
□FOOD:OBJ	food-thing	4009	object
□HELP:OBJ	help-thing	400A	object
□LUNCH:OBJ	lunch-thing	400B	object
□NAME:OBJ	name-thing	400C	object
□PAIN:OBJ	pain-thing	400D	object
□PHONE:OBJ	phone-thing	400E	object
□PRICE:OBJ	price-thing	400F	object
□SIZE:OBJ	size-thing	4010	object

Roles

PICTO label	NE-IL token	ID	Category
□DOCTOR:ROLE	doctor-er	4201	agent

Places

PICTO label	NE-IL token	ID	Category
△BUS-STOP:PLACE	bus-stop-place	5001	place
△CITY:PLACE	city-place	5002	place
△HOSPITAL:PLACE	hospital-place	5003	place
△HOUSE:PLACE	house-place	5004	place
△HOUSE:PLACE+OWN	house-place-own	5005	place
△MARKET:PLACE	market-place	5006	place
△SCHOOL:PLACE	school-place	5007	place

PICTO label	NE-IL token	ID	Category
🚻TOILET:PLACE	toilet-place	5008	place
🏠WORK:PLACE	work-place	5009	place

States and qualities

PICTO label	NE-IL token	ID	Category
🗺️BIG:STATE	big-al	6001	state
🌊BLUE:STATE	blue-al	6002	state
❄️COLD:STATE	cold-al	6003	state
⚠️DANGER:STATE	danger-al	6004	state
😊GOOD:STATE	good-al	6005	state
😄HAPPY:STATE	happy-al	6006	state
🔥HOT:STATE	hot-al	6007	state
🍴HUNGRY:STATE	hungry-al	6008	state
🤒ILL:STATE	ill-al	6009	state
📏LONG:STATE	long-al	600A	state
🆕NEW:STATE	new-al	600B	state
🕒OLD:STATE	old-al	600C	state
😞SAD:STATE	sad-al	600D	state
🛡️SAFE:STATE	safe-al	600E	state
👤TALL:STATE	tall-al	600F	state
👤THIRSTY:STATE	thirsty-al	6010	state
😴TIRED:STATE	tired-al	6011	state

Relations

PICTO label	NE-IL token	ID	Category
→AS	as	7001	relation
→AT	at	7002	relation
→BY	by	7003	relation
→FROM	from	7004	relation
→IN	in	7005	relation
→OF	of	7006	relation
→THAN	than	7007	relation
→TO	to	7008	relation

Quantity and comparison

PICTO label	NE-IL token	ID	Category
#ALL	all	8001	quantity
#FEW	few	8002	quantity
#LESS	less	8003	quantity
#MANY	many	8004	quantity

PICTO label	NE-IL token	ID	Category
#MORE	more	8005	quantity
#SAME	same	8006	quantity
#TWO	two	8007	quantity

Groups

PICTO label	NE-IL token	ID	Category
○○FRIEND:PL	friend-many	8101	group
○○PERSON:PL	person-many	8102	group

Literals

The 16-bit value 9001 is a literal type marker, not a unique identifier for each name. The marker is followed by one byte of UTF-8 length and the NFC-normalized UTF-8 bytes; therefore different literal values remain distinct in the WAVE payload.

PICTO label	NE-IL token	ID / encoding	Category
"ANA"	Ana	9001 + 03 + 41 4E 41	literal block
"DANIEL"	Daniel	9001 + 06 + 44 41 4E 49 45 4C	literal block

Annex F. Printable exercises, answer key, and checklist

F.1 Translate English to canonical NE-IL

1. I eat. _____
2. I woke up. _____
3. I will go to work. _____
4. I drink water. _____
5. I am hungry. _____
6. I go home now. _____
7. I go to the hospital now. _____
8. Do you understand? _____
9. I need help now. _____
10. I am in danger. _____
11. I need a doctor now. _____
12. I will not go to the city. _____
13. When will I go? _____
14. I have two books. _____
15. My name is Ana. _____
16. I am taller than you. _____
17. I open the door now. _____
18. I give water to a person now. _____
19. What is the price of this? _____
20. I am safe now. _____

F.2 Decode PICTO-2

1. ×YES _____
2. ×NO _____
3. ?WHERE · ◇BE · □TOILET:PLACE _____
4. ?WHERE · ◇BE · ○WATER _____
5. ?WHERE · ◇BE · □HOSPITAL:PLACE _____
6. ?WHAT · ◇BE · ○THIS _____
7. ?WHY · ○TU · ×NOT · ◇EAT _____
8. ○WATER · ×NOT · ◇BE · →IN · □BOTTLE:OBJ _____
9. ○MI:OWN · □HOUSE:PLACE · ◇BE · △BIG:STATE _____
10. ○SHE · ◇BE · #LESS · △OLD:STATE · →THAN · ○HE _____
11. ○WATER · ◇BE · △COLD:STATE _____
12. ○MI · ○NOW · ◇CLOSE · □DOOR:OBJ _____
13. ○MI · ○NOW · ◇STOP _____
14. ○MI · ○NOW · ◇COME · →FROM · □CITY:PLACE _____

15. ◦PERSON · ⊙NOW · ◇GIVE · ◻FOOD:OBJ · →TO · ◦MI _____
16. ◦MI · ⊙NOW · ◇SPEAK · →TO · ◦PERSON _____
17. ◦PERSON · ×NOT · ◇SPEAK _____
18. ◦MI · ⊙NOW · ◇NEED · ◻FOOD:OBJ _____
19. ◦MI · ⊙NOW · ◇BE · △SAFE:STATE _____
20. ◦MI · ⊙NOW · ◇NEED · ◻HELP:OBJ _____

F.3 Build the complete frame from meaning blocks

1. self + now + need + help-object _____
2. where + be + hospital-place _____
3. self + future + not + go + to + city-place _____
4. self + now + give + water + to + person _____
5. person + now + give + food-object + to + self _____
6. self-own + name-object + be + Ana _____
7. this house-own size + be + same + as + that house-own size _____
8. self + now + be + safe-state _____
9. what + be + price-object + of + this _____
10. all + people-plural + now + go _____

F.4 WAVE frame validation

1. Identify the field that detects payload corruption.
- _____
2. Explain why Length and CRC must both be checked.
- _____
3. Name the required receiver response when two valid frames share a message ID but have different payloads.
- _____
4. State the purpose of the sequence field.
- _____
5. List the four conditions that require frame rejection: invalid length, invalid escaping, unknown version, and failed CRC.
- _____
6. Describe the difference between Normal, Confirmed, and Critical reliability profiles.
- _____

F.5 Answer key

1. mi eat.
2. mi past wake.
3. mi future go to work-place.
4. mi drink water.
5. mi be hungry-al.
6. mi now go to house-place.
7. mi now go to hospital-place.
8. qa tu understand?
9. mi now need help-thing.
10. mi be danger-al.
11. mi now need doctor-er.
12. mi future not go to city-place.
13. when mi future go?
14. mi have two book-thing-many.
15. mi-own name-thing be Ana.
16. mi be more tall-al than tu.
17. mi now open door-thing.
18. mi now give water to person.
19. what be price-thing of this?
20. mi now be safe-al.

PICTO decoding answers:

1. Yes. — yes.
2. No. — no.
3. Where is the toilet? — where be toilet-place?
4. Where is water? — where be water?
5. Where is the hospital? — where be hospital-place?
6. What is this? — what be this?
7. Why do you not eat? — why tu not eat?
8. There is no water in the bottle. — water not be in bottle-thing.
9. My house is big. — mi-own house-place be big-al.
10. She is younger than he is. — she be less old-al than he.
11. The water is cold. — water be cold-al.
12. I close the door now. — mi now close door-thing.
13. I stop now. — mi now stop.
14. I come from the city now. — mi now come from city-place.
15. A person gives food to me now. — person now give food-thing to mi.
16. I speak to a person now. — mi now speak to person.
17. The person does not speak. — person not speak.
18. I need food now. — mi now need food-thing.
19. I am safe now. — mi now be safe-al.
20. I need help now. — mi now need help-thing.

Meaning-block answers:

1. mi now need help-thing. | ◦MI · ◯NOW · ◇NEED · ◻HELP:OBJ
2. where be hospital-place? | ?WHERE · ◇BE · ◻HOSPITAL:PLACE
3. mi future not go to city-place. | ◦MI · ◯FUTURE · ×NOT · ◇GO · →TO · ◻CITY:PLACE
4. mi now give water to person. | ◦MI · ◯NOW · ◇GIVE · ◦WATER · →TO · ◦PERSON
5. person now give food-thing to mi. | ◦PERSON · ◯NOW · ◇GIVE · ◻FOOD:OBJ · →TO · ◦MI
6. mi-own name-thing be Ana. | ◦MI:OWN · ◻NAME:OBJ · ◇BE · “ANA”
7. this house-place-own size-thing be same as that house-place-own size-thing. | ◦THIS · ◻HOUSE:PLACE+OWN · ◻SIZE:OBJ · ◇BE · #SAME · →AS · ◦THAT · ◻HOUSE:PLACE+OWN · ◻SIZE:OBJ

8. mi now be safe-al. | ◊MI · ⊙NOW · ◊BE · △SAFE:STATE
 9. what be price-thing of this? | ?WHAT · ◊BE · □PRICE:OBJ · →OF · ◊THIS
 10. all person-many now go. | #ALL · ◊◊PERSON:PL · ⊙NOW · ◊GO

WAVE validation answers:

1. CRC-16-CCITT.
2. Length detects truncation or framing inconsistency; CRC detects content corruption. Either failure invalidates the frame.
3. Report CONFLICT and do not select a payload automatically.
4. It identifies the order of fragments and supports reassembly.
5. Reject the frame for any of the four listed conditions.
6. Normal sends once; Confirmed requests ACK and retries; Critical transmits three times and requires ACK with conflict reporting.

F.6 Full 100-phrase mastery checklist

Done	ID	English	Canonical NE-IL
☐	1	I eat.	mi eat.
☐	2	I drink.	mi drink.
☐	3	I sleep.	mi sleep.
☐	4	I woke up.	mi past wake.
☐	5	I wash.	mi wash.
☐	6	I get dressed.	mi dress.
☐	7	I will go to work.	mi future go to work-place.
☐	8	I am working now.	mi now work.
☐	9	I am studying now.	mi now study.
☐	10	I am reading now.	mi now read.
☐	11	I am writing now.	mi now write.
☐	12	I am cooking now.	mi now cook.
☐	13	I eat breakfast.	mi eat breakfast-thing.
☐	14	I eat lunch.	mi eat lunch-thing.
☐	15	I eat dinner.	mi eat dinner-thing.
☐	16	I drink water.	mi drink water.
☐	17	I am hungry.	mi be hungry-al.
☐	18	I am thirsty.	mi be thirsty-al.
☐	19	I am tired.	mi be tired-al.
☐	20	I am ill.	mi be ill-al.
☐	21	I am happy.	mi be happy-al.
☐	22	I am sad.	mi be sad-al.
☐	23	I go home now.	mi now go to house-place.
☐	24	I am at home.	mi be at house-place.
☐	25	I go to school now.	mi now go to school-place.
☐	26	I am at school.	mi be at school-place.
☐	27	I go to the market now.	mi now go to market-place.
☐	28	I buy food now.	mi now buy food-thing.
☐	29	I go to the hospital now.	mi now go to hospital-place.
☐	30	I am at the hospital.	mi be at hospital-place.

Done	ID	English	Canonical NE-IL
☐	31	Do you understand?	qa tu understand?
☐	32	I do not understand.	mi not understand.
☐	33	I need help now.	mi now need help-thing.
☐	34	I call someone now.	mi now call person.
☐	35	I use the phone now.	mi now use phone-thing.
☐	36	I charge the phone now.	mi now charge phone-thing.
☐	37	I go by bus now.	mi now go by bus-thing.
☐	38	I go by car now.	mi now go by car-thing.
☐	39	I wait at the bus stop now.	mi now wait at bus-stop-place.
☐	40	I cross the road now.	mi now cross road.
☐	41	I am in danger.	mi be danger-al.
☐	42	I need a doctor now.	mi now need doctor-er.
☐	43	I feel pain now.	mi now feel pain-thing.
☐	44	I do not eat.	mi not eat.
☐	45	I do not drink.	mi not drink.
☐	46	I will not go to the city.	mi future not go to city-place.
☐	47	I am not sleeping now.	mi now not sleep.
☐	48	I do not work today.	mi today not work.
☐	49	Yes.	yes.
☐	50	No.	no.
☐	51	Where is the toilet?	where be toilet-place?
☐	52	Where is water?	where be water?
☐	53	Where is food?	where be food-thing?
☐	54	Where is the hospital?	where be hospital-place?
☐	55	Where is home?	where be house-place?
☐	56	Who is that person?	who be that person?
☐	57	What is this?	what be this?
☐	58	When will I go?	when mi future go?
☐	59	Why do you not eat?	why tu not eat?
☐	60	How do you make this?	how tu make this?
☐	61	I have two books.	mi have two book-thing-many.
☐	62	I have many friends.	mi have many friend-many.
☐	63	There is no water in the bottle.	water not be in bottle-thing.
☐	64	Many people are in the city.	many person-many be in city-place.
☐	65	Few friends live in the city.	few friend-many live in city-place.
☐	66	Everyone goes now.	all person-many now go.
☐	67	My name is Ana.	mi-own name-thing be Ana.
☐	68	That person is Daniel.	that person be Daniel.
☐	69	My house is big.	mi-own house-place be big-al.
☐	70	Her book is new.	she-own book-thing be new-al.
☐	71	I am taller than you.	mi be more tall-al than tu.
☐	72	She is younger than he is.	she be less old-al than he.

Done	ID	English	Canonical NE-IL
☐	73	This house is the same size as that house.	this house-place-own size-thing be same as that house-place-own size-thing.
☐	74	I am hungrier than you.	mi be more hungry-al than tu.
☐	75	I am less tired than you.	mi be less tired-al than tu.
☐	76	The friend is good.	friend be good-al.
☐	77	The road is long.	road be long-al.
☐	78	The sky is blue.	sky be blue-al.
☐	79	The water is cold.	water be cold-al.
☐	80	The food is hot.	food-thing be hot-al.
☐	81	I open the door now.	mi now open door-thing.
☐	82	I close the door now.	mi now close door-thing.
☐	83	I sit now.	mi now sit.
☐	84	I stand now.	mi now stand.
☐	85	I walk now.	mi now walk.
☐	86	I run now.	mi now run.
☐	87	I stop now.	mi now stop.
☐	88	I will wait.	mi future wait.
☐	89	I come from the city now.	mi now come from city-place.
☐	90	I bring the book now.	mi now bring book-thing.
☐	91	I give water to a person now.	mi now give water to person.
☐	92	A person gives food to me now.	person now give food-thing to mi.
☐	93	I see a person now.	mi now see person.
☐	94	I hear a person now.	mi now hear person.
☐	95	I speak to a person now.	mi now speak to person.
☐	96	The person does not speak.	person not speak.
☐	97	I pay now.	mi now pay.
☐	98	What is the price of this?	what be price-thing of this?
☐	99	I need food now.	mi now need food-thing.
☐	100	I am safe now.	mi now be safe-al.

Annex G. Machine interchange profile

G.1 Token identifier ranges

Category	Assigned range	Token count
Questions	0101-0107	7
References and entities	1001-100B	11
Possessors	1101-1102	2
Time	2001-2004	4
Polarity and answers	2101-2103	3
Actions and copula	3001-3027	39
Objects	4001-4010	16
Roles	4201-4201	1
Places	5001-5009	9
States and qualities	6001-6011	17
Relations	7001-7008	8
Quantity and comparison	8001-8007	7
Groups	8101-8102	2
Literal marker	9001-9001	1

G.2 Canonical data schema

```
{
  "id": 33,
  "english": "I need help now.",
  "neil": "mi now need help-thing.",
  "picto_tokens": ["MI", "NOW", "NEED", "HELP:OBJ"],
  "wave_token_ids": ["1003", "2002", "3014", "400A"],
  "wave_flags": "0x06",
  "wave_payload_hex": "100320023014400A",
  "crc_profile": "CRC-16/CCITT-FALSE",
  "crc16": "1012",
  "critical": true
}
```

G.3 Generation and verification workflow

1. Author or select a canonical semantic frame.
2. Generate canonical NE-IL using the fixed grammar.
3. Generate the ordered PICTO token list from the same semantic roles.
4. 4. Replace each token with its 16-bit registry identifier; encode each literal as 9001 + one-byte UTF-8 length + NFC-normalized UTF-8 bytes.
5. 5. Build the unescaped WAVE frame, calculate CRC-16/CCITT-FALSE over Version through Payload, append the CRC, and then apply byte escaping.
6. Transmit using the selected bearer profile.
7. At reception, validate framing and CRC before decoding.
8. Reconstruct PICTO and NE-IL, then compare the resulting semantic frame with the sender frame.
9. Log conformance status; never silently repair an invalid frame.

G.4 Legacy migration rule

Historical whole-phrase symbol strings may be retained as archival references, but conversion into the integrated edition **MUST** use the phrase ID or the English/NE-IL source text. A historical symbol string alone is not sufficient evidence of the intended phrase. PICTO-2 and WAVE-2 are the normative encodings in this document.

G.5 Publication checklist

- Confirm document owner, edition, publication date, license, and any reserved Zenodo DOI before publishing the immutable record.
- Publish the master data from which all tables and educational materials are generated.
- Provide Unicode and ASCII-fallback fonts or labels without redistributing font files.
- Run automated uniqueness, round-trip, CRC, and coverage tests before every release.
- Complete independent comprehension, accessibility, and channel-noise studies before safety-critical use.
- Preserve a change log for grammar, token registry, phrase inventory, and transport framing.