Translating and Extending Gestalt Grouping Principles to Include Time to Establish a Research Framework in Which to Study Motion.

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Motion is largely an untheorized aspect of communication on screen despite the fact that it will be increasingly used. It is unlikely that we can avoid seeing motion as a visual cue for action, feedback and navigation in computer use. Even now, the cursor is blinking constantly. This situation leads us to a consideration of motion, however the conception of motion itself is so involved that it has been approached piecemeal. Psychologists, neuroscientists, computer scientists, and the film and animation industries have done some research in motion. While the approach of a psychologist or neuroscientist is necessary in terms of discoveries with a scientific basis, other advances for motion research, such as the meaning of motion (Jeamsinkul & Poggenpohl, 2002) and decoding its common sense, or the structure of motion, framing dominant relations among motion qualities would serve someone who is working within a more interactive and dynamic computer environment, like interface designers or programmers aspiring to a more effective practice.

From a psychological perspective, Max Wertheimer's (1924) experimentally based Gestalt psychology from the early 20th Century provided experimental motion studies with a theoretical ground important to today's cognitive psychology (Sarris, 1989). Wertheimer said: "In my opinion physiological theorizing interacts with experimental research (in psychology) in a double functional way: On the one hand, it should…combine the single research findings and the major principles in a unified form and make them deductible; on the other hand…a (physiological) theory should promote the research process by stimulating concrete hypotheses to be tested experimentally…thus leading to deeper understanding of phenomenal laws."

The Gestalt psychologists say that visual perception supports visual thinking. Actually the term, 'Gestalt' itself emphasizes the act of synthesizing the sum of its parts for productive thinking in communication with automatic reasoning. Finally, Gestalt psychologists propose that we need to examine how elements are grouped or structured in a whole, or how conditions contribute to the whole. The unit-forming factors are proximity, similarity, closure, common fate, good continuation and symmetry known as collectively Gestalt grouping principles. However, Gestalt principles of visual grouping explain 2-dimensions only. The digital milieu including motion requires additional consideration. This paper extends the Gestalt grouping principles from 2D only to accommodate motion, which exists in time. Furthermore, searching for the relative strength of various Gestalt principles will support attention and visual clarity as screen real estate becomes more densely developed.

This paper introduces the grouping principles of Gestalt in motion. The motion attributes of speed, direction and duration are embedded in two events: transformation, meaning the act of changing in appearance, and transposition, meaning the act of moving position in space. In extending Gestalt principles from 2D, the following investigations will be visually demonstrated.

1 What is "closeness" in time that can explain proximity in motion?

2 What is "likeness" in time that can explain similarity in motion?

3 What is "absence but presence" in time that can explain closure in motion?

4 What is "correspondence" in time that can explain common fate in motion?

5 What is "steadily recurring" in time that can explain good continuation in motion?

6 What is "symmetry" in time that can explain symmetry in motion ?

This demonstration provides the framework on which subsequent research on Gestalt in motion will be based.

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BACKGROUND

Motion is a useful technique in visual communication in coexistence with stable images of content and form on screen. It provides a deeper experience, and enlivens visual communication on screen. Even now, the cursor is blinking constantly. Motion provides visual cues for action, feedback, interaction and navigation in this environment. Visual communication now inevitably involves motion as long as the computer remains a preferred environment; therefore, the use of motion to enhance visual communication on screen needs to be in correspondence to its specific mechanics within both theoretical and experimental frameworks.

Lazlo Moholy-Nagy anticipated the importance of motion in communication: "Whether we use the terms 'space-time', 'motion and speed', or 'vision in motion', rightly or wrongly, they designate a new dynamic and kinetic existence freed from the static, fixed framework of the past…Space or space-time experience is not merely the privilege of exceptionally talented persons. It is a biological function, as important and as common as the experience of color, shape and tone." (Moholy-Nagy, 1947, p. 266).
As a matter of fact, motion is largely an un-theorized aspect of communication on screen despite the fact that it will be increasingly used. However, the conception

of motion itself is so involved that it has been approached piecemeal. Psychologists, neuroscientists, computer scientists, and the film & animation industries have done some research about motion. For example, psychologists and neuroscientists discovered several principles about perception and recognition of motion based on brain mechanisms. On the other hand, interpretation of motion representations on screen has been studied in the field of communication design (Jeamsinkul & Poggenpohl, 2002).

This paper explores *apparent motion*, as a visual perceptual phenomenon, produced by viewing a succession of identical objects moving or changing on screen. *Apparent motion* is the basis of movement in all computer animation, movies, and television. The screen actually represents a rapid succession of still images; the perceived motion is entirely "apparent" and illusory (Stevenson, 1998). *Apparent motion* is based on the Phi phenomenon, which combines two or more still images that are perceived as motion. In contrast, motion in the real world is real movement based on physical phenomenon, like gravity or resistance, is not the concern for this paper. Attention-getting movement, constructive movements on the part of a user (i.e., dragging, copying, pasting, etc.) and simple acknowledgement (click) or disappearance (mouse-down – mouse-up) are also not the focus for this paper.

GESTALT GROUPING PRINCIPLES TO INCLUDE TIME

This paper seeks to explore whether Gestalt theory applies to motion by developing definitions that lead to an experimental framework. Gestalt grouping principles are a well-known sub-theory of visual perception. The term "Gestalt" emphasizes the act of synthesizing for productive thinking in communication with a kind of *automatic reasoning* (Gibson) in that sensory stimuli become meaningful information. Gestalt theory applies to all aspects of human learning (Gonzalez-Perez, 1999). Reconsidering Gestalt and *automatic reasoning* allows us to obtain a useful approach to the use of motion in visual information as it: 1) presents an objective starting point, 2) solves the problem of synthesis automatically, 3) allows *unconscious inferences* such as self observation and 4) takes feedback to the starting point (1), correcting or adjusting the fixation point (Gibson, 1950, p.19).

The Gestalt grouping principles are *proximity* grouping by smaller ***intervals*** between visual elements; *similarity* grouping by ***identities*** of visual elements; *common fate* grouping by ***sharing events*** among visual elements; *good continuation* grouping by ***regularity*** of visual elements; *closure* grouping by ***reasonability*** of visual elements and *symmetry* grouping by ***invariance*** among visual elements.

Time as another aspect for visual communication on screen is the key of issue of this paper. The Computer environment, which includes time and motion, requires a new model of problem solving for visual communication that goes beyond the environment of 2-dimensions only. *Automatic reasoning*, which refers to categorization and simplicity, is evoked as the context in which three principles of visual perception, *proximity, similarity* and *common fate* are defined and translated and extended to include time and motion on screen.

Questions are, ***"what is "closeness" in time?"*** for *proximity in motion*, ***"what is "likeness" in time?"*** for *similarity in motion*, and ***"what is "correspondence" in time?"*** for *common fate in motion*. The questions are practically developed and answered through graphs and discussion.

METHODS & REPRESENTATIONS

A storyboard with graphs showing the experimental construction is used, due to the limitations of this paper. The vocabulary of physics is borrowed to describe motion. Specifically, 'displacement' includes 'distance'; 'speed' includes 'velocity' and 'acceleration.' These terms are used to increase understanding for the experimental plan.

A regular square as the unit of a single cell (18px * 18px is the exact size of single cells in Macromedia Flash 5 for the experiments) and 15 cells for the width with 9 cells for the length are given for the total. There are 4 motion implications in a certain time, and those are described in 4 ways; environments, descriptions, results and conclusion. The graphs that follow show the scale of change that creates motion proximity, similarity, and common fate.

TRANSLATING AND EXTENDING GESTALT GROUPING PRINCIPLES TO INCLUDE TIME

In the following explorations, a definition is offered, examples of Gestalt phenomena in music (which exists through time) are offered, and finally the Gestalt implication for 2 dimensional forms in motion (through time) concludes the discussion. Graphs, diagrams of motion and statements synthesize the author's position.

1. SIMILARITY IN MOTION

Similarity in 2-dimensions is described as the tendency of like parts to band together with regard to laws of organization in perceptual forms (Wertheimer, 1923). In another words, similar characters in 2-dimensions are seen together as a group, they perform together and share a perceived ***identity.*** Identical entities for 2-dimensions can be found among colors, forms, brightness and texture, etc.

For similarity in motion, use of identical entities in time puts the emphasis on similarity in terms of motion itself. Perceived motion and configurations in 2-dimensions are separately classified, because the perceived motion is happening in-between two successive events in time. While configurations such as 2-

dimensional objects do not necessarily involve time, 2-dimensional forms can move through time.

We can look at similarity in music in relation to sensory inputs as well as its rhythmic character, which gives us an intuitive sense of time through the edit-distance between two expressions. Here the minimum number of basic modifications specifically measures its quantitative similarity (Opran & Huron, 1992). To look closer at the edit-distance as referenced above, it is said that the fewer the edits, the greater the similarity generated by scale-degree, melodic interval and pitch contour through deleting, adding and repeating notes. As a measurement for the edit-distance, quantitative and/ or qualitative aspects are used such as measuring the degrees of similarity regarding quantitative aspects, or the ways of similarity regarding qualitative aspects.

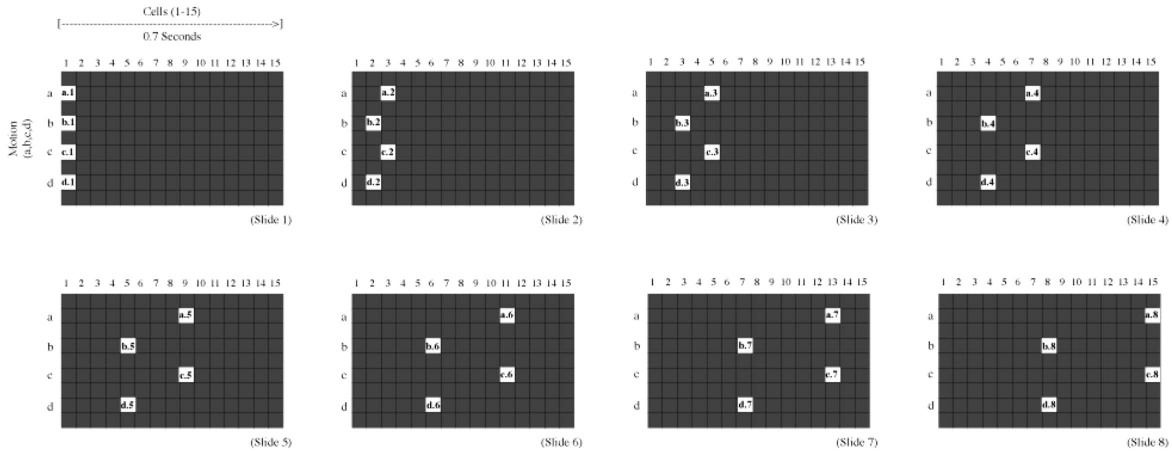
For example, "butter" and "margarine" have a qualitative similarity, while "butter" and batter" have a sound similarity or a quantitative aspect. The qualitative question, the nature of kinds of similarity, is logically prior to the quantitative question. Similarity provides a more "forgiving" approach to pattern-tasks, in which a range of musically useful patterns exists as pattern grammars in music. Rhythmic similarity, harmonic comparison and thematic statements are mentioned as different types of similarity in music (Opran & Huron, 1992). Another description for similarity in music is the smaller the frequency separation, the more likely the sounds will be grouped into one stream as shown in auditory scene analysis (Chuprun, 2002).

Finally, the question '***what is "likeness" in time?'*** is asked to identify elements of motion. ***Speed and direction*** are decisively understood as practical elements for the nature of perceived motion in relation to definitions of motion in physics, the change of location over time. Speed and direction are involved in all space-time. For instance, a blurring or flashing motion on the screen uses speed variation in time with different appearances of motion in size, brightness, or saturation etc. to change its character. Manipulating direction is not necessary for blurring or flashing, while rotating uses both speed and direction to turn from left to right or the reverse. Thus, speed and direction have been chosen to demonstrate similarity in motion on screen. ***Similarity by speed*** and ***similarity by direction*** are shown through a storyboard.

1-1. SIMILARITY BY SPEED

In order to answer the question, '***what is similar speed in perceived motion?'*** we address object behaviors ***for grouping by speed*** on screen design such that if ***displacement per time*** in movement ***is the same*** the motion is seen as a group (See Figure 1-1).

Figure 1-1.
SIMILARITY BY SPEED



Environment:

Same appearence of motion a,b,c & d

Linear motion for each
(Movement in a straight line as
from point "X" to point "Y")

Directional movement of motion a,b,c & d
(Movement in a single direction)

Given time for motion a,b,c & d
to pass through from the cell no.1 to 15:
0.7 seconds

Description:

Motion a.1 to a.8 & c.1 to c.8:

Displacement: through cell no.15
Speed: 15/0.7 = 21.42 c/s
Acceleration: 21.42-21.42/ 7 = 0 c/s/s

Motion b.1 to b.8 & d.1 to d.8:

Displacement: through cell no. 8
Speed: 08/0.7 = 11.42 c/s
Acceleration: 11.41-11.41/ 7 = 0 c/s/s

Results:

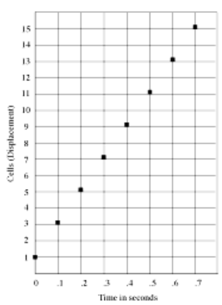
The motion a & c is seen as a group from a,b,c & d.
The motion b & d is seen as a group from a,b,c & d.

Conclusion:

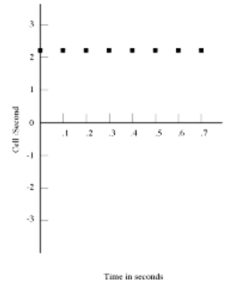
What is ***similar speed*** in perceived motion for ***grouping by speed***?

: If ***displacement per time*** in movement ***is the same,*** the motion is seen as a group.

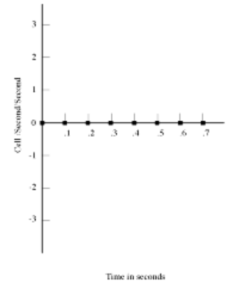
Motion a & c



Displacement (Distance)
of motion a & c

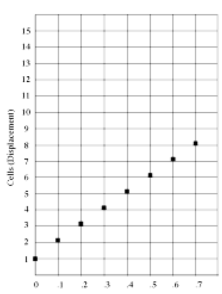


Speed (Velocity) of motion a & c

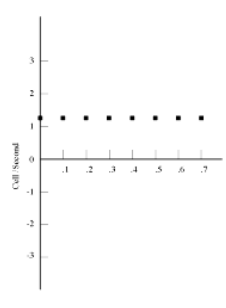


Acceleration of motion a & c

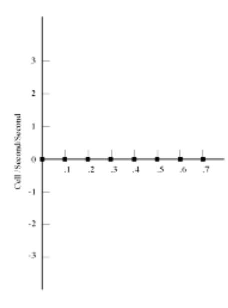
Motion b & d



Displacement (Distance)
of motion b & d



Speed (Velocity) of motion b & d

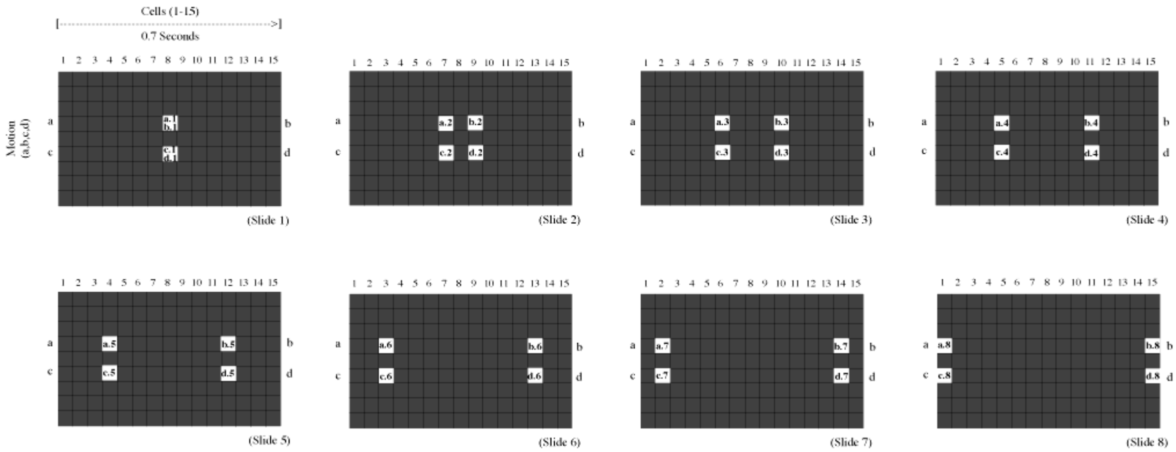


Acceleration of motion b & d

1-2. SIMILARITY BY DIRECTION

In order to answer the question, '***what is similar direction in perceived motion?***' we address object behaviors ***for grouping by direction*** on screen design such that if ***directional relation between time & displacement*** in movement ***is the same*** the motion is seen as a group (See Figure 1-2).

Figure 1-2.
SIMILARITY BY DIRECTION



Environment:

Same appearence of motion a,b,c & d

Linear motion for each
(Movement in a straight line as
from point "X" to point "Y")

Movement in two directions
of motion a,b,c & d

Given time for motion a,b,c & d
to pass in-between the cell no.1 and 15:
0.7 seconds

Description:

Motion a.1 to a.8 & c.1 to c.8:

Displacement: through cell no.8 to 1
Speed: 08/0.7 = 11.42 c/s
Acceleration: 11.42-11.42/ 7 = 0 c/s/s

Motion b.1 to b.8 & d.1 to d.8:

Displacement: through cell no.8 to 15
Speed: 08/0.7 = 11.42 c/s
Acceleration: 11.41-11.41/ 7 = 0 c/s/s

Results:

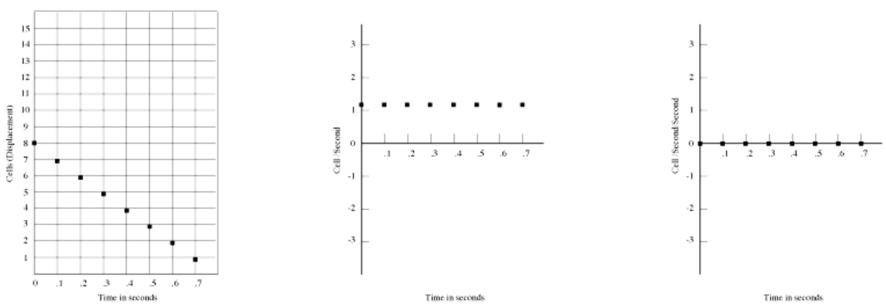
The motion a & c are seen as a group from a,b,c & d.
The motion b & d are seen as a group from a,b,c & d.

Conclusion:

What is ***similar direction*** in perceived motion
for ***grouping by direction***?

: If ***directional relation between time & displacement***
in movement ***is the same*** the motion is seen as a group.

Motion a & c

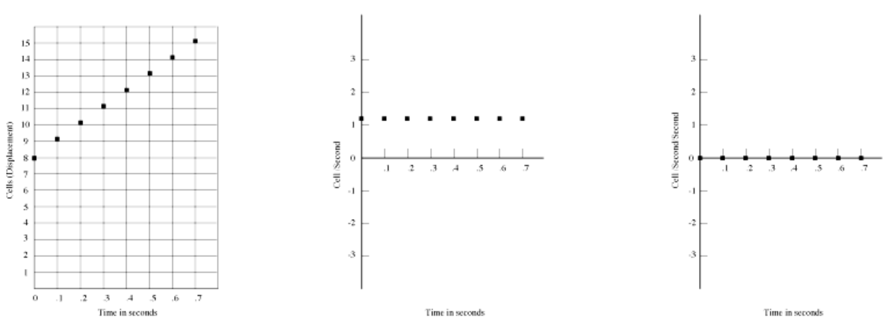


Displacement (Distance)
of motion a & c

Speed (Velocity) of motion a & c

Acceleration of motion a & c

Motion b & d



Displacement (Distance)
of motion b & d

Speed (Velocity) of motion b & d

Acceleration of motion b & d

2. PROXIMITY IN MOTION

Proximity in 2-dimensions is accounted for when things are near to each other, they are seen as a group. ***Clustering*** gives the pattern of proximity and perceptually groups a set. Wertheimer said that the smallest interval is most natural in explaining proximity in his Laws of Organization in Perceptual Forms (1923). In 2-dimensions, intervals can mean a specified unit of distance between elementary characters or elements that create meaningful configurations. The interval can also be empty space signifying the in-between among these characters or elements.

For example, in 2-dimensions, if ten dots are close in the condition of a linear and directional arrangement with regular interspaces, a particular distance between two dots including an in-between space or interval creates a regular perceptual pattern of occurrence. We usually recognize these dots as a line rather than ten dots gathered unexpectedly and independently. That is, unidentified parts or closer distances as empty spaces contribute to making consecutive and simultaneous relations that are meaningful. Recognizing the unrevealed, but that which will exist in time is considered. ***Intervals*** are associated with proximity in motion.

Looking at intervals in music can be helpful because of their time dependency. Proximity in music embeds intervals in a kind of auditory scene analysis; tones close in frequency will group together, so as to minimize frequency jumps. Sounds from different frequency registers are harder to group together across time than those from the same location (Darwin, 2002).

Proximity and similarity are related concepts in music as referenced above. Tones with similar timbre will tend to group together, and speech sounds of similar pitch will tend to be associated with one speaker. The smaller the frequency separation, the more likely the sounds will be grouped into one stream.

With greater time separation, greater perceptual segregation of high and low tones for proximity and similarity occurs in auditory scene analysis (Chuprun, 2002).

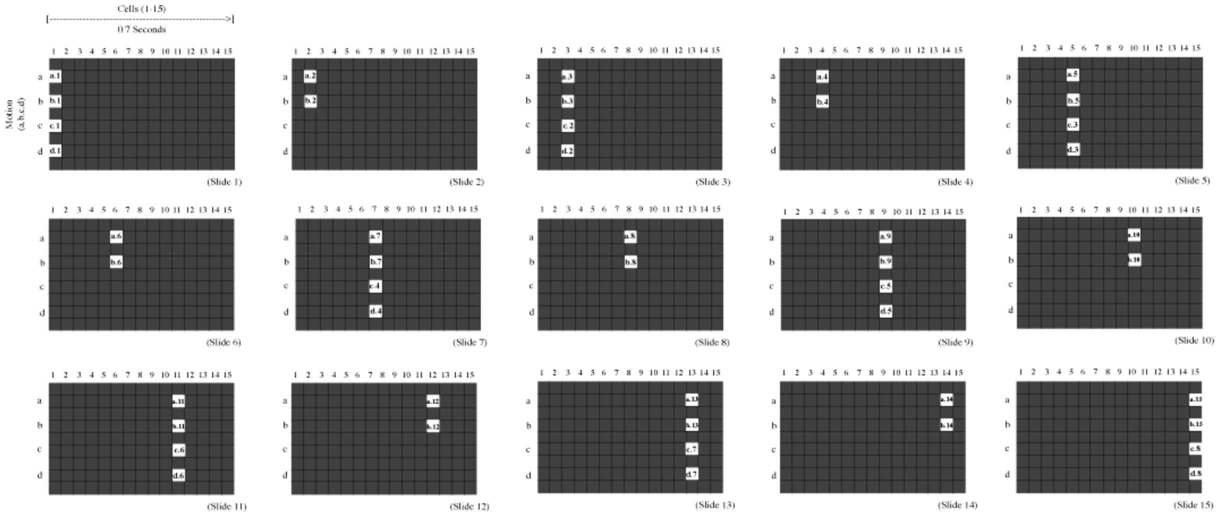
For proximity in motion, the question ***'what is "closeness" in time?'*** is answered by ***frequent and regular occurrence*** referencing intervals in time as previously discussed. Frequency and regularity make the motion more natural to see. Possibly, similarity in motion relies on elements of motion such as speed and direction, and proximity in motion relies on ***events*** of motion or occurrence.

Events can be separated from *states*. Events are essentially associated with intervals in time. States are primarily associated with *moments,* and events with *intervals.* States may obtain in an interval only by virtue of their presence at some or all moments of the interval, whereas events are first and foremost to be located *within* an interval. The sentences *Jane was swimming* and *Jane had a swim* describe the situation as a state (*Jane was swimming)* and the occurrence of an event (*Jane had a swim*). It makes sense to ask how often a given event occurs within some stretch of time. (Galton, 1984, p. 24-33).

In short, events can be counted and have a beginning and an ending. In conclusion, proximity in motion, or ***a frequent and regular occurrence presenting consecutive movements of an event oriented by identical intervals of time*** delivers natural scenes or groupings.

In order to answer the question, ***'what is a frequent and regular occurrence in perceived motion?'*** we observe object behaviors ***to be more natural*** on screen such that <u>when displacement per time is the same in movement *(similarity by speed)*</u>, if <u>***the number of series of events in one group is more than the others*** in the movement, the motions are grouped and separate</u> (See figure 2).

Figure 2.
PROXIMITY IN MOTION



Environment:

Same appearence of motion a,b,c & d

Linear motion for each
(Movement in a straight line as
from point "X" to point "Y")

Directional movement of motion a,b,c & d
(Movement in a single direction)

Given time for motion a,b,c & d
to pass through from the cell no.1 to 15:
0.7 seconds

Description:

Motion a.1 to a.15 & b.1 to b.15:

Displacement: through cell no.15
Speed: 15/0.7 = 21.42 c/s
Acceleration: 21.42-21.42/ 7 = 0 c/s/s

Motion c.1 to b.8 & d.1 to d.8:

Displacement: through cell no. 15
Speed: 15/0.7 = 21.42 c/s
Acceleration: 21.41-21.41/ 7 = 0 c/s/s

Results:

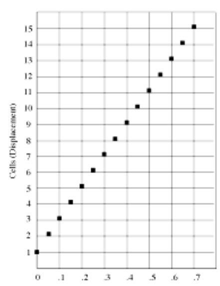
The motion a & b is seen more natural than c & d.

Conclusion:

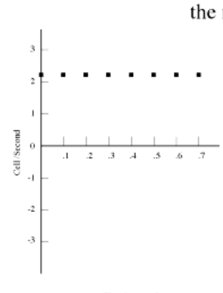
What is ***a frequent and regular occurrence*** in perceived motion ***to be more natural***?

: When displacement per time is the same in movement *(similarity by speed)*, if ***the number of series of events in one group is more than the others*** in the movement, the motions are grouped and separate.

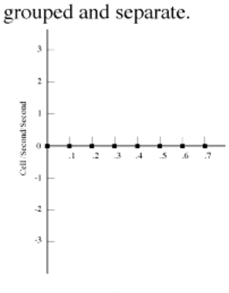
Motion a & b



Displacement (Distance) of motion a & b

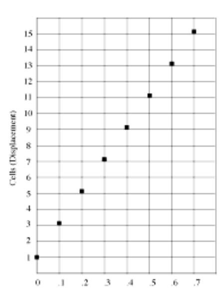


Speed (Velocity) of motion a & b

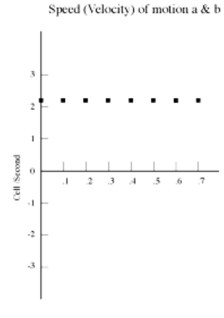


Acceleration of motion a & b

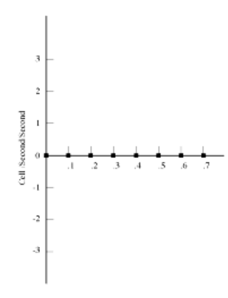
Motion c & d



Displacement (Distance) of motion c & d



Speed (Velocity) of motion c & d



Acceleration of motion c & d

3. COMMON FATE IN MOTION

Common fate is generally thought to have the status of a connected configuration when visual elements appear to move together. Max Wertheimer used *uniform destiny* as an expression for common fate; it was a *naturally related* group termed *"pro-structural*" and a *subjected* group termed *"contra-structural*" in Laws of Organization (1923).

Actually, common fate has been mentioned with motion already in existing research. Examples in research are usually embodied in the words *traveling together* and *synchronicity.* In the examples, the same speed and direction are used as attributes of *traveling together*. Simultaneous change of visual characters including speed and direction are given in the experiments for the concept of *synchronicity* in motion for common fate (Levin, 2003).

In the concept of *traveling together,* a *common destination* is revealed by a ***shared event*** for both 2-dimensional representations and motion. In 2-dimensions, the destination is formed by the direction that the elements are heading for, as if by agreement among them. For example, imagine a parabolic track, which consists of 100 separate stars arrayed in a linear display — regularity of intervals among the stars is not necessary. We see a parabolic track as identified by the linear configuration; we do not prefer to see it as disconnected assemblies where directions change. The manipulation of proximity within its display accounts for the clearness of common fate.

Regarding the tension between proximity and common fate, imagine again, dashed lines with relatively big intervals creating the same parabolic track. The big intervals work against proximity, spaces between the dashed lines can destroy the grouping, however, it cannot destroy the grouping that creates the shared event.

Let's move *common destination* into motion. Since objects in motion are virtually moving, the same direction pursuing *common destination* is more distinctive than in that of 2-dimensions. That is, it is not indirectly aimed, but directly pointed. The same speed also implies *common destination* in examples reviewed for this paper. Speed and direction are attributes of common fate in the examples of motion for *traveling together*. Is common fate in motion the same as similarity in motion? Probably, similarity in motion contributes to common fate in motion. *Synchronicity* from simultaneous occurrences can be one representation of common fate in motion rather than *synchronicity* itself as common fate in motion.

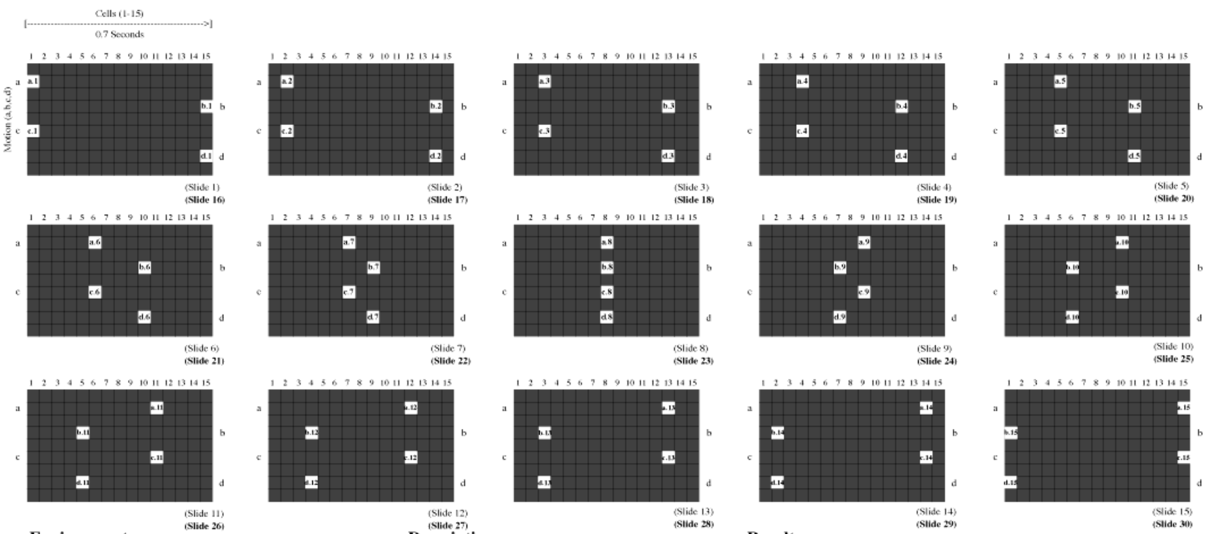
The same direction is not necessary for *traveling together*. For example, there are two opposite directions, with objects separate in 2 groups, using *similarity by direction.* However, if the movement is ***repeated*** back and forth continuously, that creates a kind of relation; they are engaged and combined with one another. For common fate in motion, the question, ***"what is correspondence in time?"*** is asked in this paper.

Common fate in motion can be understood through *structure* (Wertheimer, 1923). The concept of *structure* can be understood as a set of relations among entities that form the elements of a system; the structure will be said to be concrete if the relations are actually embodied in some system (Caws, 1997). ***Engagement*** is selected as the word for common fate in this paper. The question, ***"what is it and what was it?"*** can be helpful to understand common fate regarding the engagement.

In conclusion, common fate in perceived motion gives an ***engagement reconstructing relations among dynamic objects, and the degree of engagement can create a group in a strong sense***.

In order to answer the question, ***'what is an engagement in perceived motion?'*** we address object behaviors as ***a group that belongs together*** on screen such that if ***the event is repeated*** in movement, the motion forms a group that belongs together (See figure 3).

Figure 3.
COMMON FATE IN MOTION



Environment:

Same appearence of motion a,b,c & d

Linear motion for each
(Movement in a straight line as from point "X" to point "Y")

Movement in two directions of motion a,b,c & d

Given time for motion a,b,c & d to pass through the 15 cells:
0.7 seconds

Description:

Motion a.1 to a.15 & c.1 to c.15:

Displacement: from cell no. 1 to cell no.15
Speed: 15/0.7 = 21.42 c/s
Acceleration: 21.42-21.42/ 7 = 0 c/s/s

Motion b.1 to b.8 & d.1 to d.8:

Displacement: from cell no. 15 to cell no.1
Speed: 15/0.7 = 21.42 c/s
Acceleration: 21.41-21.41/ 7 = 0 c/s/s

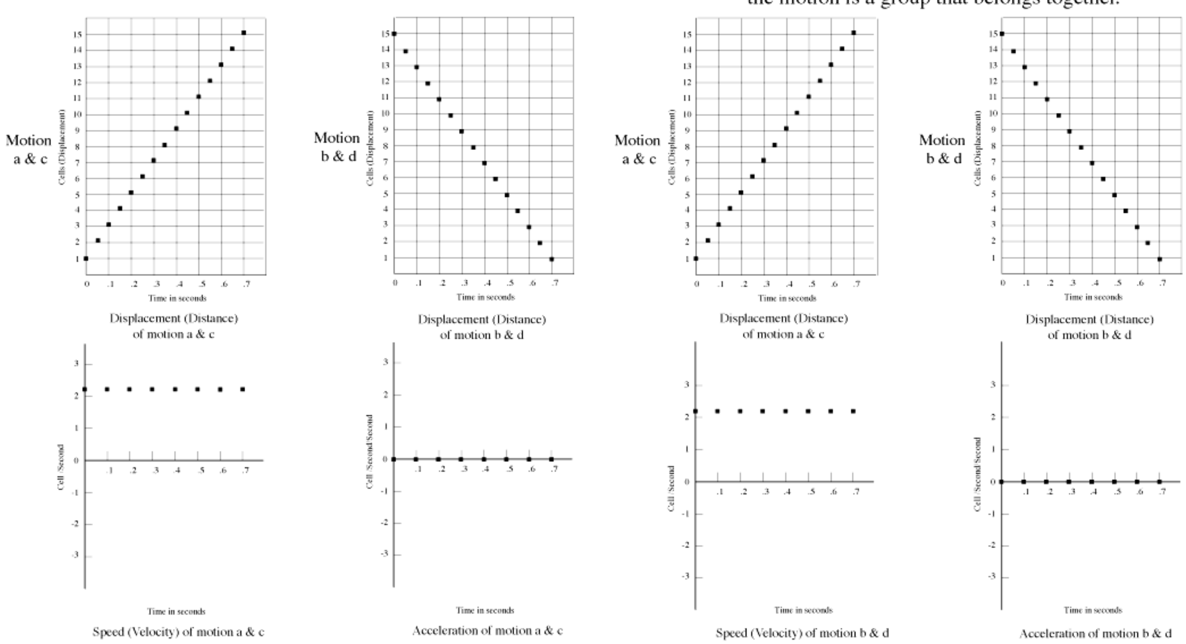
Results:

The motion a, b, c & d are seen a group.

Conclusion:

What is ***an engagement*** in perceived motion ***regenerating a group that belongs together?***

: When displacement per time is the same in the movement *(similarity by speed),* if ***the event is repeated*** in the movement, the motion is a group that belongs together.



CONCLUSIONS

Motion on screen is familiar enough, but we need to comprehend and use motion and manipulations of motion systemically for positive effect. Motion that does not function makes information on screen unproductive, awkward, or disorganized and can result in negative user reaction.

Is the research into definition of Gestalt principles into motion a legitimate undertaking in communication design, or does such study belong in psychology? Communication design is where information synthesis occurs, where people process ideas, where structures with meaningful reception are formed. While scientists or psychologists examine phenomena from scientific perspectives, application of theory is different. This research is moving toward general concepts about motion reception and understanding for design application. Thus motion phenomena need to be examined with a view to communication design use. Of course the research needs to support pragmatic application with valid guidelines for use.

This investigation sets the stage with practical methods with which to pursue motion meaning. It demonstrates the application of fundamental definitions regarding methods of ***grouping by speed*** and ***grouping by direction*** on screen, methods to create ***frequent and regular occurrence*** on screen, and methods to group ***dynamic objects that belong together*** on screen.

Translating and extending Gestalt grouping principles to accommodate motion on screen opens informational and technical benefits. The definitions this paper has developed are within the boundary of regular units of movement change. Since motion itself has unlimited possibilities, the definitions considered here are important steps toward guideline development. The remaining Gestalt grouping principles, good continuation, closure, and symmetry in motion are in the process of being similarly defined. Whether there is a hierarchy among Gestalt grouping principles with regard to time and in terms of their perceptual strength or receptive force may be a future outcome of this line of investigation. Such a discovery would deliver significant structure for guidelines or principles for motion use on screen.

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