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More to Reading Images: Motivations Underlying Horizontal and Vertical Time-related Graphics

Marilyn Mitchell, Bond University, Australia

Abstract: This article describes major motivations underlying the designs of Western, multimodal horizontal and vertical time-related graphics. The work is important as it contributes to a meta-language of design; it demonstrates that the designs of time-related signs are not arbitrary but are built upon a range of interpersonal or social needs and perceptual and physical factors, and it provides ideas that instructors may use to teach different concepts of time. The research is qualitative and progresses by using examples to discuss how time perception, the linguistic representation of time, basic principles of time measurement, processes of reading and writing, perception of areas of the page or screen, and design constraints have motivated designs of time. The research also considers how the continua of given-new and ideal-real relate to these graphics. Examples were taken from scholarly texts, textbooks, encyclopedias, newspapers, magazines, calendars, planners, software applications, and websites. Timelines are described according to their purpose and by considering the symbols or marks within them, spaces between the symbols or marks, colors, orientations of the line of time, facings of symbols along the line, reference points, and scales. The results show that although time is strongly associated with the direction of writing along the horizontal, it may be reversed to suit different purposes. Designers may resort to vertical timelines if they need to fit information into a given area or if a timeline is too long to fit along the horizontal, if they need to follow reading order, if they need to demonstrate upward movement toward some ideal, or if they need to place time against a structure of reality so as to make the timeline more comprehensible. Designers and readers should take care in creating and reading upward moving timelines as upward movement can be construed as a movement toward goodness, even when that was not the intent of the design.

Keywords: Multimodal Images, Timelines, Design Motivations, Visual Grammar

Introduction

This article aims to extend research on multimodal texts by describing major motivations for the designs of horizontal and vertical time-related graphics (e.g. calendars, historical timelines) in Western cultures. These motivations are described through the general lens of Halliday's (1973, 1994) functional linguistics and through theories of time perception, the linguistic representation of time, basic time measurement, writing, perception of information on the page, and design constraints. Time-related graphics are considered to be multimodal since they contain more than one symbol set (e.g. numbers, alphabetic text, photographs, measurement scales). While much theory exists on motivations for the structures or grammar of written texts, theory on the structures of multimodal texts is still developing. This research follows the view of Kress (2003, 42) that signs are not arbitrary but are "always motivated."

In *Reading Images*, Kress and van Leeuwen (1996) opened a path toward greater understanding of how multimodal texts deliver meaning by examining them using functional linguistics. This approach describes such texts as having three levels of meaning, which are: (1) interpersonal, or the social relationship between the message sender and receiver; (2) ideational, or how the subject matter is represented; and (3) textual, or compositional choices that allow the parts (e.g. symbols) within a message to cohere and the message theme to be expressed. In timelines, ideational and textual choices are closely interwoven and are difficult to separate and, therefore, are discussed together in this research. While Unsworth (2001) previously discussed timelines using functional linguistics, this research discusses the motivations for these graphics by considering the other perspectives listed. Mitchell and van Sommers (2007) previously used the linguistic representation of time to describe time-related graphics in computer interfaces, and Mitchell (2004, 2014) used it to describe shapes of timelines and family tree diagrams, respectively.

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This research also aims to explore how two compositional structures described by Kress and van Leeuwen (1996) relate to timelines. These structures are the horizontal continuum of given-new, which commonly appears in multimodal news-story layouts, and the vertical continuum of ideal-real, which commonly appears in multimodal product advertisements. In the given-new structure, given or known information appears on the left of a page while new or unknown information appears on the right. In the ideal-real structure, ideal information about a product's use is placed at the top of a page while real information about the product is placed at the bottom. Although the purposes of printed newspaper stories and product advertisements differ from those of timelines, this article nonetheless seeks to explore how the given-new and ideal-real structures apply to time-related graphics. Both the given-new and ideal-real structures convey information about time as they represent change, which is our fundamental perception of time (Fraisse 1984); that is, something new can be introduced to a given situation to change it, and real products that are available in the here and now can lead to ideal solutions that change people's lives. The ideal-real continuum additionally conveys information about goodness and reality that may apply to the design and interpretation of at least some vertically-oriented graphics of time.

In sum, the research aims to contribute to the development of what Kalantzis and Cope (2012, 199) referred to as a "metalanguage of design elements," which is needed for "learning about the form, structure, and social purpose of meaning making." The research also aims to help instructors better explain how some time-related graphics work so that students may be better able to create and interpret them. Thornton and Vukelich (1998) believe that time concepts should be taught systematically and reasonably sequentially within different fields of study (e.g. history, math) to help students understand the complexity of time.

Research Method

This research is qualitative and progresses by discussing how time perception, the linguistic representation of time, basic principles of time measurement, processes of reading and writing, perception of areas of the page or screen, and design constraints have motivated different aspects of horizontal and vertical timelines. The relationship of the given-new and ideal-real continua to timelines is also considered. Example graphics are presented throughout. As each example appears, its interpersonal or social purpose is discussed. Examples were selected from a broad range of sources including scholarly texts, textbooks, newspapers, magazines, calendars, planners, software applications, and websites. Ideational-textual meanings or the representation of time within each example is described by considering the symbols or marks within each graphic, spaces between the symbols or marks, colors, orientations of the line of time, facings of symbols along the line, reference points, and scale.

Graphics and the Perception of Time

As we know, time cannot be experienced directly. We perceive time as *change* or the occurrence of events. As Fraisse (1984, 2) noted, our experience of change is based upon (a) the fact that we can perceive two or more events as different and happening in succession, and (b) the "duration … or interval between two successive events." Succession "is based upon our experience of the continuous changing through which the present becomes the past" (Fraisse 1984, 2). Given this description, graphical representations of change should contain a minimum of two symbols, each of which represents a different state of affairs. The underlying logic is therefore one of order, in which an initial state visually differs from a second or final state. This model is useful for understanding how both recurring and non-recurring events unfold. An example representation of change is given in Figure 1, which shows the American Sign Language (ASL) word for "present" (now). Interpersonally, this diagram was created as a teaching or translation aid, which means that it needed to be extremely clear and easy to follow. In the diagram, the signer is placed in the best position for viewing the particular word that she is signing, which is facing forward. Change is represented by superimposing the initial position of the signer's hands and forearms over the final position. The initial position is marked in three ways, which are by the hands and arms' unique position in space, by their dotted outline, and by the placement of downward-pointing arrows next to each hand. The final position of the hands and arms is marked by their unique position in space, their solid outline, and by placement of the arrows' tips next to the hands. The background of the signer's head and torso remains the same, functioning as a map over which a path is drawn.

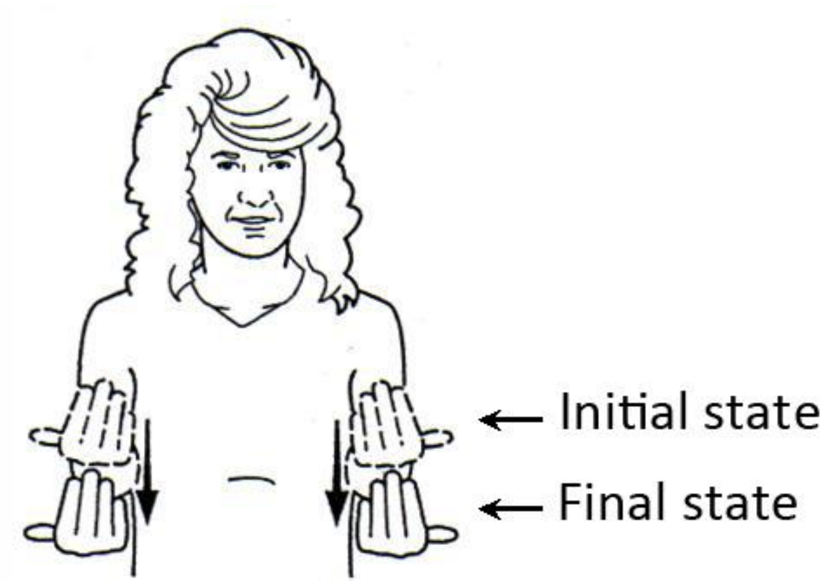

Figure 1: Example Representation of the Perception of Time or Change:
Signing of the Word "Present" (Now) in ASL
Source: Bailey and Dolby 2002

Graphics and the Linguistic Representation of Time

Linguistic time does not represent time *per se* but reflects our experience of time. Linguistic time provides detail about how different types of events occur, how they occur in relation to one another, and how they occur in relation to the speaker. Many researchers have shown that at least in Western culture, linguistic time is represented through the metaphor "time is space" (e.g. Clark 1973; Traugott 1975). The spatial metaphor of linguistic time allows speakers to distinguish between the occurrence of events and the perceived unidirectional passage of time from past to present to future. The past, present, and future act as fundamental events against which all other events can be described.

As illustrated by the examples in Figure 2, language instructors commonly teach about tense using graphics that represent time as space. These graphics visually demonstrate the separation of time and events. In the given example, time is represented as a horizontal line along which reference points for the past, present, and future are placed, and events are represented as text-filled boxes with arrowheads that are anchored to reference points along the line of time.

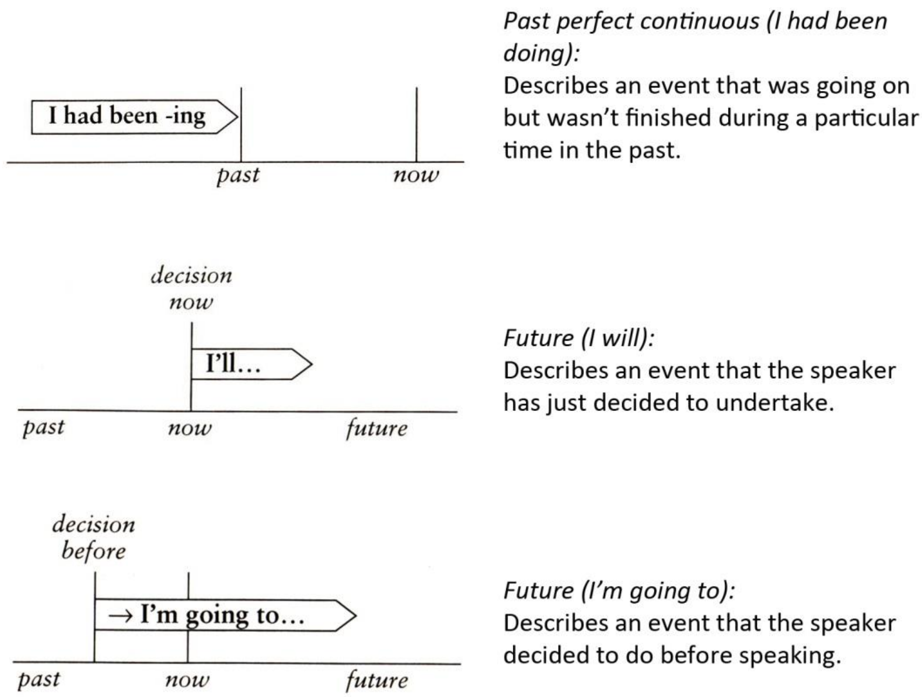

Figure 2: Visual representations of linguistic time are made along the horizontal
Source: Murphy 1994

Three subsystems of linguistic time are tense, sequencing, and aspect (Traugott 1975). Tense is the system by which we use the reference point of now, or our moment of speaking, to point at places along an imaginary line of time along which events occurred, are occurring, or will occur. On one side of this line is the past and on the other is the future. Sequencing allows us to refer to how two or more events occur in relation to one another along the imaginary line. Events may overlap, precede, or follow one another. Aspect refers to the duration of an event, whether it has boundaries, and whether and how it recurs. As Traugott (1965, 208–209) noted, these three subsystems of linguistic time "are rarely, probably never, fully differentiated from each other at the level of expression."

Figure 3 presents a timeline of the history of jazz that visually represents all three subsystems of linguistic time. The design was created to teach any interested person about the development and popularity of different types of jazz. Tense is represented by the line of time that runs from left to right on the page, which is marked using the years of the Gregorian calendar. Sequencing is represented by placement of the different types of jazz along the line of time. In this example, two types of jazz may share a place along the line of time only if they do not overlap (e.g. Country Blues and Bebop are on the same line). Aspect is represented by the boundaries or length of time when each type of jazz developed and was popular. In Figure 3, for example, "Swing" developed and was popular between 1932 and 1943.

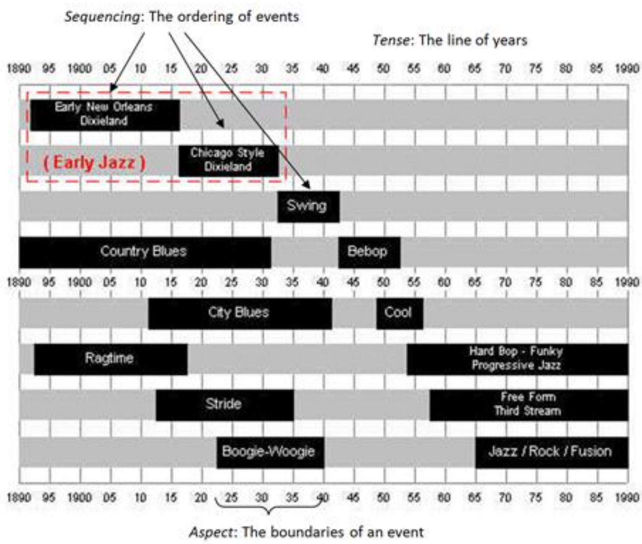

Figure 3: Tense, Sequencing, and Aspect in a Timeline of the History of Jazz
Source: The VALiens n.d.

Some expressions of time, particularly regarding tense and sequencing, rely on the position of the body in space (e.g. "I face the future," "The future is ahead of me," "Put that behind you," "We did things differently back then") (Traugott 1975). These expressions place time along the horizontal in relation to the front and back of the speaker. Some researchers (e.g., Fillmore 1971; Clark and Clark 1977) have referred to these expressions as the moving-ego version of time. When events are referred to in terms of other events (e.g. "Move the appointment forward two weeks"), we speak of the events as if they are moving toward us along the imaginary timeline. Researchers have referred to these expressions as the moving-time version of time.

Traugott (1975, 221) described linguistic time as a stationary asymmetrical line or path and discounted the moving-time version of time. She wrote, "The basic spatial image for both tense and sequencing is a horizontal line, a path along which we walk, or along which events can be arranged." On the stationary path of time, events or the speaker move, but not time. The path of time itself extends both into the infinite past and the infinite future. This explanation makes sense when we conceive of time as a still place along which either we or events can move or remain still and look forward or back. Figure 4 illustrates the horizontal path of linguistic time with either a speaker or events moving along it.

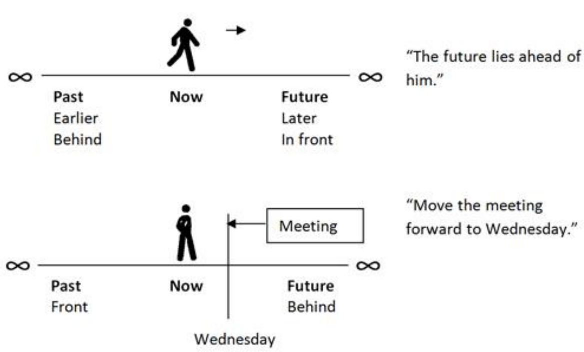

Figure 4: The Stationary Horizontal Path of Time with the Speaker or Events Moving Along It
Source: Mitchell 2016

The horizontal path of time that relies on the facing of the body appears in the visual languages of American Sign Language (ASL), the Australian sign language, Auslan, and British Sign Language (BSL). Figure 5 illustrates that the ASL signs for past, present, and future are formed along a line that moves from over one's shoulder (the past), to a place vertically aligned with the front of one's body (the present), to a position in further front of the body (the future).

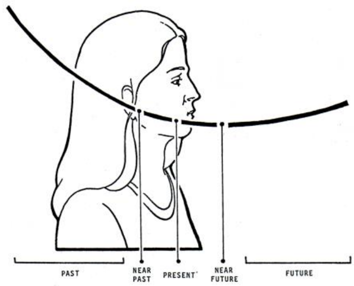

Figure 5: The Time Line in ASL
Source: Adapted from Frishberg and Gough (cited in Klima and Belugi 1979)

As demonstrated in the next figure (Figure 6), horizontal evolutionary timelines often contain images of creatures that are oriented to face toward the future. Figure 6 is a diagram of bird-wing evolution, which was made as an aid to teach evolutionary history. The diagram contains an upper line representing physical changes to the typical dinosaur arm that resulted in modern bird wings and a lower line representing the creatures that had these arms or wings. The diagram represents the creatures in their evolutionary order and does not present dates. To emphasise the path of time from earlier on the left to later on the right, the creatures are drawn to face the future on the right. Although the arms or wings on the upper line are each given equal space to maximize the amount of physical detail shown, those along the lower line are placed in relative time order, with uneven amounts of space between the creatures. The first known dinosaur that could fly, the archaeopteryx, is represented as lifting off the path, which demonstrates both its ability to fly and the break between dinosaurs and birds as species. The facing of creatures along the path of time will be discussed again in the section on writing.

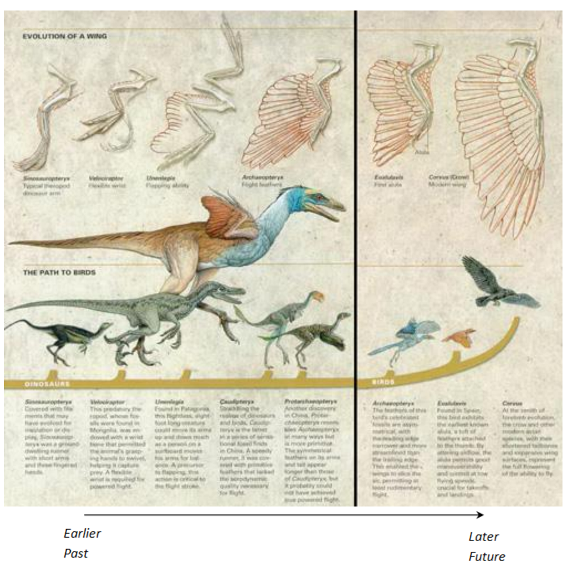

Figure 6: The *Earlier-to-Later* or *Past-to-Future* Continuum in an Evolutionary Timeline.
Source: Ackerman 1998

One type of chart that provides strong evidence for the horizontal being the preferred conception of time in the West is the Cartesian graph (e.g. Figure 7). When time is represented in such graphs, it is nearly always placed along the horizontal. Designed for business people and investors, Figure 7 serves as an aid for predicting financial market movements. It presents two measures of profitability of the US financial-market over a forty-year period.

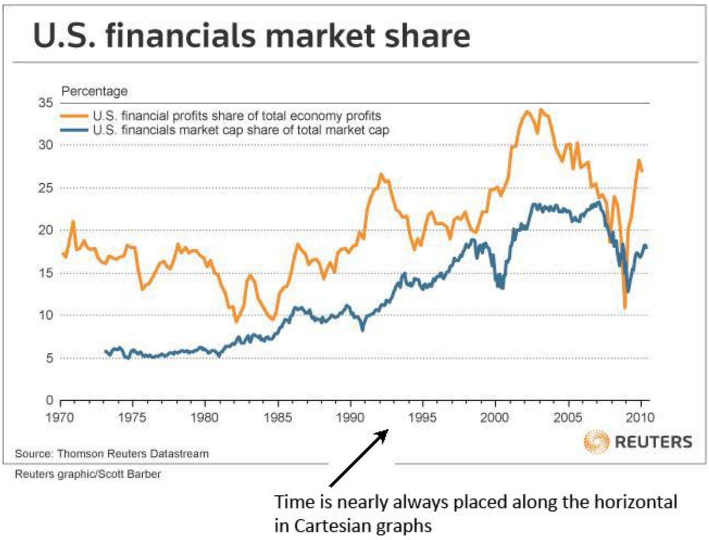

Figure 7: Example of a Cartesian Graph with Time Placed along the Horizontal
Source: Barber 2010

Another feature of linguistic time that appears in timelines is the asymmetry used to express the idea of the past versus the future. To express past tense in English, we typically add *-ed* to a verb (e.g. walked). We express future tense by adding modal auxiliaries before the present tense (e.g. will walk). (Examples of modal auxiliaries are *shall/should, may/might, can/could,* and *will/would*.) These modals allow us to express our opinion or subjective attitude regarding an event's certainty (Palmer 1986). For example, *will* and *shall* express much more certainty that an event will occur than *may* or *might*. Some graphics of time express future events as being less certain by giving them a different border than that given to more certain events. In Figure 8, for example, a tentative appointment in the Microsoft Outlook calendar is represented with a left border of diagonal lines. In contrast, more certain appointments have a solid left boundary.

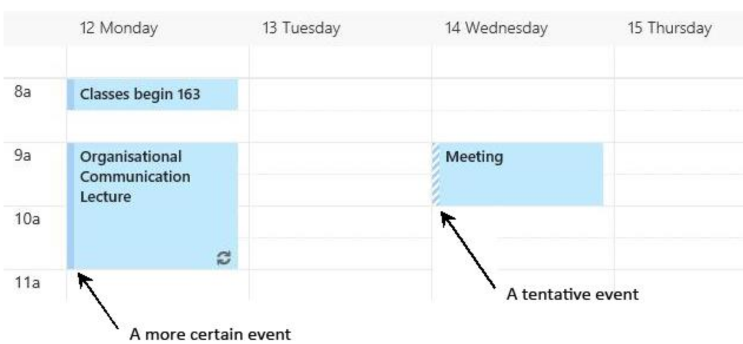

Figure 8: Example of a Visual Modal: A Tentative Meeting versus
a More Certain Meeting in the Microsoft Outlook Calendar
Source: Mitchell 2016

Events of the past can also be expressed using modals, as some events are more conjectural than certain. For example, no one has full knowledge of their family history. A person may express uncertainty over a family relationship by saying something like, “Elizabeth may have been her mother” or visually express this uncertainty by placing, for example, dotted lines and question marks between possible parents as shown in Figure 9. The tree in Figure 9 was created to represent a DNA experiment conducted for the Woodson family in the US who were attempting “to determine whether Thomas Jefferson could have fathered any of his slave’s, Sally Hemings, children” (Williams 2005, 225).

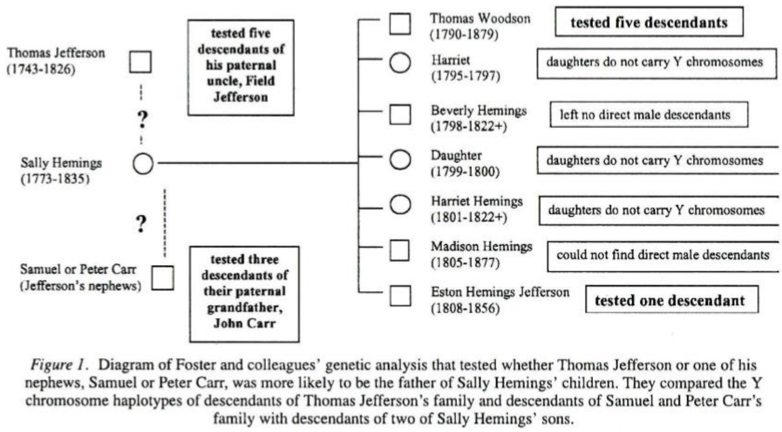

Figure 9: Tree Diagram that Visually Expresses Uncertainty over Genetic Ancestry
Source: Williams 2005

In summary, graphics of time that are created along the horizontal need to contain a line or path that represents the imaginary line of time. In some graphics, the line is composed from the events themselves (e.g. Figure 6, “Evolution of a Wing”) while in others it is composed using dates or other measures of time. At a minimum, the line needs to contain two reference points to mark the occurrence of one event in relation to another event. Optionally, symbols for events may be marked as having different durations. Further, the direction of time may point forward or back and may be indicated by facings of people, creatures, objects, or arrowheads. If the future is represented, it will be marked differently from the past, at least in the position of symbols. Finally, some graphics will contain visual indicators of mood to represent the level of certainty of a past or future event’s occurrence.

Although the basic spatial image for time in the West is a horizontal line, time is sometimes linguistically expressed as existing in the vertical plane. For example, we have sentences such as “Time is up” and “These ideas have come down from the past.” Regarding these expressions, Traugott (1975, 221) wrote: “While tense deixis [pointing] is … strictly tied to the concept of a person moving along a path, serialization is less directly tied to the speaker, and is therefore spatially less constrained. Specifically, it [serialization] admits of arrangements along the vertical as well as the horizontal plane.” Vertical timelines are discussed later.

Basic Time Measurement and Scales

Time measurement systems were developed to allow us to state exactly when an event occurred, or would occur, how long it lasted, or would last, and how it recurred, or would recur, and so on. We measure events in terms of events that occur regularly. Two examples of events that occur regularly and that have been used to mark time are the setting of the sun, which in some cultures marks the start of a new day, and oscillations of the cesium atom, which are used to measure seconds on atomic clocks (9,192,631,770 cycles of Cs-133 = one second). We also divide time into different cognitively-manageable units to suit different purposes. For example, to plan and discuss events in our social lives, the most useful measures are those of the twenty-four-hour day (especially the hours when we are awake), the seven-day week, the twenty-eight- to thirty-one-day month, and the 365- or 366-day year. In contrast, the most useful measure for a competitive 100-metre foot race is the hundredth of a second, and for dating rocks, it is millions and billions of years from the present. Some measures mark events that recur (e.g. days of the week, hours of the day), and some mark durations of time (e.g. years). These durations may be small (e.g. time to soft boil an egg), or large enough to measure back to the big bang or forward into the infinite future. All measures require a primary reference point. For some events, we count forwards from a reference point (e.g. time to run a race), for others we count backwards (e.g. time to bake a cake), and for some we count in both directions (e.g. historical time in western culture is counted backwards and forwards from the year A.D. 1 or 1 C.E.). Different types of events require different measurement systems, which have different key reference points, different scales, and different graphical representations. Although the development of number systems is not covered here, it is important to consider for a more complete description of time measurement.

Different types of time measurement also use different scales. As described by Stevens (1951), there are four types of scales, which are nominal, ordinal, interval, and ratio. A nominal scale is used just for labelling items and has no numerical significance. As time inherently involves an order, nominal scales are not relevant to time-related graphics and will, therefore, be discussed no further. An ordinal scale places items in order but the measureable differences between items are not quantifiable. Process diagrams typically use ordinal scales. Figure 10, for example, is an interactive process diagram that uses an ordinal scale to guide internet users through the purchase of an airline ticket. As a user completes each step, the diagram visually changes to indicate which steps are completed (such steps are given circled tick marks), the step on which the user should currently be working (in the current step, the text is colored and underlined in red), and steps that still need to be performed (these steps are not marked in any way).

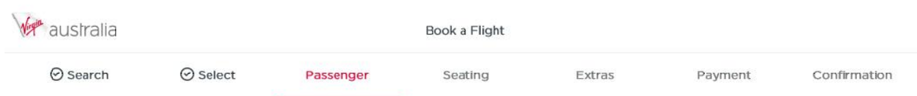

Figure 10: Example Interactive Process Diagram that Uses an Ordinal Scale
Source: Virgin Australia 2016

In an interval scale, each event has the same measurable value but no true zero point. The Gregorian calendar is an example of an interval scale as all days are of equal length but the days have no true zero point. The calendar has no zero days and no zero year, which makes sense when we consider that it would not seem right to have a day or a year counted as nothing. Figure 11 presents the month of July from an online look-up calendar. This design allows users to visually distinguish between traditional working days and weekends by (1) day names, (2) placement (e.g. Monday is always on the left), and (3) color (e.g. Saturdays are blue). It also allows users to count forward and backward to different days (e.g. “Today is Tuesday. In two days, I will go on holiday”) and to note events that regularly recur (e.g. “Karen goes to class every Wednesday”). Larger formats allow users to write in their own events to plan their time and look back at how their days were used. In the particular example of Figure 11, Monday serves as the key reference point for each week, which allows the weekend days of Saturday and Sunday to be placed together for planning time off from work. In contrast, the US calendar places Sunday, the day of Christian religious observance, at the start of the week. In its entirety, the calendar actually has several key reference points that divide up the year to make planning more manageable. In the Gregorian calendar, there is the start of a 365- or 366-day year, the first month of a twelve-month year, the start of each twenty-eight- to thirty-one-day month, and the start of each seven-day week. In practice, any day can act as a key reference point from which to count forward or backward in time. In the calendar shown, the cycle of the week provides the dominant structure for planning. This structure developed to meet our need for regular social events, such as buying and selling food at the market. Around the world, people developed weeks of five days (e.g. Mayan calendar) to ten days (e.g. Egyptian calendars) to meet this need. Our seven-day week came to us via the ancient Hebrews, early Christians, and ancient Romans. The Romans moved from an eight-day week to a seven-day week when they adopted Christianity. The matrix design of days of the week versus days of the month visually represents both the recurrence of days (e.g. Monday happens five times in the month of July 2017) and the fact that every day is unique and never happens again in just the same way. The design is actually a flattened spiral (Mitchell 2004).

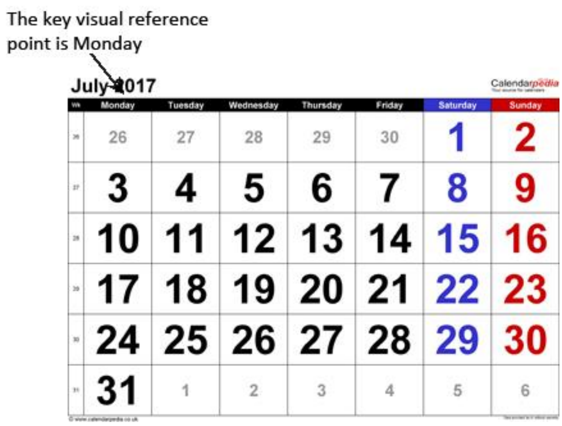

Figure 11: Horizontally-Oriented Matrix Calendar from the U.K. Uses an Internal Scale
Source: Calendarpedia 2016

Finally, ratio scales have a true zero point and provide the exact value between items. Figure 12 presents an example of a Cartesian graph that uses a ratio scale. This graph was designed to teach biology students about the need for decompression after diving to different depths for different amounts of time.

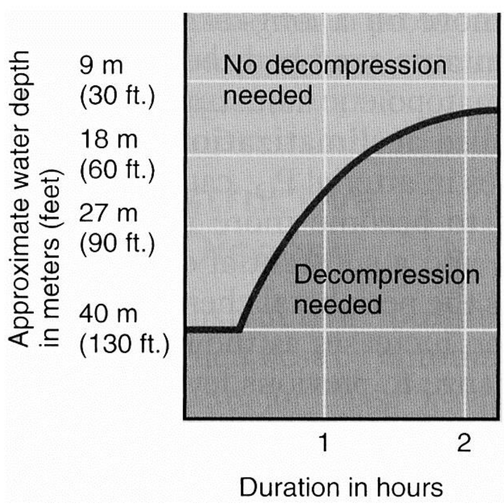

Figure 12: Example of a Cartesian Graph with a Ratio Scale of Time
Source: Marieb and Hoehn 2007

Although events may be measured cognitively using one type of scale, a designer may use a different type of scale to visually represent them. Consider the scales used in Figure 13, which was designed to teach Australian children the history of coin products and production in the country. In this figure, the scale of years is cognitively interval yet designed as visually ordinal so as to fit all of the events into the given horizontal space. Events are placed in equal amounts of space above and below the timeline.

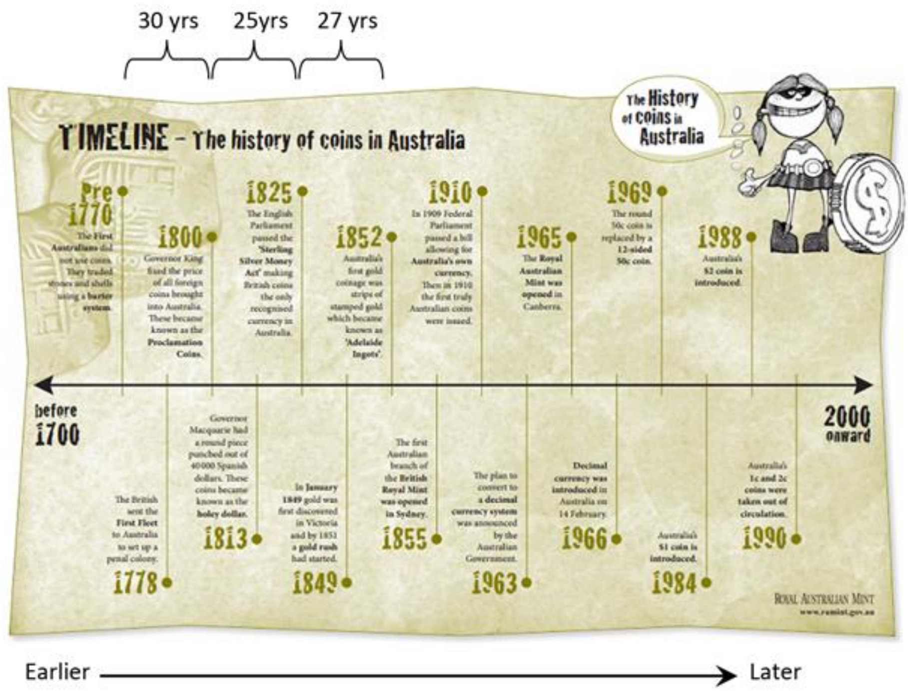

Figure 13: Example of a Historical Timeline that has a Cognitively Interval yet Visually Ordinal Scale
Source: Royal Australian Mint 2012

Reading, Writing, and the Perception of Time on the Page

In the linguistic path of time, left and right have no meaning; the only directions of significance are forward and back. However, when the path of time is placed horizontally onto the page, it maps directly onto the direction of writing and reading, and left and right gain significance.

Research by Zwaan (cited in Winn 1987) on the perception of meaning on the page for Dutch and Israel subjects found that the Dutch, who read from left to right, associate the concepts of “proximity,” “past,” and “self” with the left of the page. In contrast, the Israelis, who read from right to left, associate these concepts with the right side of the page. Similar research on English-speaking American children, Arabic-speaking children, and Hebrew-speaking children has reported similar results (Tversky 1995; Kugelmass and Lieblich 1970; Kugelmass and Lieblich 1979; Lieblich, Ninio, and Kugelmass 1975). These studies found that English speakers mark increases in time from the left to the right of the page while most Arab speakers mark these increases from the right to the left. Hebrew children mark time in both directions. They may do this since they write in both directions: They write entire sentences from right to left but individual letters from left to right. Figure 14 summarises the research findings on the perception of the left and right sides of a page or screen from cultures that read from left to right.

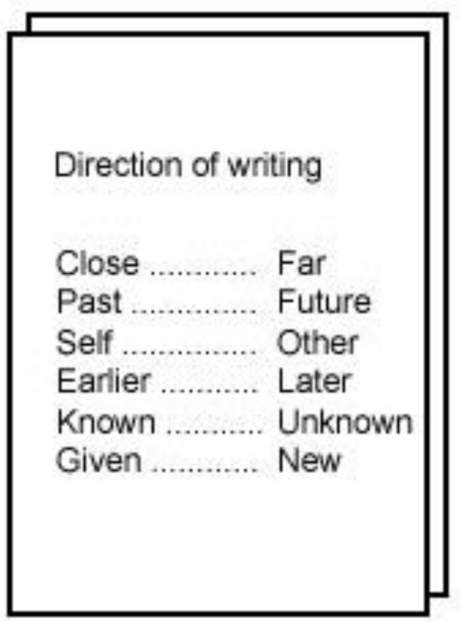

Figure 14: Perceptions of Meaning along the Horizontal Dimension
for Cultures that Read from Left to Right
Source: Mitchell 2016

It is the pattern of writing that creates the two primary horizontal continua of meaning, which are given-to-new and earlier-to-later. Therefore, it is useful here to consider what motivated different cultures to write in different directions. To tease out these motivations, van Sommers (1991) studied the effect of human physiology on writing. He theorised that right-handedness and preferred hand and wrist motions are in direct conflict regarding directional choice. Right-handedness affects the choice of where to start writing on a page, and preferred wrist and finger movements affect the writing of characters. Some cultures allowed one aspect to dominate while others allowed the other aspect to dominate. Beginning with the theory that the natural place to begin writing on a page is the side next to the dominant hand, van Sommers (1991) observed pre-literate school children to see where on the page they would begin writing. He discovered that right-handed children begin on the right side near the five o'clock position. As they learned to write, they moved their starting position up to the adult position of eleven o'clock on the left. Therefore, the left side of a page is not the natural place for right-handed people to begin writing; people need instruction to start there.

Regarding wrist and finger movements, van Sommers (1984) found that when drawing, right-handed people will avoid making strokes from the bottom-right up to the top-left of a page, and left-handed people will avoid making strokes toward the top-right. He theorised that people avoided making strokes in these directions because such movements would be uncomfortable for the wrist and fingers. Therefore, with the exception of Arabic writing, people across cultures start each character with a comfortable downward stoke and continue for the most part by making strokes from left to right (Figure 15).

Figure 15: Stroke Directions for a Few Alphabetic Characters
Source: Mitchell 2016

Since the normal starting place for right-handers (the five-o'clock position on a page) and the preferred stroke direction (from top to bottom then from left to right) conflict with one another, every group needed to choose where their writing would begin. The Greeks were more influenced by the preferred stroke direction, and, therefore, their writing began on the left, as ours does. The Chinese were more influenced by the preferred starting position, and, therefore, their writing (until recently) began on the right.

Van Sommers (1984) also observed the directions in which people draw objects in profile. He found that most right-handers draw objects such as faces as pointing toward the left. Therefore, when evolutionary timelines of creatures are drawn with their faces and bodies pointing toward the right, as previously shown in Figure 6, designers have deliberately drawn them to face the future. These designs are not accidental.

One last point to be made about writing's effect on the perception of information on the page regards asymmetry. That is, one side of a page receives more emphasis than the other. For example, in cultures that read from left to right, readers place greater emphasis on the right-hand side of each page. Eye movement studies of people reading alphabetic writing show that their perceptual span is bigger toward the right than toward the left. According to Rayner (1998, 2009), the perceptual span is three to four positions to the left of the character upon which a person is focussing and fourteen to fifteen positions to the right. Therefore, readers are always looking ahead, anticipating what is to come. Since readers continually look to the right side of the page, it makes sense for newspaper designers to place new information about a story toward the right to attract viewers' attention. The continuum of given-new in multimodal news-stories is a natural outcome of reading patterns.

Given-New in Horizontal Timelines

As stated in the introduction, one goal of this research was to consider how the horizontal continuum of given-new or known-unknown found in multimodal newspaper layouts relates to timelines. Figure 16, "Snakes Invade the Suburbs," provides an example of such a layout. The interpersonal goal of the layout is for local snake-bite victims to warn others about the appearance of snakes in human environments. The message is represented with written headlines and stories and a series of photographs. In the photo on the left, a woman faces directly toward readers, indicating that she is the center of the story, the one who survived a snake bite. Her daughter leans protectively towards her, embracing her shoulders. In the center of the right page appears a close-up photograph of a snake gazing out of the page in striking position. Below this photograph are more photos depicting places where snakes might appear in human environments. Textually, the left-placed photograph of the mother and daughter acts as the given, the known. These people represent everyday people in Australian society who are at the mercy of unseen snakes. In contrast, the image of the snake on the right represents the other, or the unknown.

Figure 16: Newspaper Layout Following the *Given-New*, *Self-Other, or Known-Unknown* Continuum
Source: "Snakes Invade the Suburbs" 2015

When examined from a time perspective, the *given* portion of the layout represents *now*, or the time of speaking, and the *new* portion on the right represents the occurrence of an event, the invasion of snakes, which has changed people's environment. The new portion of any layout may be from either the past or the present. It just must be something of which viewers were unaware.

The only type of timeline found that usually has a past event in the position for new information is the pedigree chart. As shown in the example in Figure 17, these charts place a known person on the left and allow a genealogist to add previously unknown ancestors to the right as they are discovered. Pragmatic concerns regarding the order of writing dominate the design of these diagrams; if designers continually tried to follow the path of earlier-to-later in pedigree charts, they would need to rewrite the chart each time an ancestor was found.

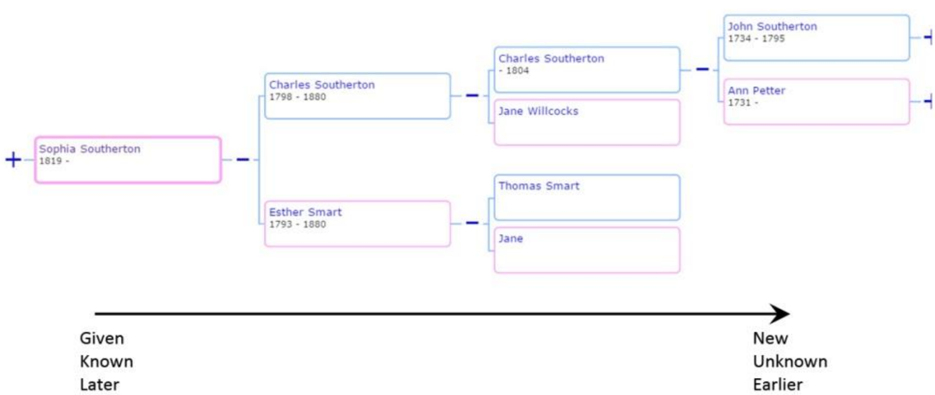

Figure 17: The *Known-to-Unknown* Continuum in a Pedigree Chart
Source: "Pedigree of Sophy Southerton" 2015

Structures of Meaning Along the Vertical Axis

Compositions that are oriented along the vertical dimension of a page or screen are subject to different influences than those that are oriented along the horizontal. Different types of time-related graphics may move up or down a page. While the horizontal dimension is strongly associated with the movement of time for westerners, the vertical dimension appears to have no specific time orientation. For at least some graphics, however, the vertical dimension can represent the idea that things that are up are good or ideal. A study by van Sommers (1984) is useful for understanding the perception of time along the vertical, and studies by Damjanovic and Santiago (2016) and Kress and van Leeuwen (1996) are useful for understanding the concept of “up is good” along the vertical.

Perception of Time along the Vertical

Van Sommers (1984) studied how people conceptualise the movement of time along the vertical dimension. Participants were asked to orient themselves in plan (top-down) view on a vertical path. Some drew themselves travelling up the page, others drew themselves travelling down the page, and others drew the arrow of time in both directions. Van Sommers argued that these inconsistencies happened because a vertical top-down view is not our natural way to visualise time. When people are forced to take this view, they will make different choices.

Vertical Representations of Affect

Damjanovic and Santiago (2016) wanted to discover whether UK English-speaking, right-handed participants mapped affect more strongly on the horizontal or vertical axis of a screen. Their aim was to test which of the metaphors “up is good,” “down is bad,” “right is good,” and “left is bad” are most dominant in the visual domain. To this end, the researchers measured the speed at which subjects were able to identify photographs of smiling and angry faces when placed in one of four locations on a screen. The photos were placed in a circle with one face at the top, one at the bottom and two on each side. Four different people posed for the photos and only one person’s photos were used on each screen. In each test, subjects were required to identify the target face (e.g. happy or angry) as quickly as they could. The results showed that participants were faster at detecting happy than angry targets regardless of location, and were “significantly faster to detect happy face targets when they appeared in the top versus the bottom” (Damjanovic and Santiago 2016, 67) of the screen. Angry faces were detected about as quickly whether they were at the top or bottom. Along the horizontal, happy and angry faces were detected about as quickly whether they were on the right or left. In summary, the researchers found that their experiment lent support “to the view that the vertical, rather than the horizontal dimension, is more salient in activating spatial representations of affect under complex attentional tasks” (Damjanovic and Santiago 2016, 70). Damjanovic and Santiago’s (2016) experiment supports previous research that “up is good” is a universal concept (e.g. Tversky, Kugelmass, and Winter 1991).

The Ideal-Real Continuum in Product Advertisements

As discussed earlier, after examining many vertical multimodal product advertisements, Kress and van Leeuwen (1996) found that designers commonly place ideal information about a product at the top of the page and real information about it at the bottom. As an example, Figure 18 presents an advertisement for Nature’s Sunshine Liquid Chlorophyll. Through this advertisement, the producers aimed to encourage people to drink it to “alkalise, detox, and cleanse,” which would make them healthy. Healthiness is represented by a top-placed photograph of a smiling young woman with clear skin, bright eyes, and thick hair and who is holding a glass filled with green liquid. She is placed against a blurred background of a green and leafy environment. Encouragement to drink the product is visually represented by the woman's smile and outward gaze. Positioned below the woman are written details about the benefits of consuming liquid chlorophyll and images of two differently-sized bottles of the product. Textually, the top-placed photograph of the healthy attractive woman drinking liquid chlorophyll represents an *ideal* situation while the bottom-placed product details represent *reality*. This vertically-composed advertisement clearly follows the *ideal-real* continuum.

Figure 18: Magazine Advertisement Following the "Ideal-Real" Continuum
Source: Nature's Sunshine 2015

When examined from a time perspective, the *ideal* portion of the advertisement, which is at the top, represents an ideal future that readers could enjoy if they regularly drank liquid chlorophyll. The *real* portion represents how a product appears in the present.

Vertical Timelines

After examining many examples of vertically-oriented timelines, the author has found several reasons why designers choose to place the orientation of time going up or down the page. As will be discussed, the main reasons are as follows:

- The need to fit information into a given area
- The need to follow the order of writing
- The need to represent events as leading upwards towards a better time
- The need to mimic some aspect of reality.

Since time may flow in either direction along the vertical and the upper portion of the page may be associated with positive affect, there may be times when readers interpret vertical timelines incorrectly. Some readers may interpret the upper portion of some timelines as representing better or more ideal times. This interpretation occurs particularly with evolutionary tree diagrams, which will be considered at the end of this section.

The Need to Fit Information into a Given Area

Figure 19 presents one month in an Australian reference calendar. Although the preferred arrangement of days is horizontal, the designers have placed the days along the vertical so as to conserve space. The vertical arrangement is therefore purely due to design constraints.

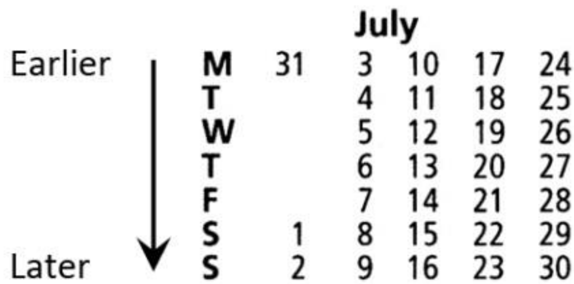

Figure 19: The Vertical Orientation of Days in an Australian Reference Calendar
Source: Collins Debden 2015

The Need to Follow Reading Order

Many vertical timelines are designed to follow reading order, which makes it easy for users to see the order of events. In the diary page in Figure 20, for example, the downward orientation of working hours along with an empty row next to each hour allows users to keep appointments in order and see what times are free. The arrangement also allows users to see how their time was or will be used.

Figure 20: Example of One Day in a Desk Diary
Source: Collins Debden 2015

The Need to Demonstrate Movement toward an Ideal

Some upward moving timelines aim to represent events as movement towards progress or steps taken toward achieving a better or an ideal situation. Such diagrams commonly use steps or ladders to represent time. For example, Figure 21 presents an upward moving timeline of the major events leading toward American independence. Designed to teach American school children about their country's history, this diagram aims to convince them that independence from England was a good outcome. The events could easily have been drawn along the horizontal but were deliberately placed in an upward moving direction to indicate movement towards goodness. The metaphor "up is good" is clearly present in this diagram even though the steps along the way are not all particularly positive.

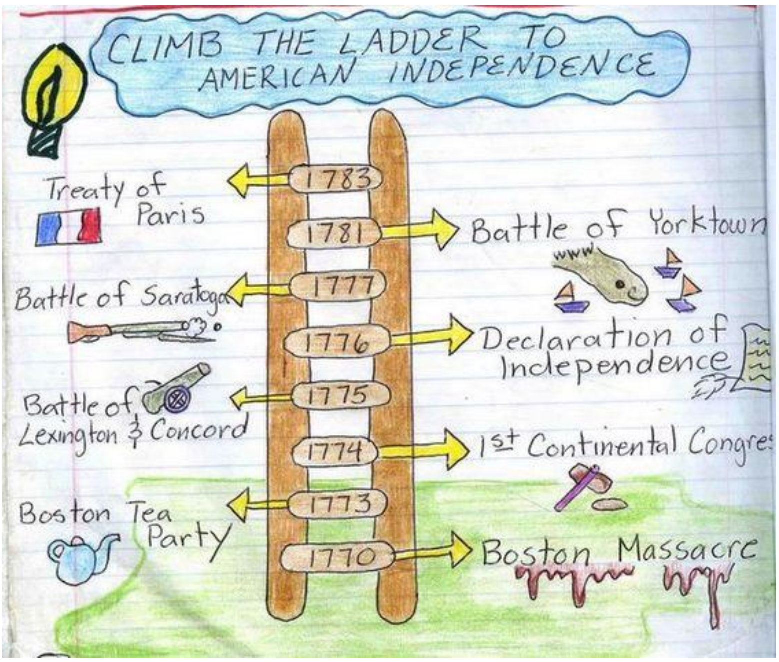

Figure 21: Example of an Upward-Moving Historical Timeline
that Represents Goodness at the Top
Source: Alvarado 2016

The Need to Place Time against a Structure of Reality

Some timelines are placed along the vertical so as to map them against a structure of reality, which makes them easier to accept, learn, and understand. For example, Figure 21 maps time from the present at the top of the page down to 650 million years ago using the geological timescale, which marks time along an abstract conception of the geological layers of the earth. The idea of geological time was promoted between 1785 and 1800 by James Hutton and William Smith, and has since been refined. The timescale was set out two ways: hierarchically by eons, eras, periods, and epochs, and chronologically, by counting time backwards from the present in millions of years ago (MYA). The present refers roughly to the latest million years of the earth's existence and not to the date of writing. The example in Figure 22 shows only those hierarchies of the geological timescale, eras and periods that are relevant to evolutionary events. These events occurred within the Phanerozoic Eon, the name of which derived from the ancient Greek words for visible life.

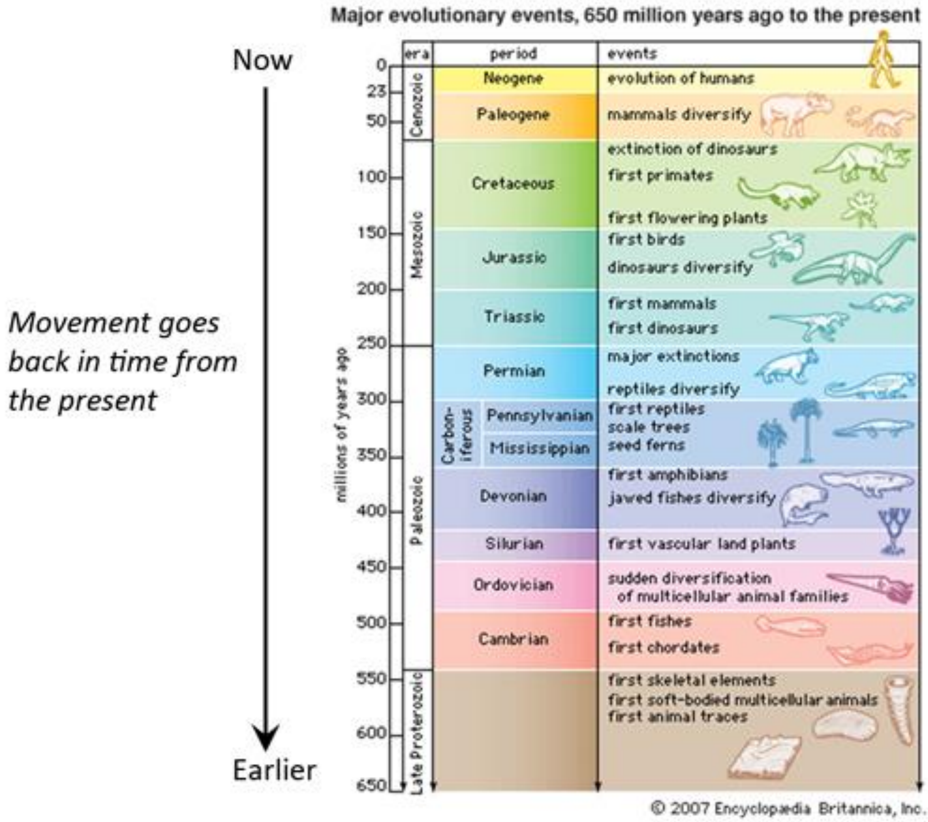

Figure 22: Evolutionary Timeline
Source: Britannica Online for Kids 2007

Rudwick (1976) described the representation of geological time as an abstraction that early geologists created about the kinds of rocks that lay beneath the surface of the earth. The key reference point for the geological timeline could have been the time of earth's creation or the present. The present was chosen since much more geological knowledge is known about it than the start of our world. Although a reader may perceive the top of the timeline in Figure 21 as more ideal than any other time, the designers most likely did not intend it to be read in such a way.

Another example of a diagram (Figure 23) that maps time against a model of reality is Darwin's [1859] (1958) great tree, which visually demonstrated the principle of divergence and the origin of species. Darwin created this diagram to persuade scientists and the general public that his new theory presented a true explanation of how all life forms were related. In the diagram, divergence, or variation in a species, is represented along the horizontal, and time is marked along the vertical similar to generations in an upward moving family tree. Therefore, the tree is meant to be read as a Cartesian graph. Along the horizontal, the greater the distance between organisms (e.g. A, B, C, etc.), the greater their genetic difference. The dotted lines represent unknown paths, the angle of which represents change or divergence in an organism. The end of a line represents the death of a type of organism. The intervals between horizontal lines represents many generations, perhaps a thousand or more, and are not meant to be understood as equal to one another even though they are drawn with equal spacing. The horizontal lines represent the appearance of an organism so changed that its appearance is "worthy of record" (Darwin [1859] 1958, 118).

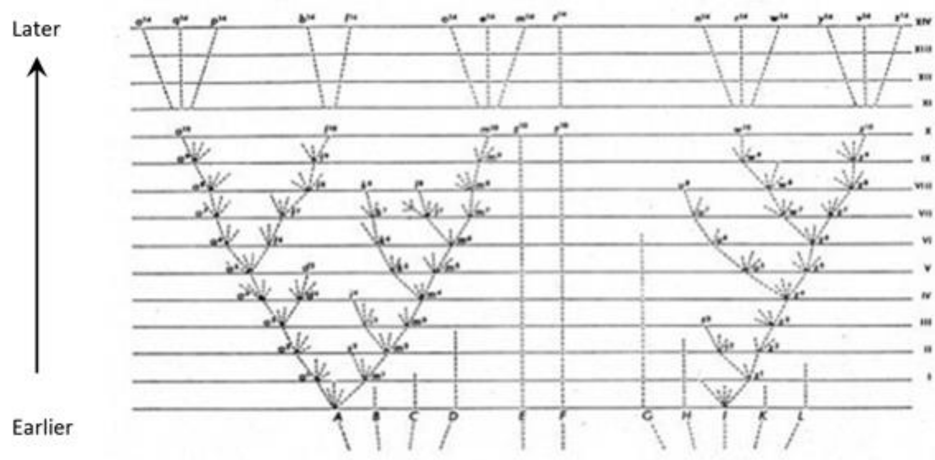

Figure 23: Tree Diagram from Darwin's *Origin of Species*
Source: Darwin [1859] 1958

Darwin explicitly revealed the simile underlying his diagram of evolution, which is that living things evolve in the same pattern as a tree grows. Darwin ([1859] 1958, 131–132) wrote:

> The affinities of all the beings of the same class have sometimes been represented by a great tree. I believe this simile largely speaks the truth. The green and budding twigs may represent existing species; and those produced during former years may represent the long succession of extinct species … As buds give rise by growth to fresh buds, and these, if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever-branching and beautiful ramifications.

Therefore, vertical evolutionary trees have a pictorial nature in that they grow up. The metaphor of the tree suited the explanation of Darwin's theory because it provided a model that people could easily visualize, it was already being used by biologists of the time to study differences among organisms, and it compared the growth process of one living thing to another living thing. When Darwin said that "The affinities of all the beings of the same class have sometimes been represented by a great tree," he was stating that others had already used the tree simile. Lamarck drew the first phylogenetic tree in 1809 (Barbieri 1985).

In Darwin's tree, the upward movement represented growth, which is considered to be good. Each incident of growth, however, was not necessarily better than any other incident of growth; each incident was good in its own time. Therefore, the overall upward movement was good but the top of the tree was not necessarily any better than any other part of the tree. As will be shown in the next section, however, novice designers may interpret the top of the tree as representing the best time rather than the latest time.

The Conflation of Upward Time Movement with Goodness

Figure 24 is an example of an evolutionary tree diagram drawn by a novice biology student. This figure exhibits what O'Hara (1997) referred to as "developmental thinking" as opposed to tree thinking. O'Hara (1997, 325–327) wrote: "Evolutionary histories of the developmental type don't narrate a tree—a branching history—they select one important endpoint (usually us) and then trace up from the root through the tree to that endpoint, employing a variety of narrative and nomenclatural devices that minimize the branching aspect of evolution."

In contrast to the student diagram, Darwin's diagram of evolution (Figure 23) emphasized divergence and complexity. In the student's diagram, the position of humans at the top indicates the mistaken view that humans are the best or most ideal life form to develop through the evolutionary process. O'Hara (1997, 327) claimed that "most of the general public and most of our students still" view "humans as the pinnacle of life."

This article would like to argue that had Darwin's original evolutionary tree been drawn as a downward moving graphic, perhaps following the metaphor of roots, there would be less misunderstanding of the evolutionary process, all withstanding that the process is complex. The upward movement of time may lead many to believe that the top of an upward moving timeline represents the best or most ideal time. Realizing the problem that many have in reading evolutionary timelines, O'Hara reinforced the idea that novice biology students should be taught how to read such graphics.

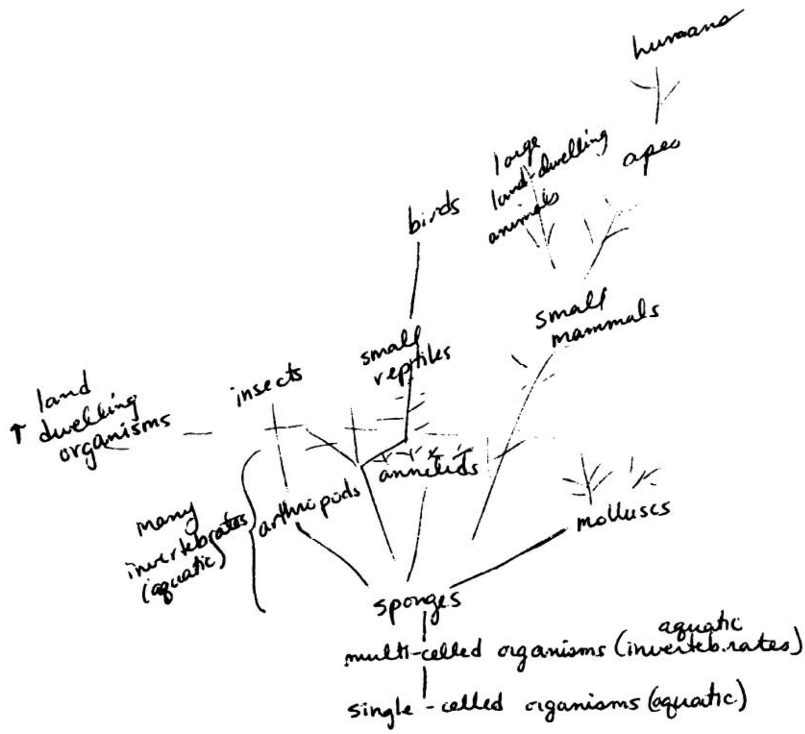

Figure 24: Evolutionary Tree Drawn by a Novice Biology Student
Source: O'Hara 1997

Conclusion

As discussed in this article, the designs of horizontal and vertical time-related graphics are motivated by their interpersonal or social purpose and by the perception of time or change; notions of tense, sequencing, and aspect; basic time measurement and scales of measurement; processes of writing and reading; perception of information on the page; and design constraints. The purpose of a graphic is always at the front of its design as choices will be made based on who will use the graphic in what situation and for what end.

The most basic influence on the representation of time is the perception of time or change, which requires that at least two states, the initial state and the final state, be represented. A second basic influence is the metaphor that time is space, which is used in Western and other languages. This metaphor reveals time to be a space that contains places or reference points for the past, the present, and the future. Events are placed along these points in order of their occurrence and according to their duration. The levels of certainty of past and future events can be expressed with different types of markings.

Basic time measurement and scales of measurement also affect the designs of horizontal and vertical time-related designs. As discussed, we measure events in terms of other events that regularly recur. While the linguistic path of time gives us the fundamental path of past to present to future, time measurement systems give us more refined paths such as the hours of the clock, the months and days of the year, and so on. Different measurement systems with different key reference points suit different types of events. Some systems measure time in reverse and some systems measure time going forward. Some measurement systems are purely linear (e.g. geological time) and some mark recurring types of time (e.g. days of the week).

As discussed, the direction of writing in a culture also affects the representation of time. Those cultures that write along the horizontal strongly associate the direction of time with the direction of writing. For graphics of time, such as evolutionary diagrams, the creatures within them will be often be deliberately turned to face in the direction of time's flow. Their facing builds upon linguistic representations of time that make use of the facing of the body such as "My future is ahead of me."

The direction of writing also creates an asymmetrical view of the page, which means that those who read from left to right will always be looking towards the right to see what is coming. Therefore, to attract readers into a page, designers may place new information on the right where readers are already looking.

Some horizontal timelines, particularly pedigree charts, may reverse the conventional order of time along the horizontal because new information (e.g. newly found ancestors) are better suited to placement on the right of the page. By placing the "new" ancestors on the right, the researcher avoids rewriting the chart each time an ancestor is found and also places the key reference point for the chart (the person who the chart is about) on the left of the page.

Although the horizontal is most strongly associated with the flow of time, designers may place timelines along the vertical for a variety of reasons. Among these reasons are to fit information into a given area, which is to manage a design constraint, to follow the order of writing, to represent events as leading upwards towards a better or ideal time, and to mimic some aspect of reality. Upward flowing timelines may deliberately or accidentally convey positive affect in their design as the top of the page is often perceived through the metaphor "up is good." Designers and readers should keep this concept in mind to determine how timelines should or could be read.

The various motivations for the representation of time along the horizontal and vertical build upon one another to help designers create a great array of designs to suit many purposes. Timelines are useful for teaching people of all ages about different aspects of our world; for convincing people that particular theories are true; for planning and predicting long-term, short-term, and regular events; for discovering patterns; for counting up or down to an important event; for documenting history; for stepping through processes; and for showing possibilities.

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