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# Relationship of a chaos equation to Piaget's developmental theory and selective attention deficits

Hideaki Yanagisawa[1]

[1]*Konosu Public Health Center, Saitama, Japan*

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Piaget's theory provides a typical example of a relationship between human development and chaos theory. Here, Piaget's developmental theory and selective attention deficits are compared with a chaos equation. Continuous covariation is a necessary condition to equilibrium and the chaos phenomenon, and equilibrium is the converged solution in a chaos equation. Each convergence and non-convergence is a fixed and a chaotic state. In many chaos equations, there are two kinds of variables that change or do not change each site beyond the Feigenbaum point. Two types of developmental disorders are assumed. One is low speed in judging convergence or non-convergence. The other is low-speed change after a person's own judgment. In the former, a person cannot sense a difference between a converging point and his present state. Because he/she cannot understand others' emotions, he/she will continue with his/her experience with no convergence . Therefore, he/she cannot request help, and it might be thought that he/she can wait. This type is equivalent to Asperger's syndrome. In the latter, a person senses a difference. Because the person strictly feels the difference between a fixed point and his/her present state, he/she cannot wait for convergence. Therefore, he can request help. His present ate might be anger, and this type is equivalent to ADHD. In the former, a wide chaotic state narrows with experience. Piaget's developmental theory might be that humans have the ability to change each state. Chaos theory shows "Selective attention deficits with autism" as two different patterns in non-convergence or convergence.

Keywords: Piaget, chaos, convergence, autism, equilibrium.

Address of correspondence: Hideaki Yanagisawa, Konosu Public Health Center, 4-5-10, Higashi, Konosu Saitama, Japan, 365-0039. E-mail: science2001007@ybb.ne.jp

## Introduction

Some clinical types of developmental disorders have been reported (Kasari & Rotheram-Fuller, 2005), and a mathematical report has been made on Piaget's developmental theory (Ojose, 2008). However, no report has analyzed developmental theory with an equation. In this report, Piaget's developmental theory (Flavell, 1996) and selective attention deficits are compared with a chaos equation.

## Explanation of Chaos Theory

*Definition*

Chaos theory can be defined as "the qualitative study of unstable a periodic behavior in deterministic non-linear dynamical systems" (Kellert, 1993). Chaos theory is a part of complexity theory that concerns itself with nonlinear dynamic systems whose behavior does not follow clearly predictable and repeatable pathways. In linear systems, the relationship between an environmental factor and system behavior is predictable and easily modeled. As the presence of an environmental factor increases, system behavior changes linearly in response to it. In contrast, behavior in chaotic systems might be perceived as unpredictable (McBride, 2005).

In this regard, it is important that such a chaotic state is not confused with the term "random." In mathematical terms, "random" means the "statistics governed by or involving equal chances for each item" (New Oxford American Dictionary).

*Relationship of continuous covariation to chaos theory*

Yanagisawa's (2015a) article "Association of Evolutionary Topics related to God and Chaos Theory" relates continuous covariation to chaos theory. The basic concepts are outlined below, and a representative chaos equation is given as:

$$Y(n+1) = p[1-Y(n)]Y(n)$$
(1)

In this case, Equation (1) has the same meaning as Equations (2) and (3):

$$Z(n) = p[1 - Y(n)]Y(n)$$
(2)

$$Y(n+1) = Z(n)$$
(3)

Since calculations in Equations (2) and (3) are alternately repeated, the solutions to Z (n) and Y (n) are in an ordered spiral chaos state. As Y (n) is determined, Y (n + 1) changes according to Equation (1). However, once Y (n + 1) moves to the position of Y (n) in Equation (1), Y (n + 2) also changes. Thus, Y (n) is unable to settle into its original pre-chaos value. This relationship means that once a variable has changed into another, it becomes unable to settle into its original value, or as defined above, it has a "correlated variable relationship" equivalent to covariation. Hence, the relationship between Y (n) and Y (n + 1) in Equation (1) is covariation, and this relationship must continue to sustain the chaotic state. Equation (1) is an example of a recurrence relation as part of covariation. If no correlated variable relationship exists between variables, then a chaotic state cannot be confirmed.

A logistic map of Equation (1) is shown in Figure 1 (Yanagisawa, 2010), with some lines, arrows, and letters added to the original figure (Kohda, 1990, p. 4). The vertical axis is Y (n), and the horizontal axis is "p." The border point between convergence and a chaotic state is called the "Feigenbaum point" in part M of Figure 1 (Feigenbaum, 1978). According to "p" that changes from 3 to 3.56995 (Feigenbaum point), the number of fixed points in Equation (1) changes to 1 (Part P), 2 (Part Q), and 4 (Part R). Fixed points are equivalent to "linear" in the definition of chaos theory. When "p" is less than the Feigenbaum point, the answer converges. When "p" is greater than the Feigenbaum point, the answers change to the localized (Part M) and proliferated (Part S) chaotic states. Points A and B are 0.16 and 2/3 when "p" is 3 in Figure 1. Points D and E are 0.16 and 2/3 when "p" is 4.

For example, the solution to Equation (1) is part P (or point B) when each "p" and Y (0) are 3 and 0.16. Each calculated Y (n) is Y (1) = 0.4032, Y (2) = 0.72188928, Y (3) = 0.6022954422632448, and Y (4) = 0.71860692747650144877089692581 88. These are shown in Figure 2. The vertical axis is Y (n), and the horizontal axis is "n."

According to Equation (5), Y (n) will converge to 2/3.

$$p = 3$$
(4)

From Equations (1) and (4),

$$Y = 3[1 - Y]Y$$
(5)

$$Y = \frac{2}{3}$$
(6)

This is point B. However, Y (n) can never converge in the chaotic state, like parts M and S. When each "p" and Y (0) are 4 and 0.16, the changes of Y (n) are shown in Figure 3. The vertical axis is Y (n), and the horizontal axis is "n." All Y (n) exist between 0 and 1. However, they never converge, and this is a chaotic state.

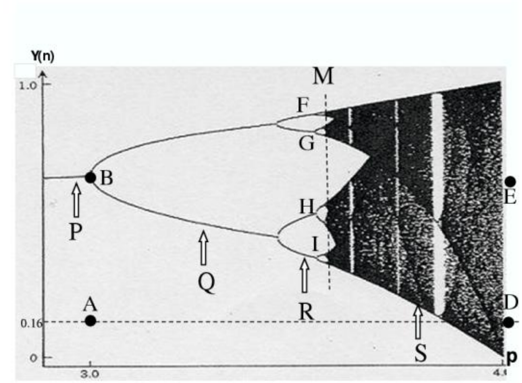


***Figure 1.*** A logistic map of Equation (1): Points A and B are 0.16 and 2/3 when "p" is 3. Points D and E are 0.16 and 2/3 when "p" is 4.

## Relation of Piaget's Developmental Theory to Chaos Theory

Next, a relation of the representative chaos equation to Piaget's theory is explained. Jean Piaget focused on accommodation and assimilation to development, in other words, adapting to a new environment. This is equivalent to: "As the presence of an environmental factor increases, the system behavior changes linearly in response to it" in the definition of chaos theory. In Piaget's theory, equilibrium, created with internal and external processes through assimilation and accommodation, is very important. In these processes, a covariant relationship between a human and the environment is required. When the person changes, the environment will also change; conversely, when the environment changes, the person will also change.

As Piaget indicated, a person can know a change in the environment from information, and from that information, can confirm the equilibrium between the environment and himself. In other words, equilibrium is the same as the converging process of answers in chaos equations. In Equation (1), each Y (n + 1) and Y (n) are considered human and information. If a person adds a covariant relation to the environment, the equilibrium might converge by changing the "n" value. This is shown in Figure 2. In this pattern, a person senses difference between the converging point and his present state. Therefore, he can request help from someone. He might be angry, but because he will regain equilibrium over time, we must await his development.

However, equilibrium cannot be attained by changing the "n" value in the chaotic state, such as in Figure 3. In this pattern, the person will have difficulty regaining equilibrium. Because the chaotic state of part S in Figure 1 localizes between 0 and 1, it can be considered equilibrium. However, a person might feel unsteady and have symptoms of anxiety in non-convergence. Persons can consider a chaos phenomenon as a kind of equilibrium after experiencing many chaos phenomena.

Even for an adult to attain their equilibrium is very difficult. Therefore, a person attempts to change his relationship to the environment, and the environment will change from that change. Through information from the environment, he will confirm equilibrium between the environment and himself. This has the same meaning as changing a chaos equation variable, such as the "p" in

Equation (1). In Figure 1, the chaotic state of part S converges to parts F, G, H, and I with the changing "p." In the chaotic state, a person senses the converging point according to his development. If his speed in judging a convergence or non-convergence is too late, his relation to information continues the chaotic state. In this case, he awaits convergence with no guarantee. He cannot sense difference between the converging point and his present state because of not being able to judge convergence or non-convergence. Therefore, he cannot request help from someone. But in this case, we must not wait for a request. If a person cannot judge convergence or non-convergence, he can never attain equilibrium with convergence. If a person cannot change himself after judgment of non-convergence, he cannot promptly attain equilibrium with convergence and feels unsteady in each case.

Which did Piaget consider equilibrium - a fixed state or chaotic state? It might be Piaget's developmental theory that humans attain the ability to judge a non-convergence state and to change from a chaotic state to equilibrium. This means that the human changes the chaos equation's variable, such as the "p" in Equation (1). Piaget's theory provides a typical example of a relationship between human development and chaos theory.

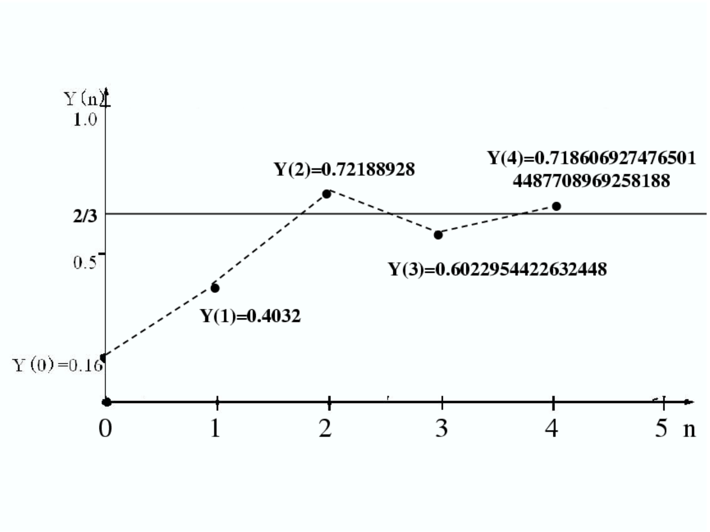


***Figure 2.*** The changes of Y (n) are shown when "p" and Y (0) are 3 and 0.16.

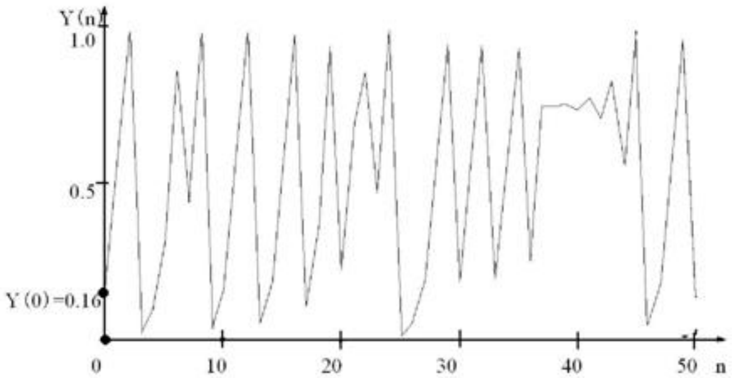


***Figure 3.*** The changes of Y (n) are shown when "p" and Y (0) are 4 and 0.16

**Relation of Selective Attention Deficits to Chaos Theory**

Next, a relationship of the representative equation to selective attention deficits is explained. Persons with autism show "stimulus overselectivity" (Lovaas, Schreibman, Koegel, & Rehm, 1971). If a person pays very much attention to point D in Figure 1, he can never change from a chaotic state to point B. If a person pays no attention to point E in Figure 1, he can never change from a chaotic state to point B either. If "Selective Attention Deficits in Persons with Autism" (Burack, 1994) is shown in the chaotic part of Figure 1, it will not change over time. However, it will improve over time if it is shown in the convergent part. For example, point A will converge to point B with many calculations in Figure 1. Many calculations are equivalent to human experience over time. Therefore, symptoms can change with age in the convergent pattern.

**Difference Between Asperger's Syndrome and Attention Defect Hyperactivity Disorder (ADHD)**

There are two different abilities for attaining equilibrium in the fixed and chaotic states. Development is explained as changing the variable, such as the "p" value or the "n" value in Equation (1). Two types of developmental disorders were supposed from the chaos equation. One is a type of changing "p" in which a person cannot judge convergence or non-convergence. In this type, he cannot sense difference between the converging point and his present state. Therefore, he cannot request help. This type might be Asperger's syndrome in Autistic Spectrum Disorder. It is very difficult for a person with Asperger's syndrome to understand others' emotion (Sanders, 2009). Therefore, he cannot attain convergence. Because he has no disorder to changing "n," he will continue infinite calculations with no convergence. But it might be thought that he can wait.

The other is a type of changing "n" so that a person cannot change himself after making a judgment. In this type, he senses difference between the converging point and his present state. This has the same meaning as non-presence of others' emotion. Therefore, he can request help. Because "n" is equivalent to time, this type might be ADHD because a person with ADHD can understand others' emotion. Therefore, he can predict convergence in relation to another person. Because he strictly feels difference between a fixed point and his present state, he cannot wait for convergence (Sanders, 2009). And chaos theory shows "Selective attention deficits with autism" as two different patterns in non-convergence or convergence, and symptoms will later be able to change with age.

Humans can consider chaos phenomena as a kind of equilibrium after experiencing many chaos phenomena. In the former, a wide chaotic state can narrow with experience. However, understanding low-speed change is difficult in the present society that educates only the fixed state. In each type, a person might sense different equilibrium. If Piaget thought of change to some equilibrium from non-equilibrium as development, both types are developmental disorders in his theory. If Piaget thought of change to a fixed state from a chaotic state, the former is a developmental disorder. Because a person has low speed in later attaining some equilibrium in the latter, he cannot attain it. Piaget's developmental theory might be that humans have the ability to change from the chaotic state to some equilibrium, in other words, both types can do so.

## Discussion

There is a report relating the chaos model to Piaget's developmental theory (Yeongmahn, 1993). However, no report explains it using one variable of a chaos equation. In this report, a relation of covariation to equilibrium was made clear. Continuous covariation is a necessary condition of chaos equations (Yanagisawa, 1996, p. 115). In Equation (1), a fixed point such as part P has the same meaning as convergence and is equilibrium. The chaotic states such as part S have the same meaning as non-convergence. A difference between a fixed state and a chaotic state is given by changing the "p" in Equation (1). For attaining equilibrium, a human changes his variable in the environment. Thus, development is explained as changing the variable, such as "p" or "n," in Equation (1). Of course, this means that a law of development is explained as the character of some variables in the chaos equation. In many chaos equations, there is a variable such as "p" changing the state beyond a Feigenbaum point, and "n" related to continuous covariation does not change the state beyond the Feigenbaum point. Each "p" and "n" in Equation (1) is equivalent to a person's thought and time. However, the thought of changing "p" can be attained only with repeated rearrangement of personal experience.

Therefore, two factors necessary for development were clarified. One is the ability of judgment for convergence or non-convergence. This is equivalent to changing the "p" in Equation (1). In part S of Figure 1, the person's relation to information continues the chaotic state until judgment, implying a long period of time. Therefore, it is difficult for symptoms of Asperger's syndrome to change with age, but there is a possibility of change over a very long time. The other is the ability to change on one's own after judgment, equivalent to changing the "n" in Equation (1) in part P. Many calculations such as "n" are equal to experiences or time, that is, a short time. Therefore, symptoms of ADHD can change with age.

Piaget's developmental theory might be that humans attain the ability to change from a chaotic state to some equilibrium, and both abilities are necessary in development. If a person's ability in one or both is low, he is recognized as having a developmental disorder. Ability has the same meaning as speeds in judging and changing. A person with a developmental disorder cannot deal with much information from the environment due to low speed. In this state, the person feels unsteady and has anxiety symptoms. In ADHD, for instance, he can sense difference between a converging point and his present state when he cannot change himself after judgment. Therefore, he might request help from somebody.

In Asperger's syndrome, for instance, a person cannot sense difference between a converging point and his present state when he cannot judge convergence or non-convergence. Therefore, he cannot request help. This difference is important for understanding developmental disorders, and, therefore, therapy for each type is different. Because a person with ADHD has low speed in attaining equilibrium, he becomes irritated. However, he can slowly attain equilibrium, and a central nervous system stimulator or excitement depression therapy might be effective. On the other hand, understanding of equilibrium is nil or very low speed in a person with Asperger's syndrome. Therefore, he must first understand some equilibrium and must have continuous experience with simple chaos phenomena. Variables must be reduced for a simple chaos phenomenon, meaning that another person relating to his needs to be in a fixed state, and if possible, there should only be one person. "Make it hard to interact successfully one-on-one and in groups" and "You may choose to stay or to marry" were reported in "Five Benefits of Therapy for Adults with Asperger's Syndrome" (Roberson K, 2013). Five benefits are equivalent to the conditions with continuous covariation to change to a fixed state from a chaotic state. The ability to attend selectively to meaningful sources of information while ignoring irrelevant ones is essential to competent and adaptive functioning (Lane & Pearson, 1982). Persons with autism not only pay attention to the unimportant, but also pay no attention to important information. They are shown as responses to points D and E in Figure 1. If a person pays very much attention to point D in Figure 1, he can never change from a chaotic state to point B. If a person pays no attention to point E in Figure 1, he can never change from a chaotic state to point B either. If "Selective Attention Deficits in Persons with Autism" (Burack, 1994) is shown in the chaotic part of Figure 1, it will not change with many calculations. However, it will improve with many calculations if shown in the convergent part.

Because many calculations are equivalent to human experience, symptoms of Asperger's syndrome can change with very long-term experiences. And those of ADHD can change with more short-term experiences. Therefore, a theoretical mechanism of autism might be explained as the low ability of judgment or convergence as well. In this way, Piaget's theory provides a typical example of a relationship between human development and chaos theory.

There are many methods to organize thoughts. The relation of the chaos equation to the KJ method (Yanagisawa, 2010), Counseling (Yanagisawa, 2004; 2015b), Peer Support (Yanagisawa, 2015c), the SEIQoL-DW (Schedule for the Evaluation of Individual Quality of Life-Direct Weighting) method (Yanagisawa, 2014) and God's Law of Nightingale (2016) has been reported with a three-dimensional logistic map. They can be explained by the same method changing "p" of Equation (1) beyond Feigenbaum point (Yanagisawa, 2012). Because covariation is made with over time, all natural phenomena with time are chaotic. Therefore, living creatures in natural phenomena experience chaos phenomena (Yanagisawa, 2011). All phenomena relating to living creatures could be explained by chaos theory.

## Conclusions

Piaget's theory of cognitive development can be explained by chaos theory, and equilibrium has the same meaning as converging in chaos equations. Here, two types of developmental disorder were supposed by a chaos equation. One is poor ability to judge convergence or non-convergence. The other is poor ability to change one's self after judgment. In the former, a person cannot sense difference between a converging point and his present state because of his inability to judge. Therefore, he cannot request help. This type is equivalent to Asperger's syndrome. In the latter, he senses difference between a converging point and his present state. Therefore, he can request help. This type is equivalent to ADHD. Piaget's developmental theory might be that humans have the ability to change from a chaotic state to some equilibrium and provides a typical example of a relationship between human development and chaos theory.

A theoretical mechanism of "Selective Attention Deficits in Persons with Autism" is shown as two different patterns in non-convergence or convergence by chaos theory. Symptoms of Asperger's syndrome might change with very long-term experiences, and those of ADHD might change with more short-term experiences.

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