Chapter 2
Chance Discovery as Value Sensing for Innovation

2.1 Modes of Intelligence and Emotion

As discussed in the previous chapter, we require participants in the market to understand other stakeholders' contexts and values in the market and to sustain interactions in order to realize their innovations. In other words, communication based on "cognitive empathy" is desired. As in the reference (Thompson 2001), cognitive empathy is not a disembodied and affectless knowing of the other, but rather the feeling of being led by another's experiences. Here, feeling means the integrated sense of bodily sensation and the emotional feeling of values.

The developmental psychologist Margaret Donaldson wrote that the essence of emotions is the feeling of value, and that human beings experience emotion only in regard to things in concern (Donaldson 1992). It is meaningful to borrow Thompson's understanding about Donaldson's theory, for interpreting innovation from the aspect of emotion and intelligence. She has shown that humans have as much potential for emotional development as for intellectual development, although the balance of the two may vary with social and cultural states. Donaldson modeled the development of the human mind on map with four main "modes of mind," each with four components: perception, action, thought, and emotion.

Each of the four modes is defined by its own "locus of concern." These include: (1) *the Point Mode*, of which the locus of concern is the present moment, "here and now" (available to young infants under 8 months); (2) *the Line Mode*, which appears at 8–10 months, of which the locus of concern is "there and then," expanded to include certain times in the personal past and personal future; (3) *the Construct Mode*, of which the locus of concern is "somewhere/sometime" (no specific place or time), emerging around the age of three; and (4) *the Transcendent Mode*, of which the locus of concern is "nowhere" (i.e., not in real space or time but in the spiritual world, which is beyond the imagination of the future world), which emerges around the age of nine.

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Regarding the line mode, Donaldson wrote that the infant has a sort of "rolling" sense, i.e., the movement from the immediate past to the immediate present and to the immediate future. This mode enables the baby to oneself in relation to a remembered past and a possible future.

In the construct mode (3), one moves away from concrete personal events. Donaldson wrote that the mind will here begin to concern itself with a locus conceived as just somewhere/sometime, or anywhere/anytime, without fixating on a certain place or time. Thus, in this third mode, individuals are no longer restricted to a consideration of events that concretely exist in their own or colleague's experience. Individuals start to become actively and consciously concerned about the general nature of things. The mental context of humans here depends on their interaction with the environment involving deliberate constructive acts of imagination, rather than just passive perceptions or memories of events that occurred and have been perceived in the past. In some part of the construct mode, thought without emotion predominates over emotion. This is called the intellectual construct mode, where one is concerned about the nature of impersonal phenomena in space and time. As a result, humans can think of events and a series of events that they have never experienced: that is, they imagine scenarios that may have occurred in some past or may occur in some future.

Next, one moves from the intellectual construct mode to the transcendent mode, where the locus of concern is no longer bound to space and time. The feeling is not temporally or specially constrained. At this transcendent point, individuals are concerned with patterns of all kinds of relations into which things can enter. We can, for example, imagine a desirable mood in living without fixing the temporal order of events in a new life or space, develop faith in a religion, and understand others' concepts and abstract desires for comfortable living. Our sense of transcendent values may come in here, so the invariant values of love, peace, etc. can take place regardless of time and space. Donaldson asserts that there is a mode for emotions that develops in tandem with the intellectual modes above. This is called a *value-sensing mode*, with the proviso that the values in question must transcend personal concerns.

2.1.1 The Value-Sensing Modes

As Donaldson wrote and Thompson discussed, there are two value-sensing modes: the value-sensing construct mode and the value-sensing transcendent mode. These modes can be understood by linking them to the construct and transcendent modes above and introducing a new dimension of transpersonal relations to time and space. In the value-sensing construct mode, the main component of experience is an awareness of transpersonal importance that depends on the support of the imagination to identify the desires and feelings of others. In the value-sensing transcendent mode, self-transcending values can be experienced and responded to by properties that are beyond the imagination.

Donaldson says evidences of these modes in human thought can be found in the wisdom traditions that initiated religions, such as contemplative Christian mysticism, Buddhism, etc. For example, when St. John explained "how to reach divine union quickly," he distinguished between meditation, focusing on an image (such as a beautiful light), and contemplation, emptying oneself of all images so as to attain a receptive awareness of "divine union." Contemplation thus belongs to the value-sensing transcendent mode, where the locus of concern is not in space or time but something conceived as infinite and eternal and also as a non-measurable value. The value-sensing construct mode is more limited in its perception of value, since the "divine" surpasses anything we can imagine.

Although these studies are about infant development and not business people, the process of the development of intelligence and emotion is meaningful when discussing the co-elevation of the ability to objectively understand real events and the sense to subjectively expect values in the future. Under the assumption that the former corresponds to intellectual development while the latter at least partially corresponds to emotional development, we can conclude that objectivity and subjectivity both develop in accordance with an individual's interaction with the real-world environment.

When discussing innovation, we should take into account the discovery of values that underlies the market and that can be recognized by the innovator. Trends related to products and services existing in real space and real time should be grasped intelligently, and the emotional desires of potential consumers in the market, which have not been seen or imagined yet, should also be grasped thus. In this book, we do not discuss the highest level of value-sensing (the value-sensing transcendent mode) but rather focus on methods for elevating human ability corresponding to the value-sensing construct mode. However, if we regard religious or eco-centric lifestyles as forms of the transcendent mode and the different events in life, such as buying eco-oriented products to protect the environment, as the construct mode, it seems clear that Donaldson's modes should co-elevate that is, work at the same time with mutual reinforcement. Thus, we position our innovation-aid method as a method for cultivating and activating the human sense of values.

2.1.2 Compassion and Empathy

Let us return to learning from Thomson (2001). As he wrote, the progression of value-sensing modes leads to an acquisition i.e., an embedding of the egocentric sense of self. This acquisition is intuitively called "compassion" which is the super-concept of the human capacity for empathy. Compassion is regarded as a kind of value sensing that emerges as a result of inward meditation and also guides the progression of value-sensing modes.

Empathy precedes compassion and is a pre-requisite for compassion. When we feel empathy for someone, we are picking up emotional information about them and their situation. Collecting information about another's feelings allows us to get to know them better. As we get to know others on an emotional level, we are likely to see similarities between our own feelings and theirs, and between our basic emotional desires and theirs. When we realize that some of these basic emotional desires are similar to our own, we are better able to relate to others and to empathize with them. This point will play a role in later chapters of this book, in that emotional communication may enable players feel similarity to others, so that they can analogically create solutions to forthcoming problems.

Compassion can be defined as a combination of empathy and understanding. Greater empathy gives us more information for understanding things and people linked to ourselves. A higher level of emotion and intelligence creates a greater capacity for such understanding. Higher emotional sensitivity and awareness leads to higher levels of empathy, which leads to higher levels of understanding and then higher levels of compassion. As a result, we start to feel and understand how others feel. This dimension of emotion enables inventors and consumers deepen mutual understanding in Innovators Marketplace as in later chapters, via communication rich in emotion and intelligence.

In abstract terms, we can say that empathy should be established first, and then individuals can relate and co-elevate their values by exchanging emotional modes with each other, thereby reaching compassion. With this interaction and the deepened relationships among individuals, both emotional (subjective desire and feeling of connection with others) and intellectual (objective analysis and planning) modes are developed. Although Donaldson focused on the development of the minds of children, we feel we can extend her ideas to the training of grown adults because, even 30 years after we have graduated from schools, we daily experience new feelings that create new instances of empathy, compassion, and mutual understanding with people we have never created intimate relationships with in the past.

In the introduction of his paper, Thompson argues that we need the next step for new insights into human society (enlightenment in his words): He says we need to pursue a “science of interbeing” that integrates the methods of cognitive science, phenomenology, and the contemplative and meditative psychologies of the world’s wisdom traditions. One of the essential aspects of this new progress is, according to him, the development of experimental techniques to assess the effect of value-sensing training, such as meditations on the equality of self and others and the mental putting of oneself in another’s shoes.

It should be clear to the reader why we spent so much time discussing developmental education, which on the surface might seem irrelevant to innovation. Our point is that innovation is not the mere creation of something new but rather a combination of strategies and actions to join the emergence of a value-co-creative society, which amounts to a discontinuous development of the market. Thus, it is meaningful to extend the concept of intellectual and emotional development to the development of senses for creating business strategies based on experiences and new talents acquired in and going beyond experiences in the real world. The “value” here can be viewed as a relation to the social environment, which business workers and customers create from their interaction via products and services, in order to redesign the market sustainably.

2.2 Sensemaking Approach as a Basis of Qualitative Scenario Mining

For discussing information- and organization-scientific basis of our methods for innovation, we can also borrow concepts from studies on Sensemaking, meaning the process by which people give meaning to experiences (http://en.wikipedia.org/wiki/Sensemaking). It is a collaborative process of creating shared awareness and understanding of events via the collection of different individuals' perspectives and interests. Sensemaking has been discussed in organizational studies (Weick 1979) and in the field of information science (Dervin 1983).

In organizational studies, the concept of sensemaking has been used to express cognitive activities in general terms in order to focus on meaningful situations that have been experienced. In contrast, in information sciences as on the Web site created by Dervin (http://communication.sbs.ohio-state.edu/sense-making/), Sense-Making (capitalized) refers to the methodology, whereas sense-making (not capitalized) refers to the phenomena of making sense.

For the decisions and actions of organizations in uncertain or ambiguous situations, a central concept of sensemaking is *identification*, a process in which people interpret how they came into their current context by looking at a scenario in their past using methods of chance discovery (discussed later) and at a possible event in the future (Weick et al. 2005). Retrospection has been encouraged to aid with this identification process. The manner of retrospection, as well as the time it is focused on, affects what people notice (Dunford and Jones 2000). Then, people re-enact: i.e., they express the environments they face in dialogues and narratives (Watson 1998). As they speak and create narrative accounts, they understand what they themselves are thinking, organize their experiences, and are then able to control and predict events (Isabella 1990). In literature related to the cognitive sciences, retrospection and enactment are relevant to metacognition (Brown 1987;Flavell 1987;Cohen et al. 1996;Suwa 2008). We discuss metacognition in more detail in Chap. 4, as it plays an important role in the technical process of the Innovators' Marketplace.

An important point about sensemaking in organization is that it is a social activity. Plausible stories are preserved and shared among members of a group, communicating for their decision (Watson 1995). This social interaction is continued as individuals shape and react to the environments they face. As they project themselves onto this environment and observe the consequences, they learn about their identities in the world and the value of other entities in the world.

In other words, sensemaking is a feedback process in which individuals become aware of their identity due to the mutual influence of others. Participants use this process to extract cues for making decisions on what information is relevant and what explanations are acceptable (Brown et al. 2007). Extracted cues provide links to what may be occurring (Weick 1995). We should note that this process takes advantage of subjectivity, not just objective analysis or a clear understanding of the situation. Therefore, users of the sensemaking approach favor plausibility over accuracy in accounts of events and contexts. Ideally, the empathetic understanding of other participants is coupled with a high level of intelligence to understand the causality and scenarios of events in the past and in the future. We can think of sensemaking as a process that is available to people who have sufficiently developed their own modes of intelligence and emotion.

In information science, sensemaking is approached a little differently. (For clarity, here we unify Sense Making and sense-making into "sensemaking.") As in the Wikipedia's chapter above on Sensemaking, Dervin (Dervin 1983, 1992) has investigated sensemaking experienced by individuals when attempting to make sense of observed data. In systems engineering and the analysis and synthesis of human factors, the concepts extracted and the theories obtained should be both measurable and testable. For this sake sensemaking enables us to investigate and improve the interaction between humans and information technologies, where humans play a significant role in adapting and responding to unexpected or unknown situations as well as to recognized ones.

A noteworthy point we lean from these studies on sensemaking cited from Wikipedia is that it is a process that is initiated when an individual or organization recognizes the inadequacy of their current understanding of events (Klein et al., 2006). Sensemaking is a two-way process of collecting data in a temporary frame and then fitting the frame around available data. The formation of frames and the revision of the data and the frame are intrinsically connected: the data evoke frames and these frames are used when sensing the valuable parts of an environment and selecting/connecting data. As in organization studies, this description resembles the model of metacognitive processes that are used by both individuals and groups to build, verify, and modify scenarios with situational awareness and can be extended to account for an unrecognized situation which may appear in the future. We technically realized chance discovery as mentioned later that is conceptually quite close to sensemaking/Sensemaking as early as 2000, independently of studies introduced above (Ohsawa and Fukuda 2002; Ohsawa and McBurney 2003). However, we should say they still provide us with fundamental reasons why human- and process-centric approach works for chance discoveries as mentioned later, and why the approach can be realized by the Innovators Marketplace in this book.

2.3 Innovation as Interactive Value-Sensing with Insight

When we read about innovators in history, and when we meet people creating ideas in business, there are certain patterns that appear common to the moment of insight, i.e., finding latent values via breaking the *impasse*. We can define insight as the introduction of a novel variable that solves a posed problem satisfying a set of constraints by escaping from an impasse. By impasse here we mean being trapped in a local optima where some part of the problem is unsolved or some constraints are unsatisfied. For example, following the experiment by Terai and Miwa (Terai and Miwa 2003), let us try to solve the problem of finding a co-relation between the values of x, y, and z, where the sequence of (x, y, z) has been observed in the order of time as

$$(0, 1, 1), (1, 3, 4), (5, 2, 7), (0, 0, 0), (1, 1, 3), \ldots \quad (2.1)$$

Here, we normally hypothesize the linear equation "$z = x + y$" based on the first four triples, and get confused with the fifth because 3 is not equal to $1 + 1$. We are trapped by the simple constraints, or the bias, due to our implicit belief that we should find the relationship between the given three variables and that the correlation should be simple-ideally, linear. What would happen if we abandoned this belief?

One thing to try would be introducing a new variable, u, which takes the value of 0 until the fourth triple and 1 after the fifth. This enables us to make the new hypothesis that z is the last digit of the sum of x, y, and u. Then, let us continue the following sequence that appears with the passing of time as

$$(3, 2, 6), (5, 3, 9), (1, 0, 2), (3, 3, 5), \ldots \quad (2.2)$$

Here again, with the fourth (the ninth from the very first of the sequence), we find ourselves in error because 5 is not equal to $3 + 3 + 1$. At last, we find that we have been tricked by our own common sense into feeling that z should be a function of the variables including x and y. By excluding this constraint, we can introduce a new variable, t (time), which is not really new but of which we have been previously unaware. That is, z is just a linear function increasing by three every time z is equal to the third digit of $3t - 2$.

In this example, we created or became aware of an essential underlying variable to explain observed facts with/by excluding constraints. If the reader feels the above example is irrelevant to innovation, let us change from the triple of (x, y, z) to (*"x/: the daily number of people who eat at the sushi bar close to the station," "y/: the daily number of people who drink at the pub close to the station," and "z/: the daily number of passengers who disembark at the station"*).

Suppose the values of these variables are collected every day by the station's data center. If x' plus y' looks close to z', it may look like people who disembark at the station are interested in drinking or eating. However, in a few days, we may find that z' is increasing while x' and y' are both decreasing. Thus, we should consider other variables that govern the behaviors of the passengers. After a couple of days, the increase in the number of passengers comes out to be radical, which makes us aware of a hidden factor like u, as we mentioned above. This is how we come to highlight an event that we had not noticed until then: the town had suddenly become famous for the discovery of a hot spring. In this scenario, we should find a way to link the station with the hot spring, such as by selling discount tickets for visitors to the spa or making a specially designed coach for elderly people who may become repeat customers of the spa. Such new designs result in an innovation, for not only this area but also for other areas with underlying hot springs.

2.4 Auxiliary Lines as Signs of Insight in Interpreting Images

In order to show the fundamental cognitive model of insight, here we show evidence of eye movements connecting important parts of a presented image. The movement of eyes has been shown to be a key factor in human decision making, for example, in consumers' brand choices (Pieters and Warlop 1999;Pieters et al. 2002;Pieters and Wedel 2004). When customers in a supermarket are looking at commodities on a shelf, their view may be focused on something they have been unconsciously looking for. Therefore, by investigating eye movement, we should be able to determine the unconscious interests of customers.

There have been significant advances in the study of eye movement in recent years. The basic models have been developed on the basis of the amount of time spent fixating on an object (Just and Carpenter 1980; Rayner 1995). Methods for automating the protocol for analyzing eyes have also been developed using the cognitive models of fixation and object tracking (Salvucci and Anderson 1998).

Cognitive scientists link eye movement to high-level (intelligent) information processing. Terai and Miwa discovered that the direction of eye movement changes discontinuously when insight occurs, i.e., when an individual overcomes an impasse. For example, Fig. 2.1 shows a table of various digits placed in the cells, forming lines that are scrolled up with time. This table was shown to participants wearing eye-tracking glasses who were instructed to look at the table and search for a pattern ruling the values in the three numbers in each line, e.g., "$x + y = z$." They were then asked to utter which number they were thinking about each time (Terai and Miwa 2003).

In this experiment, insight meant the release from the blocking hypothesis, i.e., from an impasse due to the artificial constraint "$x + y = z$," where participants first tried to interpret the rule underlying the first three lines. The results showed that an insight causes a discontinuous change in the movement of eyes. Eye movement was in the horizontal direction when a participant was saying "maybe $x + y = z$, but the fourth line violates this rule ...." However, when the participant found the correct rule, i.e., "$z_r =$ *(the last digit of)*$z_r - 1 + 3$" for all r, the eyes discontinuously changed their movement to the vertical direction. From this example, we conclude that eye movement signals a measure of *insight*, which is an essential cognitive effect for understanding the structure of a target problem.

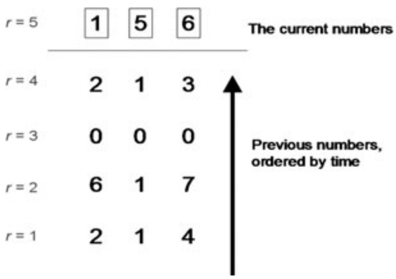

Fig. 2.1 Experiment to find the rule *underlying digits* (Terai and Miwa 2003). The digits are scrolling: the values of x, y, and z (the digits in the *left*, *central*, and *right* cells) in each line appear simultaneously, and new lines appear from the *bottom*

2.4.1 Vision, Attention, and Interpretation

To expand on these studies on eye movement, let us deal with the question of how a viewer interprets what is supposed to be an abstract image. For example, in his painting *Guernica*, it is thought that Picasso meant to convey that the air force attacked innocent people in the city, people and animals are dead on the road, and women are crying and hugging dead babies in their arms. Our point here is to investigate the human cognitive process when obtaining an interpretation, which is a hypothetical scenario, after an individual has viewed an image for a short time. That is, when individuals interpret an image, they create a hypothesis of an underlying scenario that may or may not correspond to the scenario imagined by the person who created the image. This can be regarded as an example of how an individual interprets an image that has been designed as the medium of a message.

Below, we discuss an experiment in which participants viewed images for a fixed length of time and we then investigated the fragments of messages they perceived. To quickly summarize the results in advance: A *slow saccade line* (SSL), a continuous line of eye movement that is as slow as the pursuit (a slow eye movement in pursuing a moving object, as stated later) but that occurs while gazing at a still image, partially corresponds with the viewer's interpretation of the image. That is, *auxiliary lines* emerge in eye movements when interpreting an image.

Auxiliary lines are strongly linked to *chance discovery* (discussed in more detail in the next subsection), which has been studied as a topic for the development of methods to discover a *chance*: an event that may be significant in human decision making. A chance might be rare, and its meaning can be too uncertain to interpret from the observable part of the real world, so pure computational analysis for understanding a chance is difficult. In this sense, the human cognitive process in interpreting and understanding the meaning of a chance is the core issue in chance discovery.

Researchers on chance discovery have studied the perception of decision makers by interpreting maps of the co-occurrence among events in various types of real environments, such as supermarkets, textile exhibitions, risk evaluation in banks, product design, etc. Such maps are obtained by visualizing the co-occurrence of items representing events in data collected from a business environment (e.g., Ohsawa and Usui 2005; Goda and Ohsawa 2007; Horie et al. 2007). In the process of chance discovery, users follow four steps (Fig. 2.2) when presented with a map:

(1) Users perceive the existence of patterns of event-occurrence that are easy to understand (there are no conflicts with intuition).
(2) Users explore new scenarios by trying to connect the episodes corresponding to the patterns perceived in step (1).
(3) Users then identify a bridge, i.e., an event that rarely occurs in the data but may be relevant to multiple episodes.
(4) Users have an "aha!" moment and perceive a meaningful combination of episodes via the bridge, creating a scenario they can then use as a guideline for

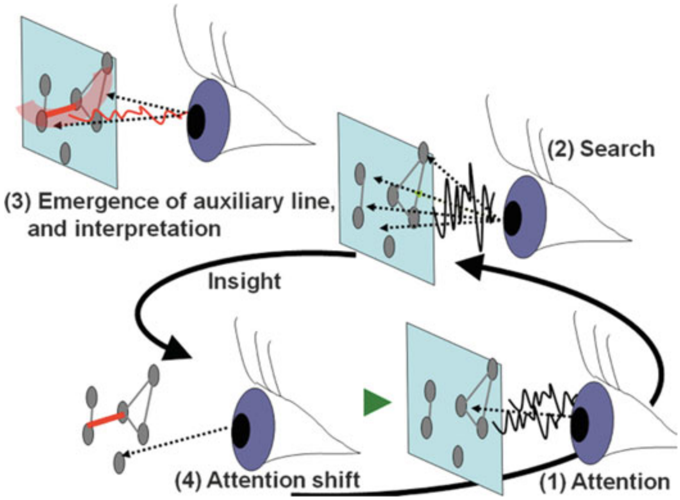

Fig. 2.2 Human cognitive process for interpreting an image by identifying auxiliary (bridging) lines

choosing actions in the future. In other words, they create a new plan of action by connecting episodes and bridges in the visualized map. After this plan is created, users shift their attention back to the map and return to step (1).

In step (1), users might be trapped in an impasse posed by cognitive constraints that could force them to consider only common-sense episodes corresponding to patterns. In steps (2)–(4), users are released from the constraint and create new scenarios. We expect this process model (in other words, the imagination of underlying scenarios) to also work for human interpretation of images such as artwork and commercial posters, not just puzzling event maps or scrolling tables. For steps (2) and (3), users should find auxiliary lines (Ohsawa and Maeda 2008, 2009) between basic patterns that equip them with effective clues for creating scenarios. In the experiment below, we instructed ten participants to look at images that were new to them: four abstract paintings by Pablo Picasso.

2.4.2 *Experiment*

We showed ten participants (two groups of five) abstract images with meanings that are said to be difficult to interpret but possible to understand once explained. The images were photographs of pictures by Pablo Picasso. One of them, shown in Fig. 2.3, is a photograph of the central part of the large picture *Guernica*, an artwork on warfare. The participants could not explain the artist's intended meaning ("*the scene of an air-force attack*") in preliminary interviews (we selected participants who were unfamiliar with this famous painting).

Fig. 2.3 The center-part of Pablo Picasso's *Guernica*

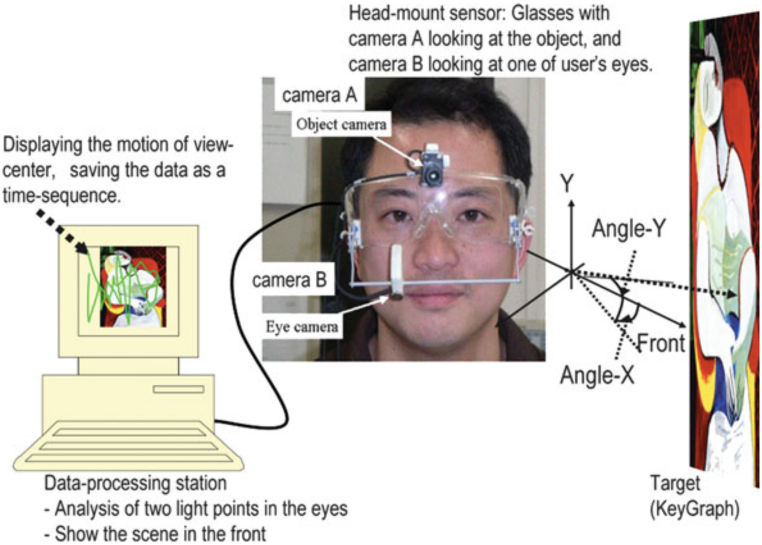

Fig. 2.4 The eye-movement sensing system (FreeView glasses)

The pictures were placed 1.5 m away from the participant. Each participant wore FreeView glasses (Fig. 2.4) produced by Takei Scientific Instruments Co. Ltd. These glasses are part of the most widely used eye-movement sensing system in Japan. In this system, eye-track data can be obtained as long as the view angle is within 20° from the center of the sight, with a sampling rate of once per 0.033 s. The movement of the eyes to the target was obtained and is indicated by the curves on the left-hand side of Fig. 2.4. We ensured that the target images, which were 0.5×0.5 mm in size, stayed in the 20° range by placing them 1.5 m in front of the participant's eyes.

2.4.3 Results

First, let us focus on one participant. The eye movements during the 3 min he was looking at *Guernica* are shown in Figs. 2.5, 2.6, and 2.7. The number above each picture means where the participant is in the steps after he started looking at the image, where 30 corresponds to 1 s. For example, "2,500–3,500" in Fig. 2.5 means that the dots in this figure represent eye movements from 1.5 to 2.0 min after the viewing started.

In the case of this participant, the eye movement started from two parts of *Guernica*: the face of the horse on the left and the people on the right. This attention lasted for about 2 min. Next, the eyes quickly traced a line connecting the horse face and the people, as shown in Fig. 2.6. This line was then revisited and reinforced, i.e., the eyes focused on the line connecting the right and left parts of the picture, as shown in Fig. 2.7.

We say that the line was "revisited and reinforced" because we found a dramatic change in the eye movement between Figs. 2.6 and 2.7. The velocity of the participants' eyes decreased, especially for the last 6.7 s, which was just before the participant's insightful comment, "This picture looks like a war, probably an air force attack." An interesting phenomenon was that the participant could not explain why he finally reached this interpretation. However, when we showed him

Fig. 2.5 Eye movement from 1.5 to 2.0 min after starting to look at Guernica

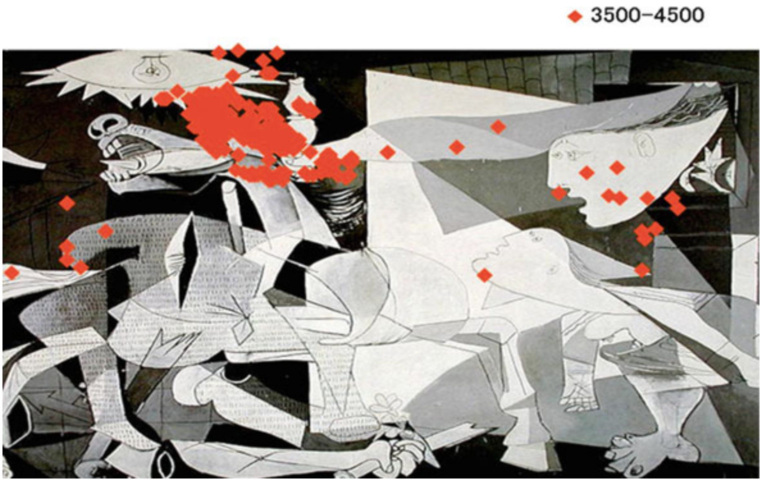

Fig. 2.6 Eye movement from 2.0 to 2.5 min after starting to look at Guernica

Fig. 2.7 Eye movement for the final 36.7 s (*white dots* show the final 6.7 s)

the eye-track (Fig. 2.7), he said “The object in the hand of the citizen is a lamp, and the one at the top of the picture may be a bomb . . . killing the horse and soldiers! The two citizens on the right-hand side needed the light of the lamp, because after the bomb attack the city was dark.”

Let us categorize different types of eye movement when fixated on a still object in the conventional manner, as follows:

- *A (slow) drift*: A low-velocity movement taking place invariantly, of about 5 min of view angle.
- *A tremor*: A high-frequency tremble of 1 min width, mostly co-occurring with drifts.
- *A micro-saccade, or flick*: A stepwise movement ranging up to 20 min.

When the target of attention moves, the eye movements are classified on the basis of the viewer's attention type. These types correspond to different velocities of eye movement:

- *Saccade* (50° or 60–600°/s): A large swing that occurs when the viewer shifts the target of attention. Intentional shifts of attention are reflected to saccade.
- *Pursuit* (5–30°/s): Middle-velocity movement that occurs when looking at a moving object.

Let us compare the phenomena in our experiment with these known patterns. The eyes, for the last 6.7 s just before insight (Fig. 2.7), after the earlier periods (Figs. 2.5 and 2.6) trying to interpret *Guernica*, moved at a velocity of 10–40°/s, which is slower than an ordinary saccade, but faster than the range of pursuit (5–30°/s). Note that all the images in the experiment were still. Although some quick movements, as fast as saccade, were observed, the participants' utterances about their impressions often occurred with slower velocity eye movement. A possible explanation of this exceptional velocity may be that the participant is searching for evidence to support the scenario that he/she has thought about for each local part of the picture. In other words, the movement in the last 6.7 s may have been a series of intentional saccades, the swift length (and accordingly the velocity also) of which has been reduced so that it can fit the restricted local area of attention focus.

We can infer that this participant found the lines (by which Picasso is said to have meant light rays) radiating from what he called the bomb and the lamp and connected them to the people on the right of the picture, thus forming a meaningful structure. Similar phenomena occurred in our experiments with other Picasso pictures. Let us call such a line, where the eyes move slowly to form a meaningful scenario by connecting parts on the way, a *slow saccade line* (SSL). We performed experiments to validate our hypothesis that SSL reflects the human process to reach the interpretation of a target image, the results of which have been published in a previous work (Ohawa and Maeda 2008).

Scan paths, which are lines that connect the major components of a picture, are said to play an essential role in the human cognition of artwork (Norton and Stark 1971). However, the results of the experiment described above imply that some small part of the scan can be regarded as an auxiliary line for combining components of the target image to achieve the externalization of a meaningful structure. We find SSL-like movements in the literature relevant to the shift of covert (implicit) attention, until acquiring overt (explicit) attention where sense organs are directed to a stimuli source (Hoffman and Subramaniam 1995; Peterson et al. 2004). The experimental results above may be regarded as an evidence of the process to reach an explicit attention to an image embracing a meaningful story, where eyes reveal the story before the mouth.

Let us summarize this section about eye movement. Sequential changes in eye movement can be interpreted as evidence of the participant's attention process. First participants pay attention to parts of an image that are easier to interpret, which in *Guernica* are the eyes of the horse and of the inhabitants of the city, and then they search for and find bridges to connect these basic parts. The emergent interpretation of the figure may further be reinforced by slow eye movement at a velocity and shape close to SSL that follows the bridge above, as in the 6.7 s just before the insight of the viewer of *Guernica*. Eyes can also move relatively slowly (less than 60°/s, which is incomparably slower than an ordinary saccade) along SSLs. Steps (1), (2), and (3) in the process model we presented in Fig. 2.2 are evident in such cases.

Furthermore, looking a one's own eye-track lines urges the mind to think of the reasons behind an interpretation, which can be regarded as an effect of metacognition.

2.5 Summary

Our findings show that individuals subjectively externalize the latent meaning underlying an image by relating parts that are easy to see and understand. In other words, we relate things that are familiar to us with or via things that may be unfamiliar. Regardless of our accuracy, i.e., whether the externalized meaning corresponds to facts or to what the artist intended, the finding instills in us a sense of new value. We can thus conclude that value sensing results from the human cognition of visualized information that includes both familiar and unfamiliar parts by making latent connections. The process of sensemaking as a methodology for elevating and using the sense of value provides hints for realizing the value-sensing lifestyle of people in communities. The methods and techniques of chance discovery we have been developing since 2000 can also be positioned as a way to develop and utilize data visualization tools that take advantage of the nature of human insight and apply them to business-oriented processes that can be explained by theories on sensemaking. Because the methods of chance discovery form the essential base for the Innovators' Marketplace, the core concept of this book, we will now present cases of chance discovery in actual business scenarios.

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