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THE ADULT-CHILD DYAD AS A PROBLEM-SOLVING SYSTEM: AN EXPERIMENT WITH ONE BILINGUAL INDONESIAN CHILD

Rentauli Mariah Silalahi[1]
[1)]Institut Teknologi Del, Samosir, SUMATERA UTARA
rentaulisilalahi@gmail.com[1]

ABSTRACT

This study tries to reveal how the transition from interpsychological to intrapsychological functioning happens in an adult-child dyad's activity involving a 3.6 year-old-child and the child's mother. The study explores how the adult and child divided up the strategic responsibilities for carrying out a problem-solving task of completing a puzzle. The experiment, which took place in the child's living room and lasted for 48 minutes, was videotaped and observed while all utterances by the adult and child were transcribed verbatim. Coding was done in order to note information showing the gaze behavior, interventions from the adult, and episodes for each correct match. Thematic analysis was chosen as the method to analyze the transcripts in order to find meaningful patterns. The study found that the adult's intervention is important in the early stage of the joint-problem activity while, when the child takes more responsibility and develops some strategies as the child becomes more self-regulated, the adult's role in scaffolding decreases. There is a transition from the interpsychological to intrapsychological functioning in the adult-child dyad while gazes towards the played cards outweigh the role of gazes towards other objects.

Keywords: adult-child dyad, zone of proximal development, interpsychological, intrapsychological, gaze behaviour, scaffolding

Introduction

The concept known as Zone of Proximal Development (ZPD) was firstly introduced by Vygotsky in his book entitles *Mind in Society* (Vygotsky, 1978). ZPD is an abstract measure as 'the concept of ZPD was created by Vygotsky as a metaphor to assist in explaining how social and participatory learning takes place' (John-Steiner & Mahn, 1996, cited in Daniels, 2001, p. 56). Vygotsky said:

> An essential feature of learning is that it creates the zone of proximal development; that is, learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers. (Vygotsky, 1978, p. 90)

In his book, Vygotsky defined Zone of Proximal Development as:

> The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

That indicates that there is negotiation happening in the learning process involving both the child and the more knowledgeable others. Vygotsky's idea on ZPD shows 'the dynamic region of sensitivity in which the transition from interpsychological to intrapsychological functioning can be made' (Wertsch, 1985, p. 67) in oneself as Vygotsky explained:

> Every function in the child's cultural development appears twice, on two levels. First on the social, and later on the psychological level; first *between* people as an *interpsychological* category, and then inside the child, as an *intrapsychological* category. (Vygotsky, 1978, p. 128)

The more knowledgeable others (KMO) in social interaction are the persons who assist the child. The demonstration of the role of the adults in giving response to the child's needs is understood as scaffolding with the adults' regulation contingent in the child's actions as the adult's assistance will be 'more explicit following children's incorrect activity and less explicit following the children's correct activity' (Pacifici and Bearison, 1991, p. 266, Hoogsteder, 1996, Part and Cowan, 1988). Wood

et al. (1976, p. 90) defined scaffolding as 'sensitive, supportive intervention of a more expert other in the progress of a learner who is actively involved in some specific task' (Mercer and Littleton, 2007, p. 18) that enables the learner to 'solve a problem, carry out task or achieve a goal which would be beyond his unassisted effort' (Wood et al., 1976, p. 90). Wood et al. (1976) added that in the process, the more expert other controls 'those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence' (p. 90).

Language plays an important role throughout the learning processes from interpsychological to intrapsychological categories. It is a psychological tool or sign (Wertsch, Cole, & Daniels, 2007) that functions to 'direct the mind and behavior' (Daniels, 2001, p. 15). Language is the fundamental means of mediation in all Vygotsky's work (Daniels, 2015; Wertsch, Cole, & Daniels, 2007) and is 'considered the most important cultural tool' (Mercer and Littleton, 2007, p. 13) as language is composed of words that have meanings in which Vygotsky viewed to symbolize 'not only as a unity of thinking and speech, but as a unity of generalization and social interaction, of thinking and communication' (Minick, 1987, p. 45). Language enables collaborative interaction and 'only subsequently, upon conversion to internal speech, does it come to organize the child's thought, that is, *become an internal mental function'* (Vygotsky, 1978, p. 89).

Gazes are also important factors in the learning process from interpsychological to intrapsychological categories. There have been several studies conducted investigating the importance of gazes at the model in a puzzle problem-solving task in adult-child dyadic interactions whose analysis show the relationship between interpsychological and intrapsychological functioning. Among them are the studies by Wertsch, James V; McNamee, Gilian Dowley; Mclane, Joab B; Budwig (1980), Pacifici and Bearison (1991), Nilholm and Säljö, (1996), and Zuckerman (2007). This current study looked closely at Wertsch et al.'s (1980) as preference in doing a quite similar experiment.

The study by Wertsch et al. (1980) entitles *The Adult-Child Dyad as a Problem-Solving System* shows an example of 'how strategic problem-solving activities are carried out by children in collaboration with adults … to understanding how the child will later function as an independent

cognitive agent' (p. 1215). Their study involved a task for the children to complete a puzzle to resemble a cargo model. Wertsch et al. (1980) argued:

> Before the child is able to function as an independent (i.e., self-regulated) problem solver, the adult in the adult-child dyad functions to plan, regulate, and reflect on the problem solving at hand. Instead of having a single individual who is responsible for planning and monitoring the strategies for reaching a goal and for carrying out the behaviors involved, these responsibilities are divided up between two individuals who function in an integrated social system. (p. 1216)

In their study using three groups of six dyads based on the child's age, Wertsch et al. (1980) considered the instances children consulted the model important. They did quantitative analysis towards the instances of the children's gazes at the model either through self-regulation or other-regulation in order to make comparisons among the groups. Their data comprised of the mean and standard deviation of episodes of puzzle completion, gaze at the model and at model per cargo episode, proportion of gazes at the model which were other regulated, proportion of instances when adult intervened between other- and self-regulated gaze at the model, and correct insertion of cargo square.

They found that different groups of children understood differently 'of the strategic significance of this gaze behavior' (p. 1221) in which contrary to younger children, they found that the older children could use the information from the gaze to insert the cargo pieces correctly without further assistance from the adult. Through the structured adult-child interaction, Wertsch et al. (1980) found that the cognitive processes 'are carried out on what Vygotsky called the interpsychological plane before they appear on the intrapsychological plane' (p. 1221).

Their study also shows what Vygotsky meant about assistance and development. Vygotsky said it is not 'the competence per se of the more knowledgeable person that is important; rather, it is to understand the meaning of that assistance in relation to a child's learning and development' (Chaiklin, 2003, p. 43), and it is not 'the development of skill of any particular task, but must be related to development' (Chaiklin, 2003, p. 43) as 'the focus of change within the ZPD should be on the

creation, development and communication of meaning through the collaborative use of mediational means rather than on the transfer of skills from the more to less capable partner' (Moll, 1990 cited in Daniels, 2001, p. 60).

Understanding that the concept of Zone of Proximal Development is a metaphor and that 'it is the dynamic region of sensitivity in which the transition from interpsychological to intrapsychological functioning can be made' (Wertsch, 1985, p. 67) as 'a child can always do more with the help of more competent persons than she or he can do alone' (Hedegaard, 2012, p. 128) , this study did an experiment almost similar to Wertsch et al.'s (1980) study of adult-child dyad. The experiment involved one Indonesian child as participant; a 3.6 year-old-child and one adult who is the mother of the child; who is also an Indonesian and played the role of the more knowledgeable other. The child and adult speak both English and Indonesian language. This study intends to give new insight to the context of Indonesian adult-child dyad as there is scarcely any similar study conducted observing bilingual Indonesian adult-child dyad using puzzle as a media. This study tries to reveal how the transition from the interpsychological to intrapsychological functioning happens in the adult-child dyad' activity.

Though having only one adult-child dyad, this analytical procedure follows Wertsch et al.'s (1980) study as the research interest is in the importance of gaze behaviors. In this study of adult-child interaction in problem-solving, the researcher represents the object and task setting as what Wertsch (1984) called 'object-to-be-used-in-the-copy-because-of-the-presence-of-a-corresponding-piece-in-the-model' (p. 9) which means the researcher considers consulting the model important in order to complete the puzzle; indicated by gazes.

Like Wertsch et al.'s (1980) study, this study was carried out based on an interest in investigating the way that the adult and the child divided up the strategic responsibilities for carrying out a problem-solving task which involved doing a puzzle by following a model. The strategy refers to is looking at the model or as Wertsch called it eye gazes that can be initiated by the adult (other-regulated) or the child (self-regulated). This study intended to answer the following two questions:

1. What are the least and most significant objects of gazes that help the child complete the puzzle?
2. How does the transition from the interpsychological to intrapsychological functioning happen in the adult-child dyad experiment?

Research Method

This qualitative study used observation to an adult-child dyad experiment; the child is 3.6 years old girl. Although numbers are found in the analysis, they are used as supportive data to the qualitative data analysis. The material used for the joint problem-solving interaction is a puzzle. The puzzle consists of 42 cards and is commercially designed for children age 4. The puzzle was chosen as a tool because the child has prior knowledge doing puzzles on an electronic puzzle board. Those puzzles on the electronic board have nine big pieces of cards that must be touched and dragged to match. Knowing the child's maturing function in doing puzzles encouraged the researcher to do this study by choosing a card puzzle designed for children above the child's mental age as 'there is little point in teaching aimed below the bottom of the ZPD because the child's functioning here is already mature, or in teaching aimed above the top of ZPD, because the difference from the child's actual present functioning may be too great'(Meadows, 2018, p. 110).

The experiment lasting for around 48 minutes is carried out in the living room of the child's home and is videotaped using a video recorder positioned in a place that enables it to capture all the gaze behaviors. The task involves using the model of the puzzle as a guide to select the cards from the pile of the puzzle cards and match them to result in the same picture as the model. The model which is a picture of some characters from a children's movie called 'peppa pig' was placed near the mother and the child so that they can consult it anytime during the collaborative work. During the activity, the adult only provides help when she thinks the child needs it. For ethical concerns, during the analysis, letters C and A are used to refer to the child and the adult respectively. Further, as the experiment involves a child, the researcher collects a consent form from the child's parents.

Thematic analysis is chosen as a method to analyse the transcripts in order to find something meaningful, the patterns or themes, within data concerning the research questions (Braun & Clarke, 2006). Using thematic analysis, the researcher can actively and reflectively engage with data to identify meaningful themes through the lens of an interpretivist paradigm. As Vygotsky's concept of zone of proximal development is used to develop this study, the author intends to use the theoretical thematic analysis and semantic approach (Braun & Clarke, 2006). In order to address the research questions, all utterances by the adult and child are transcribed verbatim. Coding was also done in order to note information showing the gaze behaviors, interventions from the adult and episodes for each correct match. The gaze behaviors are coded to show those that are done by self-regulated and other-regulated at several directions that the adult and child find useful to assist the child in completing the task in the collaborative work with the adult.

However, before presenting the data, the definition of some terms used following Wertsch et al.'s (1980) study is provided although it may sound simplified for this study. Firstly, an episode means 'the segment of interaction centered around one piece of the puzzle. It included the adult's and the child's speech and actions concerned with identifying the piece to be used (by consulting the model), selecting the piece from the pieces pile, and inserting it into the copy' (p. 1218). Secondly, other-regulated gaze behavior means the child's activity of gazing as preceded by the adult as the adult withdraws the child's attention by several ways like pointing and making complete utterances to explicitly or implicitly withdraw the child's attention to what the adult wants the child to gaze. Finally, self-regulated gaze behavior refers to the child's activity of gazing by her own will which is not preceded by the adult's activity of drawing the child's attention like in the other-regulated gaze.

Results and Discussion

The least and most significant objects of gazes that help the child complete the puzzle

The following table presents all information collected from observing the video, which is important for the analysis.

Table 1. Information related to gazes and episodes

Measure	Total number
Puzzle episodes completed	43
Gazes at the model which were self-regulated	4
Gazes at the model which were other-regulated	2
Instances when the child did self-regulated gaze at the model which resulted in a correct match of the puzzles without intervention from the adult	3
Instances when the child did other-regulated gaze at the model which resulted in a correct match of the puzzles without intervention from the adult	1
Instances when the adult intervened between self-regulated gaze at the model and correct match of the puzzle cards	1
Instances when the adult intervened between other-regulated gaze at the model and correct match of the puzzle cards	1
Instances when the adult intervened between self-regulated gaze at the played cards and correct match of the puzzle cards	8
Instances when the adult intervened between other-regulated gaze at the played cards and correct match of the puzzle cards	6
Instances when the adult intervened between self-regulated gaze at the card in the child's hand and correct match of the puzzle cards	3
Instances when the adult intervened between other-regulated gaze at the card in the child's hand and correct match of the puzzle cards	1
Instances when the adult intervened between self-regulated gaze at the pile of the puzzle cards and correct match of the puzzle cards	1
Instances when the adult intervened between other-regulated gaze at the pile of the puzzle cards and correct match of the puzzle cards	1
Instances when the adult intervened and the child can match the cards correctly	22

Measure	Total number
Instances when the adult did not intervene, and the child can match the cards correctly	21

The data shows that there are four objects of gazes found that help the child during the puzzle completion including gazes at the model, played cards, card in the child's hand, and pile of the puzzle cards. However, the child only gazes at the model through self-regulation for four times and with other-regulation for two times, which are less than the number of gazes at the played cards. Unlike Wertsch et al.'s (1980) study that found gazes at the model effective in assisting the child to complete the puzzle, in this study, it turns out that the child's gazes at things other than the model like the pile of the puzzle cards, the card in the child's hand, and the played cards are also important.

Interestingly, gazes at the played cards become more significant of all as it was discovered that the number of the child's gazes at the played cards was significant and outweighed the rest. Therefore, gazes at the model, card in the child's hand, and pile of the puzzle cards become less significant factors helping the child to complete the puzzle as there are only six, four, and two instances respectively. Meanwhile, gazes at the played cards become the most significant factor helping the child to complete the puzzle as the correct matches resulted from the gazes at the played card is fourteen. However, as the data shows, with intervention from the adult after other- or self-regulated gazes at either the model, the pile of the cards, the card at the child's hand, or the played cards, the child could match the cards correctly in 22 episodes. It indicates that intervention from the adult helps the child to do the puzzle completion in the joint-meaning making activity.

The following extract shows how the child gazes at the model through self-regulation although shortly after the child's action, the adult asks the child to look at the model. After the intervention from the adult, the child understands what to do and makes a correct match.

Table 2. Gazes at the model through self-regulation

Minute	Person		Speech	Note
04:00	C	:	This. Alright. Peppa pig.	C gazes at the model through self-regulation.
04:31	A	:	No, look at this picture.	A asks C to look at the model just after C just did.
04:40	C	:	Boat?	C gazes at the model again through self-regulation.
04:55	A	:	Don't worry about that, put another. Put another similar picture.	A gives direction for C to find another card that can be matched to the played cards.
05:02	C	:	No, this one. Daddy pick *di sini, di belakang.* Ah. See!	C matches the cards correctly after the intervention from the adult. (*di sini* = here; *di belakang* = behind)

Meanwhile, the following extract shows how the child gazes at the model as a result of other-regulation. It also shows how the adult continues withdrawing the child's attention to gaze at the played cards and the pile of the puzzle cards, which eventually results in the correct match of the cards.

Table 3. Gazes at the model, played cards and pile through other-regulation

Minute	Person		Speech	Note
07:30	A	:	Maybe it's another one, can you find another one. Look! It is missing… What… the… here… find something like this here. The same color, the same color.	C gazes at the model through other-regulation; to a particular part A points. C also gazes at the played cards and the pile of the

Minute	Person	Speech	Note
		Is that the same color? Is that the same color? Ehem… Find the same color.	puzzle cards which A points.
		You can try… Ya, fix it. Good girl.	C firstly chooses a card to match into the played cards but fails. Later, when A says 'Is that the same color?' C stops her attempt, drops the card, picks a different card from the pile, and matches it to the played cards successfully.

The transition from interpsychological to intrapsychological functioning

During the 43 episodes, the observation revealed that the child was moving from other-regulation to self-regulation. As shown by Figure 1 below, the child moved from other-regulated gaze (indicated by the blue color) to more self-regulated gaze (indicated by the orange color) from the middle to the end of the interaction. It shows how the scaffolding happens in which the role of the adult is decreasing with the child taking more responsibility for the problem-solving task.

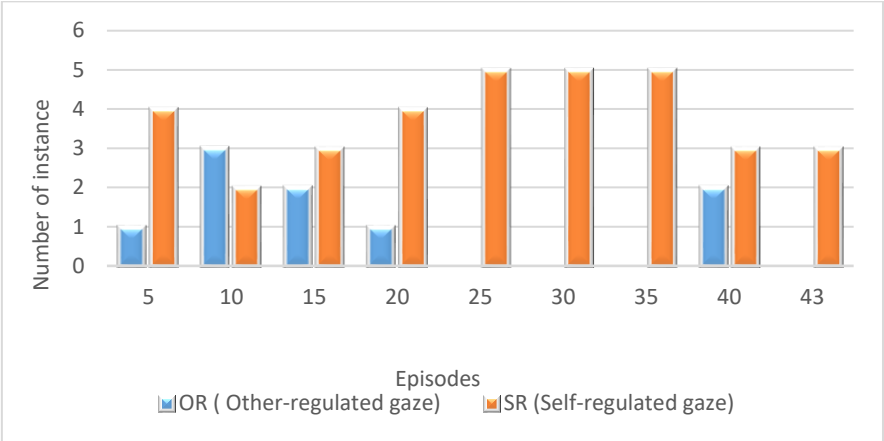

Figure 1. The pattern of the gazes from other-regulation to self-regulation

The following extract shows some of the instances in which the child develops some strategies as she becomes more self-regulated from episode thirteen onwards.

Table 4. Instances when C develops a strategy as she becomes more self-regulated

Minute	Person		Speech	Note
22:34	C	:	This, maybe this one. Nope. Maybe this one. No.	Through self-regulation, C gazes at the played cards and makes several attempts to match the cards she picks.
29:33	C	:	Maybe this one. This.	C does self-regulated gazes at the pile of the cards and the card at her hand.
29:34	A	:	Ehem…	
29:35	C	:	This.	C uses rotating strategy to match the cards successfully.
29:45	A	:	Okay, great.	

Before the transition from interpsychological to intrapsychological functioning happens, the adult's intervention in the joint-problem solving activity is necessary. The extract in table 2 above is the instance when the child completes one episode with the adult's intervention after self-regulated gazes as there is only one instance for that event. Meanwhile, the following extract shows the instance when the child completes one episode with the adult's intervention after other-regulated gaze.

Table 5. Correct match after other-regulated gaze and intervention from the adult

Minutes	Person		Speech	Note
37:38	A	:	Alright! If it is not, then it is a different one. Okay, hurry up. Maybe it is a different one. Can you find a same…?	A assists C by giving direction for what C can do to match the cards.
			Look! Is there any circle here, missing circle here… again. Turn around, turn around, again, turn again, turn again, turn again…	Through other-regulation, A withdraws C's attention to the model.
			Good girl! Okay… Okay… (*clapping hand*) Good girl!	A gives further intervention by telling C to rotate the card, which eventually results in the correct match.

Further, the following extracts are some examples that present those instances where the child matches the cards successfully with intervention from the adult either after self- or other-regulated gaze.

Table 6. Gazes at the played cards, the pile of the cards, and the card at the child's hand

Minute	Person		Speech	Note
03:46	A	:	Is the picture same?	
03:47	C	:	Ye… No.	
04:00	C	:	This…	
04:23	C	:	Alright…	Through self-regulation, C gazes at the pile of the cards and chooses one card. She then matches the card to the played cards correctly.
09:43	A	:	Look! Look! Mmm… this is a head. Find the missing head, find the missing head and the face. Aha! Excellent!	Through other-regulation C gazes at the played card and with intervention; A's instructions, C can match the cards correctly.
18:01	C	:	This.	With self-regulation C gazes at the played cards.
18:02	A	:	Ehem.	
18:03	C	:	The ears.	
18:04	A	:	Alright.	
18:07	C	:	This maybe the ears.	
18:10	A	:	Look at the picture. What is that? What picture is the one you are holding?	With other-regulation, C gazes at the card in her hand.
18:16	C	:	This. This.	C understands the meaning of the assistance; A's questions.

Minute	Person		Speech	Note
18:24	A	:	Mmm... What is that? Mmm… See! You can make it.	C matches the cards successfully.

Furthermore, the 21 instances presented in table 1 showing the child matches the cards correctly without intervention from the adult indicates that the child for several times has taken responsibility from the strategic problem-solving activities. It indicates the child's internalization of the social activity which shows what Vygotsky meant when he said 'development moves from the social to individual' (Rogoff, 1990, p. 144) and that cognitive processes 'are carried out on what Vygotsky called the interpsychological plane before they appear on the intrapsychological plane' (Wertsch, James V; McNamee, Gilian Dowley; Mclane, Joab B; Budwig, 1980, p. 1221).

Overall, language plays an important role as a media of communication during the collaborative work which also helps the child understand the meaning of assistance given. It indicates the importance of language as a psychological tool during the joint-meaning making activity (Wertsch, Cole, & Daniels, 2007) that helps the process of negotiation as the child tries to perceive the meaning of the assistance provided by the adult.

Conclusion

The experiment that shows with an adult's assistance, a child can do a problem-solving task to create a picture similar to the model of a puzzle indicates that doing the 42 cards puzzle designed for children age four is still within the dyad's potential development. It also shows that 'a child can always do more with the help of more competent persons than she or he can do alone' (Hedegaard, 2012, p. 128).

Unlike one of the findings from Wertsch et al.'s (1980) study that found younger children; the 2½ and 3½-year-old groups still could not make meaning from the gazes towards the model, this experiment shows the contrary. In this study, the 3.6-year-old child seems to understand the meaning of the assistance as the child can match the cards correctly for

three out of four times of her self-regulated gazes at the model without intervention from the adult. It shows what Vygotsky meant saying it is not 'the competence per se of the more knowledgeable person that is important; rather, it is to understand the meaning of that assistance in relation to a child's learning and development' (Chaiklin, 2003, p. 43).

Interestingly, unlike Wertsch et al.'s (1980) study that considered gazes at the model very significant in the joint problem-solving activity, this study found that gazes at the played cards outweighed the importance of gazes at the model. The number of successful matches of the cards resulted from gazes at the played cards are more than the successful matches resulted from gazes at the model; fourteen and six times respectively. The study found that the pile of the puzzle cards was the least significant object contributing to helping the child complete the puzzle while on the contrary the played cards played the prominent role.

While this experiment has proven that there is transition from the interpsychological to intrapsychological functioning in the adult-child dyad, the findings showing how the transition happens and the number of instances found in this experiment may not be generalized to other bilingual Indonesian adult-child dyad for each child has differences in understanding the meaning of assistance given to them during any joint-meaning making activity. Following the findings, however, comparative studies can be done for investigating the transitition from the interpsychological to intrapsychological functioning in the adult-child dyad with more varied samples and more varied joint-meaning making activities.

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