1. Development of Coding Scheme

The coding scheme was developed by the author using a directed approach (Hsieh & Shannon, 2005). First, categories were defined in response to the foreshadowing questions, in alignment with the discussion of form and space in Tversky (2011). The author then reviewed a subset of diagrams (n=5), and applied the coding scheme. Multiple modifications were made during this inductive process, including the addition of two categories the researcher noted as present and variant in the sample, and removal of one category that proved too subjective to evaluate[1]. The researcher then developed operational definitions for each variable and set variable values that were exhaustive and mutually exclusive (Theo & Jewitt, 2004).

The resulting scheme was then applied to the diagrams by two additional raters, who coded the entire sample. After every five diagrams, the raters paused to discuss their evaluations, following the constant comparison method (Glasner & Strauss, 1967 as cited in Marsh & White, 2006). In the case of discrepancies, each rater explained their interpretation of the code, after which raters could revise or maintain their original assessment. In one case, a revision to an operational definition was proposed, and the corresponding components of the previously reviewed diagrams were re-evaluated. The final coding scheme reflects a response to the both the research questions and the evidence present in the sample.

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[1] The researcher decided to treat all depictive representations in a single category (drawing), rather than differentiate them as icons, indexes, representative depictions, etc.

1.1.   USE OF SPACE

We first sought to categorize the students' use of space. In language we use conflicting spatial metaphors when describing time. We describe history as a series of "timelines" but sleep as a circadian "rhythm". Before dissecting the representations into component dimensions, we first considered the nature of their Gestalt use of space. Raters were asked to categorize an overall pattern as *linear* or *circular*. Linear representations appeared to follow a line whose end did not return to its beginning, while circular representations resembled a curved path with no start or finish. This distinction formed the basis for the first variable in the coding scheme (S1).

Next, we turned to the dimensions of the page, defining them in regard to the student's frame of reference. The horizontal and vertical orientations corresponded (respectively) to the long and short sides of a sheet of A4 paper, and the center-periphery to the middle and boundaries of the page.
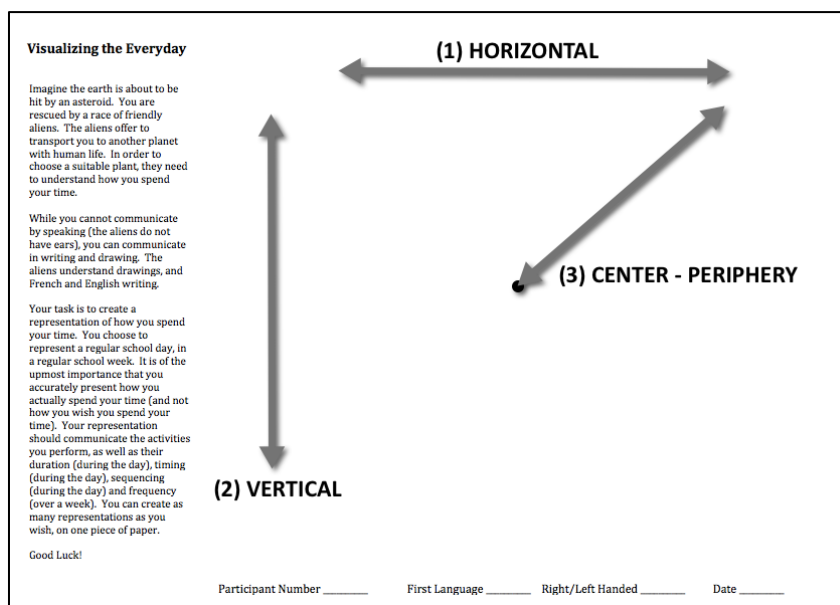

Figure 1 depicts the three spatial dimensions we examined, imposed on the experimental materials: (1) horizontal, (2) vertical, and (3) center - periphery

Figure 1: Page Dimensions

We at first considered these orientations universally, coding the directional flow of information in each dimension, for each representation. During the inductive coding however, it was apparent that the use of each dimension was dependent on the overall pattern of space (S1). The horizontal and vertical were only relevant for linear representations, while the center-periphery distinction was relevant in circular cases. Variables (S2-S5) were assigned to evaluate the direction of flow for: (2) horizontal, (3) vertical, (4) clockwise/counterclockwise and (5) center-periphery. Raters considered the questions: in what direction does the author intend you to follow in the information? In which (if any) direction does the information "flow"? In evaluating this task, it was critical to consider the whole representation as the unit of analysis in order to code the flow of information, rather than the direction of text, which would skew the

results in favor of left to right, top to bottom and clockwise values. Finally, we chose to categorize the point of origin in each representation (S6). The raters agreed on the "start" of the day as earliest activity beginning after 12:00 AM.

Table 1 summarizes the six variables evaluating space, along with their range of values and operational definitions.

Table 1: Coding Scheme for Use of Space

#	VARIABLE	VALUES	OPERATIONAL DEFINITION	
S1	PATTERN	1 = LINEAR 2 = CIRCULAR	Overall, the use of space…	follows a line (visible or not) with an end and beginning
				follows a circular path
S2	(LINEAR) HORIZONTAL	0 = NONE 1 = LEFT → RIGHT 2 = BOTH 3 = RIGHT → LEFT	The linear use of space in the horizontal plane proceeds primarily…	NA: The dimension is not used
				from left to right
				In both directions
				from right to left
S3	(LINEAR) VERTICAL	0 = NONE 1 = TOP → BOTTOM 2 = BOTH 3 = BOTTOM → TOP	The linear use of space in the vertical plane proceeds primarily…	NA: The dimension is not used
				from top to bottom
				in both directions
				from bottom to top
S4	(CIRCULAR) CIRCUMFERENTIAL	0 = NONE 1 = CLOCKWISE 2 = BOTH 3 = COUNTERCLOCKWISE	The circular use of space around the perimeter of the proceeds primarily…	NA: The dimension is not used
				in a clockwise direction
				in clockwise and counterclockwise directions
				In a counterclockwise direction
S5	(CIRCULAR) RADIAL	0 = NONE 1 = PERIPHERY → CENTER 2 = BOTH 3 = CENTRE → PERIPHERY	The circular use of space inside the perimeter of the proceeds primarily…	NA: The dimension is not used
				starts in periphery, moves to center
				in both directions
				starts in center, moves to periphery
S6	LOCATION OF ORIGIN	0 = TOP LEFT 1 = BOTTOM LEFT 2 = BOTTOM RIGHT 3 = TOP RIGHT 5 = CENTER	The location of the origin (start of the individual's day) is located in the …	top left area of the page
				bottom left area of the page
				bottom right area of the page
				top right area of the page
				center of the page

1.2. USE OF FORM

In analyzing form, we chose to assume a pragmatic stance, allowing for a wide range of artistic abilities. We read for forms that were used consistently throughout a drawing, reflecting intentional choice by the author. We were particularly interested in evaluating when students chose to use text, versus numbers versus drawings. In support of this goal, we adopted two conventions:

1. Text vs. Symbol augmenting numbers

This sentence is text, and "12" is a number. But what about "12h14", or "4pm": text or number? The answer in the strictest sense is *both*. However, we chose to allow a limited number of textual characters to be considered numeric in our coding scheme, when their purpose was clearly to label a numeric quality. These include the conventions: h, m, s, hr, min, sec, x (for number of times), am, pm.

2. Text vs. Symbol augmenting a drawing

Similarly, text can be used to *accompany* a diagram, or, text may be *present* in a diagram, as it is present in the physical world. Imagine a photograph of a road sign. Most would consider the words on the sign a part of the image, while the caption of the photograph constitutes a textual description of the image. We chose to make a similar distinction, allowing for a pragmatic treatment of integrated text labeling otherwise realistic depictions.

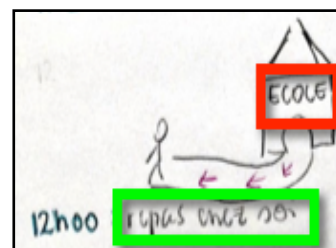**Figure 2:** Symbol augmenting drawing

Figure 3: Text, and symbol augmenting drawing

In the *Figure 2,* the author represented their arrival at school using a combination of numeric symbol [7h55] and realistic drawing. The word "UPMF" (in red: acronym for their university) is used to distinguish the building as a school. As the remaining drawings in the representation do not contain text labels, the coders agreed, in this case the author used the text only to augment their drawing skills. The representation was coded as having included number (7h55) and drawing.

In *Figure 3*, the author represented their departure from school using text description (in green) and drawing (a pathway and building). The word "ECOLE" (in red: English = "school") is used only to identify the building as a school. The representation was coded as number (12h00), text ("repas chez soi") and drawing (the building and path).

Table 2 summarizes the five variables evaluating form, along with their range of values and operational definitions.

Table 2: Coding Scheme for Use of Form

#	VARIABLE	VALUES	OPERATIONAL DEFINITION	
F1	TEXT	0 = NO 1 = YES	Is the following present in the representation?	Symbols: english or french language (not embedded in images, intended only to mitigate poor drawing skills)
F2	NUMBER	0 = NO 1 = YES	Is the following present in the representation?	Symbols: numbers, including linguistic labels: s, m, h, seconds, x, minutes, hours, times
F3	DRAWING	0 = NO 1 = YES	Is the following present in the representation?	depictive representation
F4	ARROW	0 = NO 1 = YES	Is the following present in the representation?	line with a directional end
F5	COLOR	0 = NO 1 = YES	Is the following present in the representation?	more than one color

1.3. PRIMARY MECHANISMS

Finally we turned to the essential components of time use, and sought to identify which graphic mechanisms were used in their depiction. Raters were asked to identify each component in the diagram, and indicate which of the previously identified spatial and form elements were employed in their representation.

Table 3 summarizes the five variables evaluating primary mechanisms, along with their range of values and operational definitions.

Table 3: Coding Scheme for Primary Mechanisms

#	VARIABLE	VALUES	OPERATIONAL DEFINITION	
M1	ACTIVITY	SPATIAL/SIZE SPATIAL/POSITION	Which mechanisms are used to represent the component?	Activities: the actions the individual performs (i.e. eating, driving to work)
M2	DURATION	TEXT NUMBER DRAWING		Duration: the quantity of time the individual spends performing the activity. (i.e. 2 hours, 1.5 hours)
M3	TIMING	ARROW COLOR OTHER		Timing: the start and or end time at which the individual performs the activity (i.e. 9:00 am, 8pm)
M4	SEQUENCE			Sequence: the order in which the individual performs the activity (i.e. brushing teeth is followed by going to bed)
M5	FREQUENCY			Frequency: the number of times the activity is performed in a given time interval (i.e. 4 times per day, 2 times per week)