

Details of observational and experimental procedures in the JCS cohort study (1): Procedures and Results on Experiments on Self-Regulation in infancy

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This is a report on the experiments on self-regulation in the JCS cohort study. The self-regulation experiments were incorporated into observations at the age of 2.5, 3.5, 5, and 6. This report describes the procedure and simple aggregate results at each stage.

Keywords: Self-regulation, cohort study, infancy, experimental procedures.

Introduction

Details of observational and experimental procedures in the JCS cohort study contains a sequential listing of the observational and experimental procedures used in the Japan Children's Study (hereafter "JCS") and their simple aggregate results. Since many of the observations and experiments in the JCS have been used in published papers, it is possible to cite and describe the original source when writing a report or paper. However, changes have been made due to constraints on time and

the observations, and while the concept and framework of the original has been left as-is, the target age range was expanded and the procedures were adapted to the target ages. It is not realistic to include all the details of these changes in each report, especially when the target ages span several points in time.

Therefore, with consideration of the shared use of the data in the future, we decided to record the procedures in Details of observational and experimental procedures in the JCS cohort study. It is difficult to cover all observations and experiments, so we will prioritize those which cover multiple points in time. Since the purpose is to describe the details of the procedures, explanations of concepts and background information and the presentation of results will be kept to a minimum.

JCS is a birth cohort study that was started in Japan in AY2004. The details of the study up to 3 years of age are described in Yamagata et al. (2010). Our research group has inherited that data and continues to conduct follow-up studies, mainly on participants in Mie and Hyogo Prefectures.

Experiments on Self-regulation

What is Self-regulation?

Many experiments have been conducted to understand the process by which children develop patience. These include tasks that test their resistance to temptation, in which they are not allowed to do some indicated activity like touching an interesting toy or eating an interesting food item in front of them (ex. Harting & Kanfer, 1973) and tasks involving delay gratification, in which

they must pass up getting some interesting item immediately in order to get a bigger reward later (ex. Mischel et al., 1989).

The willpower to overcome temptation and delay or abandon the immediate satisfaction of a desire that emerges within oneself has been described via the concept of self-regulation. Studies on self-regulation have involved behavioral observation to see what kinds of strategies are effective for self-regulation and the age when children start to be able to use them. In a longitudinal study on the relationship of self-regulatory behavior in early childhood to subsequent socially adaptive behavior and educational achievement, the effect of the former was shown to persist into adolescence and adulthood (Mischel et al., 1988; Casey et al., 2011).

Position of Self-regulation in JCS

In this way, while self-regulatory behavior in early childhood is initially about patience and self-control in relation to what is directly in front of the child, it is considered to form the basis for relating to others and following the rules of society. This makes self-regulation an important factor when considering the development of sociality, which is the objective of the JCS cohort study. Therefore, the JCS incorporated experiments to observe self-regulatory behavior from the 2- to 6-year-old age range.

Currently, there are two ways to define the task for describing the development of children in a longitudinal study. One is to continue assigning the same task (to see how a child develops the ability to do something they previously could not); the other is to assign age-appropriate tasks by which some concept can be measured. In the former case (same task), the researcher records

the age where the child first completes the task successfully. In the latter case (different tasks), the researcher records whether or not the child has developed the target functionality to be measured to a level appropriate for their age. To use crawling as an example, the researcher in the former case would record the fact that the child still could not crawl at 8 months, was able to crawl along on their knees at 9 months, and crawl while lifting their knees alternately off the ground at 10 months. In the latter case, on the other hand, a record of the development of motor function would report that the child could crawl at 9 months, walk while holding on to something at 10 months, and walk at 13 months.

Let us consider an experiment on self-regulation where the task for the child is to wait for one minute without touching a toy presented to them. Conducting the experiment with 3-year-olds might yield a distribution of successes and failures, but by the age of 6, most children can be expected to succeed. However, since what we would like to confirm in this study is whether children are capable of age-appropriate self-regulation, this requires changing the task to place a similar level of burden on the 6-year-olds as the 3-year-olds—for example, by presenting the 6-year-olds with a toy that would be more interesting to them or asking them to wait longer. To facilitate comparison with previous empirical studies, the JCS cohort study refers to the procedure and experimental conditions for 5-year-olds in Mischel et al. (1989). The experiments for the 2.5-, 3-, and 6-year-olds were defined based on this experiment for the 5-year-olds. Consequently, the procedures for these ages in the JCS cohort study are original.

Method

Research Participants

Participants were among those who participated the Japan Children's Study (JCS) and consisted of (a) 154 groups of children and their caregivers who consented to being observed and studied at Mie Central Medical Center and who gave permission to use their data after the completion of the study, and (b) 59 pairs of children and their caregivers who were observed and studied at Mukogawa Women's University. The data from the 2.5-, 3-, 5-, and 6-year-olds were selected for analysis in this study. Since the experimental procedure for the experiment on self-regulation in the 2.5-year-olds was different, the results contain only the data from Mie Central Medical Center.

Of the children who were observed in JCS, six of the 2.5-year-olds, 14 of the 3-year-olds, six of the 5-year-olds, and four of the 6-year-olds were unable to begin the self-regulation experiment and so were excluded from this study. There were 72 children for whom we had complete data across all four time points.

Ethical Considerations

In the longitudinal study that contains this study, the plans for the 2.5- and 3-year-old children were subject to an ethics review by the ethics committees of the Japan Science and Technology Agency (JST) and the National Hospital Organization (NHO) Mie Central Medical Center, and the plans for the children aged 5-year-old and above were subject to an ethics review by the

ethics committees of the NHO Mie Central Medical Center and Mukogawa Women's University. Research participants also signed consent forms after they were informed of the research plan and about the protection of their personal information. The caregivers served as proxies for their children. Participants were told that they did not need to answer any questions on the questionnaire that were difficult to answer and that observation at the observation site would be interrupted at any time if the participants showed discomfort and could not complete a task.

Survey Period and Observation Sites

The self-regulation experiments were conducted from 2007 to 2012. Observations were conducted within 2 weeks before or after the children's birthdays, or 1 month before or after in the case of 5-year-olds and up. They took place at the Observation Booth at the Mie Central Medical Center and at the Observation Room at the Institute for Education, Mukogawa Women's University, both of which were soundproof rooms of the same standard, adjusted so that the position of the video cameras in either room would be roughly the same. Five cameras recorded the activity in the observation rooms, which was recorded digitally on VR777.

The total time required for the entire observation, including the self-regulation experiments in this paper, was roughly 1 to 1.5 hours. The experiments were inserted in the latter half of the entire observation period, for all ages, so that they could be conducted under conditions where the children were adequately familiar with the observation room and the instructor. However, for the 2.5- and 3.5-year-old experiments, we had the caregivers who

accompanied the children sitting somewhere out of their sight, out of consideration for children who might experience greater separation anxiety. The caregivers were instructed beforehand in writing to pass the time without actively engaging with their child.

Procedure

The details of the experiment for each age group and its running time are summarized in Table 1. The basic structure was as follows: After giving an instruction that piqued the child's interest, the instructor would say "Wait for a bit" and disappear from the child's sight. It would then be observed how the child spent the time while continuing to be presented with visual and auditory stimuli. The stimuli were changed according to the child's age.

2.5-year-olds. The child's photo was taken and printed using an instant camera or a digital camera and mobile photo printer. They were shown the photo paper just for an instant as the image was developing or becoming visible, which was then placed in a small box that they could easily open. The instructor told the child "Let's look at it together, don't touch it," and put the box somewhere that they could not easily reach.

3.5-year-olds. The instructor would take out a bag and tell the child they brought a present. They then told the child not to look in their direction because they would make another present for the child. They would then make a rustling sound behind the child's back.

5-year-olds. The instructor would put a piece of candy (Ramune candy or the child's favorite candy) on a plate, telling the child they would get another one if they could wait, and then leave

Table 1
Overview of self-regulation procedures

Age for experiment	Task	Setting	Materials	Starting prompt	Standard duration of task	Indication of task ending
2.5 years	The instructor takes a picture of the child with an instant camera, and puts the print in a box just as it starts to develop. The instructor leaves the room, after which the child is supposed to wait without looking at the print.	The instructor asks the child to sit down, takes a picture of the child with an instant camera, and puts the print in a box just as it starts to develop. The mother is instructed to sit out of the child's sight and read a sheet with instructions.	Instant camera, photo paper, box with a lid	"Sit in the chair, we'll look at it later." The instructor puts the box slightly far away (where the child cannot reach it) and leaves the room.	60 seconds.	The instructor enters the room.
3.5 years	The instructor makes rustling noises behind the seated child's back and the child is supposed to wait until the instructor signals the end of the task.	Turn the chair to face the wall and ask the child to take a seat. Tell the child "I've brought you something" and take out a bag (place the bag on a desk between the researcher and the child with the bottom of the bag toward the child). Instruct the mother to sit on the floor out of the child's sight and read a sheet with instructions.	Origami (2 ninia stars), paper bag, something plastic or paper that makes a rustling sound	"I'll make you another one, but I want to make it in secret, so can you turn the other way for me? Don't look this way until I say you can." * Remind the child to face forward every time they turn around.	60 seconds.	"Okav, all done." "Thanks for waiting."
5 years	After mother leaves the room, the instructor places a dish with candy on it on the table. The child is supposed to wait and not eat it until the instructor returns. The child will get one more if they can wait.	Mother leaves the room to go to the bathroom, etc. Prepare a table and chair, and have the child take a seat.	Plate, Ramune candy (five candies wrapped in cellophane. Use something else if the child does not like Ramune)	"I've got an errand to run so just wait until I get back. If you can't wait, you can eat the candy." "If you can wait without eating the candy, I'll bring you another one." The instructor leaves the room.	5 minutes.	Mother enters the room.
6 years	Put a hanko stamp in front of the child and show them where to stamp it. The child is supposed to wait to use the stamp.	Mother leaves the room to go to the bathroom, etc. Prepare a table and chair, and have the child take a seat. The child then draws a picture and writes their name. "Good job. There are hanko stamps here. Like these... (stamps a piece of scrap paper). Alright, I'll stamp your paper. (Stamps the paper.)" Immediately after this, someone steps in the room and says to the instructor, "Someone's on the phone for you."	Paper printed with spaces to draw pictures and spaces for stamping a hanko, scrap paper, hanko stamps (4 kinds), ink pad, pencil	"Sorry, I have to make a phone call, so just wait for a bit, okay? When I get back, you can stamp your paper with the other stamps." The instructor leaves the room.	5 minutes.	Staff enters the room. "The instructor is still busy, but you can stamp your paper."

the room.

6-year-olds. The child would draw a picture, and then put a stamp for kids on the paper. After another picture, the instructor would tell them to wait instead of stamping their paper and then leave the room.

Beginning and ending of the experiment. For the 2.5-, 5-, and 6-year-olds, the clock was started after the instructor left the room; for the 3.5-year-olds, the clock was started when the instructor gave the prompt to begin. According to the procedure, the experiments for the 2.5- and 3.5-year-olds were to be run for 60 seconds with the caregivers in the room and only the experiments for the 5- and 6-year-olds were to be run for 5 minutes; however, during the analysis, the observation times were changed based on the video camera images so that the conditions for the experiments would line up. For the 2.5-, 5-, and 6-year-olds, the observation time was changed to be until the instructor or caregiver re-entered the room, and for the 3-year-olds, it was changed to be until the children were told "Okay, you can look now."

We did not conduct experiments with, for example, children who were in a bad mood and would not leave their caregiver's side. If a child showed discomfort at any point during the experiment, we terminated it immediately. Even when children stopped being able to wait midway through, observation was continued for the rest of the allotted time as long as they could get back on task after being prompted (2.5- and 3.5-year-olds) or of their own accord. After the experiment was finished, the children were given time in which they were allowed to do whatever they wanted.

Index

During the experiments, we created a simple observational record while confirming the children's behavior from behind a one-way mirror. The record contained the experimental procedure (instructions, changes to the stimuli, etc.) and whether the children were able to wait or not. We separately extracted an index based on the recorded videocamera data after the experiments were finished. We also performed detailed behavioral coding during the experiments with the 3.5-, 5-, and 6-year-olds. The tasks were performed by trained collaborators belonging to the Mukogawa Women's University Center for the Study of Child Development.

If a child was able to wait for the entire standard running time of the experiment without engaging in the prohibited activity, this was considered to be a success in terms of self-regulation. This includes instances of "Touch-and-Go" behavior that would be difficult to consider a complete success but where the child did not necessarily deliberately look at or eat the item in question. If the child looked at or ate the item in question without being able to wait or the experiment was interrupted because the child insisted on leaving the observation room, such results were considered failures (Table 2).

We called the duration during which the children were able to exercise self-regulation the "duration of control." In successful cases, the duration of control was the standard running time of the experiment (though in some cases, there was a slight discrepancy in relation to the timer used during the experiment, and the duration of control calculated from the videocamera data was less

Table 2
Judgment of success or failure

Age for experiment	Success		Failure	
	Was able to wait	Touch-and-Go	Could not wait	Other
2.5 years	Was able to wait until instructor entered the room	Peeked at the photo (Closing a slightly ajar lid or touching the box itself did not count)	Deliberately opened the lid of the box and looked at the photo	Could not complete the experiment
3.5 years	Was able to sit still while waiting	Peeked at what the instructor was doing	Deliberately turned to see what the instructor was doing	Could not complete the experiment
5 years	Was able to wait	Turn the bag over, loosen the wrapping	Ate the Ramune candy	Shortened because the child had to go to the bathroom or could not stay in the room
6 years	Was able to wait	Stamping the scrap paper, one's hand, the container, the ink pad; or inking the stamp	Stamped their card	Shortened or could not complete the experiment

than the standard running time even though the result was successful). In the case of failures, we measured the time until the child looked at or ate the item in question or opened the door to leave the observation room.

For the behavioral coding, we started with facial expression, line of sight, hand movements, body movements, moving around, vocalizing, and added specific behavioral categories pertaining to each task (head movements for 3.5-year-olds, mouth movements for 5-year-olds, etc.). Note that while the behavioral coding categories are listed in the Appendix, this paper does not cover the aggregate results for the categories.

Results

Successes and Failures at the Four Time Points

We confirmed the details of the experiment at each time point and excluded from the analysis those instances where the experiment could not be run or the procedure was clearly different (placement of the item, running time, prompt, etc.). The results of the self-regulation experiments conducted on the 2.5-, 3.5-, 5-, and 6-year-olds with the invalid results excluded are shown in Table 3. Among the 2.5-year-olds, 78 succeeded and 16 failed; among the 3.5-year-olds, 84 succeeded and 57 failed; among the 5-year-olds, 123 succeeded and 34 failed; and among the 6-year-olds, 129 succeeded and 37 failed.

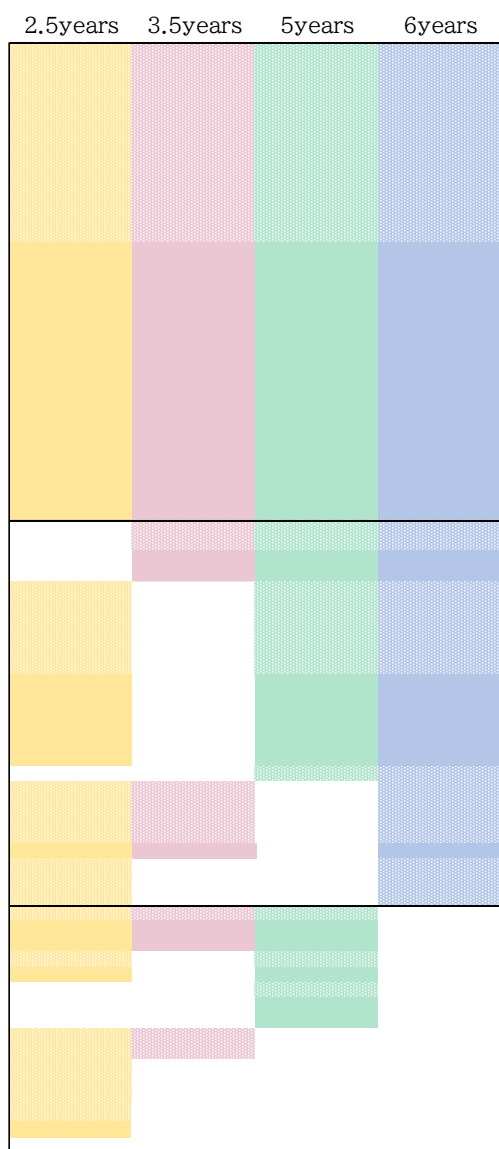
Next, of the 72 children (38 boys, 34 girls) for whom we had the same experimental conditions at all four time points, 31 (13

Table 3
Results of the self-regulation experiments and duration of control

Result	Age for experiment							
	2.5 years*		3.5 years		5 years		6 years	
	behavior	<i>n</i>	behavior	<i>n</i>	behavior	<i>n</i>	behavior	<i>n</i>
succeeded	Did not look inside until instructor entered the room	78	84	123	129			
		boys :38 girls:40	boys :34 girls:50	boys :61 girls:62	boys :62 girls:67			
failed	Opened the box and looked inside	16	57	34	37			
		boys :7 girls:9	boys :36 girls:21	boys :22 girls:12	boys :24 girls:13			
	Duration of Control (sec.)	<i>Mean</i> (SD)	<i>Mean</i> (SD)	<i>Mean</i> (SD)	<i>Mean</i> (SD)			
		23.64 (13.86)	23.40 (18.09)	122.63 (87.39)	114.07 (89.99)			
non-conformance		37	8	7	0			
not conducted		6	16	7	4			

*: Mie-cohort group only.

Figure1
Three groups divided by the results of the self-regulation tasks.



Coloured=succeeded, white=failed.
Pale coloured=boys, dark coloured=girls.

boys, 18 girls) were able to exercise self-regulation at all four time points. Of the remaining children, there was one child (a girl) who failed at all four time points. Forty children (25 boys, 16 girls) had a mixture of successes and failures. Theoretically, there are 14 possible combinations of successes and failures, but only 11 occurred in reality.

Duration of Control

The mean duration of control was 23.64 ± 13.86 seconds among the 2.5-year-olds; 23.40 ± 18.09 seconds among the 3.5-year-olds; 122.63 ± 87.39 seconds among the 5-year-olds, and 114.07 ± 89.99 seconds among the 6-year-olds.

Summary

The results show that 43% of the children were

consistently capable of self-regulation at a level appropriate for their age. This indicates that the development of self-regulatory behavior is not something that is suddenly completed at the age of 5, but rather that roughly half of all children become progressively capable of self-regulatory behavior as they grow up, although many children show some instability in this regard, sometimes being capable of self-regulation and sometimes not depending on their age or the task.

These experiments on self-regulation were set up so that the results on the 5-year-olds could be compared with the series of results in Michael et al. (1989). However, it has recently been pointed out that the experiments by Michael et al. lack reproducibility as they did not control for variables like the home environment (Watts et al. 2018), which is something that ought to be paid attention to in future analyses.

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APPENDIX

Table of codes

Age	Category	Code	Definition	
3.5 years	Baby Face (bf)	po	Positive emotion such as laughter/smile	
		nega	Negative emotion such as anger/disgust	
		fr	Unease	
		neut	Neutral expression	
			oth	Other
			ob	Look at the object
			s.c	The child's body
			te	Tester
		Baby Gaze (bg)	ro	Direct one's gaze toward somewhere in the room (including the cameras or door)
			mo	Look toward one's mother
			clo	Shut or cover one's eyes
			m_w	Look at a window or the mirror
			oth	Other
		Baby Hand (ha)	ob	Touch/grab the object
			ch	Hit the chair or one's own body
			s.c	Touch/grab one's own body or clothes (Including sucking one's thumb, covering one's eyes, plugging one's ears)
			c_f	Touch the chair or floor
			inhi	Restrain one's hand
			oth	Other (camera, window, wall, mother, etc.)
		Baby Body (bb)	move	Moving one's head, body; swinging one's arms/legs; standing up and sitting back down
			oth	Dummy code for when the child is moving around
		Move (mo)	m_a	Getting up (running around, lying down, sitting on the floor, etc.)
			m_m	Go to one's mother
	no		Self-regulatory utterance	

5 years	Baby Vocal (bv)	t_m	Utterance to the observer or mother
	Baby Head (he)	look	Turn around and look
		gla	Glancing (lying on one's side), peeping, glancing at mother
		oth	Dummy code for when the child is moving around
	Tester Vocal (TV)	tv	Utterance to the child (reminders, etc.)
	Baby Face (bf)	po	Positive emotion such as laughter/smile
		ne	Negative emotion such as anger/disgust
		cry	Cry
		fun	Make a funny face or strange face
		neut	Neutral expression
		anxi	Anxiety
		oth	Other
	Baby Gaze (bg)	ob	Candy (including the wrapper after eating the candy)
		pl	Plate
		clo	Shut or cover one's eyes (including putting one's face down on the desk)
		oth	Other
	Baby Hand (ha)	ob	Touch/grab the object (candy)
		pl	Touch/grab the plate
ta		Touch/hit the desk	
oth		Touch/grab something else (including door, window, camera, chair, wall, etc.)	
unpa		Open or turn over the wrapper	
Baby Hand (ha)	w	Close the wrapper	
	s_c	Touch/grab one's own body or clothes (Including sucking one's thumb, covering one's eyes)	
	inhi	Restrain one's hand (including resting one's chin on the desk, putting one's hand underneath the desk [in one's lap, etc.], or restraining one's hand by sitting on it, putting it behind the chair, or holding it with the other hand)	

6 years	Baby Body (bb)	move	Moving/swinging one's head, body, legs; standing up and sitting back down
		oth	Dummy code for when the child is moving around
	Move (mo)	m_a	Getting up (running around, lying down, sitting on the floor, etc.)
	Baby Vocal (bv)	no	Self-regulatory utterance
		t_m	Utterance to the observer or mother
		cry	Cry, whine
	Baby Mouth (bm)	eat	Eat
		lick	Lick
		sm	Smell
		mo	Put in mouth
		po	Positive emotion such as laughter/smile
		ne	Negative emotion such as anger/disgust
	Baby Face (bf)	cry	Cry
		fun	Funny face
		neut	Neutral expression
		anxi	Anxiety
		oth	Other
	Baby Gaze (bg)	ob	Hanko, ink pad, container (any of the contents)
		pa	Paper
		pen	Pencil
		clo	Shut or cover one's eyes (including putting one's face down on the desk)
		oth	Other
	Baby Hand (ha)	t_st	Touch the hanko
		t_pi	Touch something near the object (ink pad, pencil)
		oth	Touch/grab something else (including door, window, camera, chair, wall, etc.)
		s_c	Touch/grab one's own body or clothes (Including biting one's nails, sucking one's thumb, covering one's eyes)
	inhi	Restrain one's hand	
Baby Body (bb)	move	Moving one's head, body, or legs back and forth; swinging one's arms, standing up and sitting back down	

	oth	Dummy code for when the child is moving around
Move (mo)	m_a	Getting up (running around, lying down, sitting on the floor, etc.)
Baby	no	Self-regulatory utterance
Vocal (bv)	t_m	Utterance to the observer or mother
	cry	Cry, whine
Baby	lick	Lick
Mouth (bm)	sm	Smell
	mo	Put in mouth, nibble
	dr	Draw a picture
Baby Behavior (bbe)	st-p	Stamp the actual paper
	st-o	Stamp something else (scrap paper, box, hand, ink pad)