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Delayed self-recognition in children with autism spectrum disorder

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Abstract

This study aimed to investigate temporally extended self-awareness (awareness of one's place in and continued existence through time) in autism spectrum disorder (ASD), using the delayed self-recognition paradigm (DSR; Povinelli, Landau, & Perilloux, 1996). Relative to age and verbal ability matched comparison children, children with ASD showed unattenuated performance on the DSR task, despite showing significant impairments in theory-of-mind task performance, and a reduced propensity to use personal pronouns to refer to themselves. The results may indicate intact temporally extended self-awareness in ASD. However, it may be that the DSR task is not an unambiguous measure of temporally extended self-awareness and it can be passed through strategies which do not require the possession of a temporally extended self-concept.

Keywords: Autism spectrum disorder; metarepresentation; self-awareness; self-concept; self-recognition; theory-of-mind.

Delayed self-recognition in children with autism spectrum disorder

A number of studies, using a variety of paradigms, suggest that aspects of self-awareness are diminished and/or atypical in autism spectrum disorder (ASD). For instance, individuals with ASD have difficulty identifying and reflecting on their own mental states (Frith & Happé, 1999), as well as their own emotions (Ben Shalom, Mostofsky, Hazlett, Goldberg, Landa, Faran, McLeod, Hoehn-Saric, 2006; Gaigg & Bowler, 2008; Hill, Berthoz, & Frith, 2004). At a more basic level, a specific difficulty amongst children with ASD with using personal pronouns such as "me" and "you" to label self and others suggests a diminished ability to explicitly differentiate themselves from other selves (Jordan, 1989; Kanner, 1943; Lee, Hobson, & Chiat, 1994).

However, not all aspects of self-awareness are impaired in ASD. Many have argued that the "litmus test" of explicit, conceptual self-awareness is mirror self-recognition (Amsterdam, 1972; Gallup; 1970). The mirror self-recognition task involves covertly marking a child's face with a spot of rouge and then presenting them with a mirror. An objective representation of self is ascribed to any child who touches the rouge upon seeing their reflection. Typically developing children pass this task at approximately 18 months of age (Anderson, 1983; Courage, Edison, & Howe, 2004; Lewis & Ramsey, 2004) and a number of studies have demonstrated that children with ASD are capable of mirror self-recognition at a mental age of 18 months (Dawson & McKissick, 1984; Ferrari & Matthews, 1983; Neuman & Hill, 1978; Spiker & Ricks, 1984). This demonstrates that children with ASD detect the equivalence between the currently perceived mirror self-image and their represented bodily self-image (Povinelli,

2001). Thus, even relatively developmentally immature children with ASD appear to possess accurate mental representations of what they look like – they have *own-body* concepts (but see Hobson, 1990; Loveland, 1993; and Mitchell, 1997, for alternative explanations).

Further suggesting that individuals with ASD are aware of their physical selves, Williams and Happé (in press) found that children with ASD could successfully discriminate between internally and externally caused changes in their perceptual experience. These results suggest that individuals with ASD are self-aware of their agency. Thus, although some aspects of self-awareness are atypical in ASD, at least some elements appear to be intact. However, a relatively under-researched question is whether individuals with ASD show *temporally extended* self-awareness.

Temporally extended self-awareness involves awareness of one's place in and continued existence through time (see Moore & Lemmon, 2001). It is what allows me to recognise that "I am the same self that I was yesterday" (James, 1890/1950, p.332), providing a sense of personal continuity through time. Temporally extended self-awareness is likely to depend on certain representational abilities as well as aspects of temporal understanding. The fact that the temporally extended self-concept incorporates multiple representations of past, present, and future states of self suggests that it takes the form of a metarepresentational structure (Povinelli, 2001). Metarepresentation enables an individual to entertain multiple, and possibly contradictory, representations of the same object or event, and understand them as (alternative) representations of that object or event (Perner, 1991). In relation to temporally-extended self-awareness, metarepresentation may allow one to "organise previous, current and future

representations [of self] under a temporally extended metaconcept of 'me'" (Povinelli, 2001, p.87). Through metarepresentation, therefore, alternative representations of self could be understood *as* alternative instances of a single self that persists through time.

Temporally extended self-awareness may also presuppose a concept of the "causal arrow of time" – a conception of time as a sequence of chronologically ordered, causally related episodes (Povinelli, Landry, Theall, Clark, & Castille, 1999). Metarepresentation allows one to represent multiple states of self from different time points. However, a degree of temporal understanding may be required to understand the temporal-causal connections between these states of self, and this is essential for temporally extended self-awareness.

Given the possible cognitive underpinnings of temporally extended self-awareness, there are grounds for predicting that individuals with ASD will have attenuated temporally extended self-awareness. For example, it is established that children with ASD have difficulties with metarepresentation (e.g., Happé, 1995) and with aspects of temporal cognition (Boucher, Pons, Lind, & Williams, 2008). Boucher et al. found that children with ASD were significantly impaired in their ability to represent and understand changes over time. Specifically, they found that children with ASD had difficulty (a) with envisaging the past and future stages of a current situation, (b) with representing qualitative changes across time, and (c) with representing a series of subordinate events as comprising a unified whole event spanning the component stages. Accordingly, children with ASD may be less able than children without ASD to consider multiple, alternative representations of the self from different time points and to

understand the temporal-causal relations among these past, present and future states of self, resulting in diminished temporally extended self-awareness.

In typical development, temporally extended self-awareness has been assessed with the delayed self-recognition (DSR) paradigm (Povinelli, Landau, & Perilloux, 1996). In this test, the experimenter and child are filmed playing a distractor game, during which the child is patted on the head in praise. Whilst praising the child, the experimenter covertly places a large sticker on top of their head. After a delay of three minutes, the pair watch the recording of the distractor game, including the sticker placement, and the child's reaction is assessed. Successful performance, like mirror self-recognition, involves mark-directed behaviour – reaching up to touch or remove the sticker.

The test is supposed to establish whether the child understands the temporal-causal relation between their "past self" (represented on the screen) and their "present self" (currently watching the video image). According to this logic, individuals who possess a temporally extended self-concept should expect the sticker to be on their head *here-and-now* (i.e., when watching the video recording) not just *there-and-then* (i.e., in the video recording). Typically developing children pass the task at around 4 years of age (Povinelli et al., 1996; Suddendorf, 1999; Zelazo, Sommerville, & Nichols, 1999), during the same developmental period in which metarepresentation (Perner, 1991) and an understanding of the causal arrow of time (Povinelli et al., 1999; McCormack & Hoerl, 2007) emerges. During the DSR task, children are also asked to name their video image. Children below 4 years of age show a greater tendency to label their image using their

proper name rather than the pronoun “me”, and this tendency is associated with failing to show mark-directed behaviour (Povinelli et al., 1996).

The aim of the current study was to assess temporally extended self-awareness in ASD using the DSR paradigm. There has been one previous investigation of DSR in ASD, summarised in a book chapter by Nielsen, Suddendorf and Dissanayake (2006). A sample of 15 children with high functioning ASD and 15 mental age matched comparison children aged 5 to 9 years was assessed. Whilst all of the comparison children passed the task, 83%[1] of the children with ASD were found to pass. However, no statistics or methodological details were reported making interpretation of these results difficult.

On the basis of previous research, indicating ASD-specific impairments in metarepresentation and temporal cognition, it was predicted that children with ASD in the present study would show diminished performance on the DSR task. It was also predicted that children with ASD would show an increased propensity to use their proper names as opposed to the pronoun “me” to label their video self-images. Previous research has indicated that even fairly verbally able children with ASD show an elevated tendency to use their proper names when naming photographs (Lee et al., 1994). The same pattern is, therefore, likely to apply to video images. Finally, the relation between performance on the DSR task and a false belief task was explored, since both are thought to rely on the capacity for metarepresentation.

Method

Participants

Approval for this study was obtained from the appropriate university ethics committee. Participants were recruited through schools located in South-East England. The parents of all participants gave their informed, written consent for their children to take part.

The ASD and comparison groups each consisted of 30 participants who were individually matched on chronological age (CA) and verbal mental age (VMA), as assessed with the British Picture Vocabulary Scale (Dunn, Dunn, Whetton, & Burley, 1997). Participant characteristics are presented in Table 1.

[Place Table 1 about here]

The groups did not differ significantly in terms of VMA, $t(58) = -0.13$, $p = .90$, $r = .02$; CA, $t(53.29) = 0.25$, $p = .81$, $r = .03$; or verbal IQ, $t(55.00) = -0.99$, $p = .33$, $r = .13$.

All of the children/adolescents in the ASD group attended specialist autism schools or units. A thorough review of their Statements of Special Educational Needs confirmed that they had received formal diagnoses from qualified clinicians of Autistic disorder ($n = 23$) or Asperger's disorder ($n = 7$), according to the criteria set out in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1994). The comparison group consisted of children/adolescents with general learning disability of unknown origin ($n = 14$) and typically developing children ($n = 16$). Any mention of social communication difficulties in any comparison child's

Statement of Special Educational Needs resulted in exclusion from the comparison group, as this may have been indicative of ASD-related symptoms or even undiagnosed ASD.

Apparatus

The recording equipment used for the DSR task included a digital video camcorder, which was connected to a 38cm flat-screen, colour monitor. This equipment was used to record the distractor game and subsequently replay the recording of the game to the child. An additional video camera was used to record the entire session, the recordings from which were later used to code participant responses. The two video cameras were positioned opposite the table at which the child was to be seated, approximately 1.5 to 2.5 metres away. The screen was also placed facing the table where the child was to be seated. During the sticker game, the screen was covered with a piece of fabric to eliminate reflections.

The materials used for the distractor game included two plastic cups, featuring cartoon animal pictures (Donald Duck and Mickey Mouse), and a selection of children's stickers. Neon coloured sticky notes (3.8 × 5.1cm) were used to mark each child's head. These were hidden, out of the child's sight, on the back of the child's chair.

Procedure

The child was invited to play a distractor game in which they could win some stickers. Experimenter and child sat side-by-side at a table. The experimenter told the child that she was going to record the game on video so that they could watch it back later. She turned the cameras on and returned to her seat. She then invited the child to choose a

sticker that they would like to win and then asked them to cover their eyes so that they could not see what she was doing. She then hid the sticker under one of the cups. She told the child that they could uncover their eyes and then gave them a simple clue indicating which cup the sticker was under. For example, *"It's under the animal who's wearing shoes."* When the child had correctly guessed and retrieved the sticker from under the cup, the experimenter patted the child on the head in praise (sham marking). On the third round of the game, when the time came to pat the child on the head, the experimenter reached for a sticky note from the back of the child's chair and surreptitiously placed it on top of their head, near the front of their hair. The child was then given an unrelated filler task (they were asked to draw a picture of their choice), which lasted three minutes. The experimenter then told the child that it was time to watch themselves on television. They watched the playback together on a monitor and this was filmed by the second video camera in order to record the child's reactions to the image. The video was replayed to the child from the second round of the distractor sticker game. The experimenter ensured that they paid attention throughout. Before the marking event, the child was asked, *"Who's that?"* (pointing to their image on the screen). If they did not give a response they were asked, *"Can you tell me who that is?"* (pointing to their image on the screen).

If the child had not spontaneously removed the sticker within five seconds of seeing the marking event, they were given Prompt 1: *"What's that?"* (pointing to the image of the sticker on the screen). If they did not respond, the experimenter gave them Prompt 2: *"I think it's a sticker. Can you get that sticker for me?"* If the child was unable to locate the sticker after these prompts, they were shown live video feedback of

themselves on the same screen. Prompts 1 and 2 were once again used. Live video feedback acted as a control procedure to ensure that participant's who failed DSR were doing so because of difficulty with *delayed* self-recognition rather than difficulty with self-recognition *per se*.

The children also completed a standard unexpected contents – "Smarties" – false belief task (Perner, Frith, Leslie, & Leekam, 1989). The Smarties task was implemented because it provides an assessment of mental state understanding in self, as well as others. In this task, participants are asked test questions about their own previous false beliefs as well as the false beliefs of another person.

Reliability

An independent rater was trained to code performance on the DSR task, according to the level of prompting required to elicit mark-directed behaviour, as well as verbal responses. The second rater re-scored 17 of the videos. Inter-rater reliability was assessed using Cohen's Kappa, the value ($\kappa = .91$) of which indicated "almost perfect agreement" (Landis & Koch, 1977). Disagreements were resolved through discussion.

Data Analysis and Scoring

The data from the DSR task were analysed in a number of different ways. Firstly, group differences in the number of children who showed mark-directed behaviour *at any point* during the delayed video playback period were analysed. Secondly, the amount of prompting required to elicit mark-directed behaviour was considered. It has been suggested (D. Povinelli, personal communication) that spontaneous and prompted mark-

directed behaviour may index different underlying abilities. Whereas spontaneous mark-directed behaviour is most likely to indicate the presence of a temporally extended self-concept, showing mark-directed behaviour after Prompt 2 ("I think it's a sticker. Can you get that sticker for me?") may be the consequence of a simple search strategy. Hence, the child may reason: *I'm being asked to find the sticker, therefore there must be one somewhere around here. In the video it's on my head so maybe I should check there.* In other words, individuals may be primed to search on their heads without understanding the causal connection between the past self represented on screen and their present self.

Showing mark-directed behaviour after Prompt 1 ("What's that?") is unlikely to reflect such a simple search strategy, since it is not a directive. Whilst the first prompt might serve simply to draw the child's attention to the image of the previously un-noticed sticker, the second prompt may actually scaffold the child's performance to a significant extent, encouraging mark-directed behaviour through a search strategy.

DSR performance was also analysed as a continuous variable. Continuous DSR scores were assigned as follows: if children showed mark-directed behaviour spontaneously they scored 3 points; after Prompt 1 they scored 2 points; after Prompt 2 they scored 1 point; and if they failed to show mark-directed behaviour at all during the delayed video feedback they scored 0 points.

Given that directional hypotheses were proposed, unless otherwise stated, all *p*-values reported are for one-tailed tests. Effect sizes are reported in terms of *r* for continuous variables and phi (ϕ) for categorical variables.

Results

Results indicated that whereas every comparison participant showed mark-directed behaviour at some point during the delayed video playback period, only 25 (83.3%) of the 30 children with ASD did so. This group difference was statistically significant, Fisher's exact $p = .03$, $\phi = .30$.

Of the five children with ASD who failed to show mark-directed behaviour during the delayed feedback period, only two responded by showing mark-directed behaviour when given live video feedback. Thus, only 2/30 children with ASD could be said to have a *specific* difficulty with DSR. The three children who failed both delayed and live video self-recognition were excluded from subsequent analyses (except where noted). Thus, a total of 25/27 participants with ASD and 30/30 comparison participants showed mark-directed behaviour at some point during the delayed feedback period. This group difference was not significant, Fisher's exact $p = .22$, $\phi = .20$.

The degree of prompting required to elicit mark-directed behaviour was considered next. Table 2 provides a breakdown of DSR performance according to the level of prompting required to elicit mark-directed behaviour within each of the groups.

[Place Table 2 about here]

Group differences in the number of children showing mark-directed behaviour spontaneously, after Prompt 1 and after Prompt 2 were analysed using a 2 (Group: ASD/comparison) × 3 (DSR: spontaneously/after Prompt 1/after Prompt 2) Chi-square

test[2]. This test revealed no significant group differences, $\chi^2(2, N = 55) = 2.68$, p (two-tailed) = .29, $\phi = .22$. Thus, children with ASD were not significantly less likely than comparison children to spontaneously notice the sticker and show mark-directed behaviour when presented with delayed video feedback, and not significantly more likely to require Prompt 2 in order to elicit mark-directed behaviour.

DSR performance was also analysed as a continuous variable. Group differences in continuous DSR scores were assessed using a Mann-Whitney test, which indicated non-significantly better performance in the comparison group ($M = 2.13$, $SD = 0.86$) than in the ASD group ($M = 1.78$, $SD = 0.86$), $U = 320.00$, $z = -1.43$, $p = .07$, $r = .20$.

Participants' verbal responses to the self-image naming question, "Who's that?" were considered next (for the entire sample, including live video failers). One child with ASD failed to respond and was excluded from the subsequent analysis. Within the ASD group, 8/29 (27.6%) children used their proper name. This compared to only 2/30 (6.7%) children in the comparison group. All remaining children used the pronoun "me". The association between group and response to the naming question was significant, Fisher's exact, $p = .04$, $\phi = .28$.

Since only two participants failed to show mark-directed behaviour during the DSR task, it was not viable to statistically assess the association between DSR performance and verbal responses. However, it should be noted that one of these children failed to provide a verbal response and the other responded with the pronoun "me". Similarly it was not possible to analyse the relationship between DSR and false belief task performance. The two children who did fail DSR also failed both the Smarties "self" and "other" questions.

In terms of performance on the false belief task (for the entire sample, including live video failers), two children with ASD, but no comparison child, failed the "reality" control question. Of the remaining 28 children with ASD, 14 (50%) passed the other-person false belief question, compared to 24/30 (80%) comparison participants. This difference was significant, $\chi^2(1, N = 58) = 5.77$, $p = .02$, $\phi = .32$. Nineteen out of 28 (67.9%) participants with ASD passed the own false belief question, compared to 26/30 (86.7%) comparison participants. This difference only approached significance, $\chi^2(1, N = 58) = 2.95$, $p = .08$, $\phi = .23$.

Discussion

Contrary to predictions, the results of this study demonstrated undiminished DSR performance amongst children with ASD relative to age and verbal ability matched comparison children. Once children who failed live self-recognition were excluded from the analysis, no significant differences between the groups were observed in terms of the numbers of children showing mark-directed behaviour during the delayed feedback period. Overall, only two out of 30 children with ASD were found to have a *specific* difficulty with *delayed* self-recognition. These results are consistent with those obtained by Nielsen et al. (2006), who also found that the majority of children with ASD passed the DSR task.

When the degree of prompting required to elicit mark-directed behaviour was considered, it was found that children with ASD were neither significantly less likely than comparison children to show spontaneous mark-directed behaviour, without the

need for verbal prompting, nor significantly more likely to require Prompt 2 ("I think it's a sticker. Can you get that sticker for me?") to demonstrate mark-directed behaviour. Thus, the high rate of mark-directed behaviour in the ASD group could not be attributed to the use of a simple search strategy elicited by Prompt 2. Furthermore, when DSR performance was considered as a continuous variable, the group difference only approached significance.

It is important to contrast the unattenuated DSR task performance amongst participants with ASD in the current study with their significant impairments in the use of personal pronouns and in metarepresentational ability. Relative to comparison participants, participants with ASD were significantly more likely to respond with their proper names, rather than the pronoun "me", when asked to label their video image. This observed difficulty with pronoun use is consistent with previous studies (e.g., Lee et al., 1994) and implies diminished self-awareness in a proportion of children with ASD. Children with ASD were also impaired in their capacity for metarepresentation, relative to comparison participants. Indeed, the percentage of children with ASD in the current study who passed the other-person test question of the unexpected contents false belief task (50%) was closely comparable to previous studies assessing participants with ASD of similar developmental levels (e.g., Fisher Happe, & Dunn, 2005). This demonstrates that false belief task performance in the current study was representative of the performance of children with ASD of this ability range in general, making the lack of a significant group difference on the DSR task even more striking.

Despite the fact that the current study showed DSR performance to be intact in ASD, it may be premature to draw the conclusion that temporally extended self-awareness is, therefore, unimpaired in ASD. Firstly, it must be acknowledged that neither the current study nor the study by Nielsen et al. (2006) addressed the question of whether children with ASD would show DSR at the appropriate *chronological* age of four years (the youngest child in the current study was five years old). Indeed, it seems likely that a certain level of cognitive ability is necessary for successful DSR. Thus, any four year old child who is cognitively delayed, as many children with ASD are, may experience difficulties with the DSR task.

Moreover, whilst some may consider the DSR task to be the litmus test for temporally extended self-awareness in typically developing children, the task is not unambiguously such a measure. For example, Povinelli (2001) argues that DSR may be achieved without a temporally extended self-concept, through alternative cognitive mechanisms. He suggests that some children may simply detect the match between their mental representations of what they look like and the images presented to them on the television screen. Although there is a kinaesthetic mismatch, in that the movements of the video image of the child are not contingent with the current movements of the child themselves, there is a featural equivalence between the video image of the child and the child's physical self-representation. It may be that this featural equivalence is sufficient to prompt mark-directed behaviour in the absence of a temporally extended self-concept. In other words, the child may recognise themselves in the video, without understanding that it is a representation of them as they were three minutes previously.

If it is possible for children to show mark-directed behaviour in the DSR task in the absence of a *temporally extended* representation of self, then the lack of a relationship between DSR and false belief task performance is unsurprising, with only the latter relying on metarepresentation. It might also mean that some of the children in the current study who appeared to pass the task, in fact, lacked a fully developed temporally extended self-concept. This might account for the ceiling effect and lack of a group difference in DSR performance observed in the current study.

Moreover, there is indirect evidence to suggest that temporally extended self-awareness may be impaired in ASD. For example, individuals with ASD have impaired episodic memory (Bowler, Gardiner & Grice, 2000; also see Boucher & Bowler, 2008). Episodic memory is defined as memory for personally experienced events that occurred in a specific place at a specific time. Wheeler, Stuss and Tulving (1997, p.349) argue that episodic retrieval involves the understanding that "the self doing the [re] experiencing now is the same self that did it originally". Thus, episodic memory difficulties in ASD may at least be partially attributable to an underlying impairment of temporally extended self-awareness (Lind & Bowler, 2008).

Further research could clarify the issue of whether or not children with ASD pass the DSR task because they have temporally extended self-concepts. Following the rationale of Povinelli and Simon (1998), children with ASD could be tested for DSR after both brief (3 minute) and extreme (7 day) delays. If children with ASD show mark-directed behaviour because they detect the featural match between their bodily self-representation and the video self-image, they should do so when presented with recordings after both short and long delays, since their physical features will remain

largely invariant across both durations. On the other hand, if they show mark-directed behaviour because they possess a temporally extended self-concept, they should only do so after a short delay. If they understand the temporal-causal relations between present and various past states of self, they should realise that the image recorded shortly before bears a fairly direct causal relation to their current self, whereas the image recorded a week before bears a far less direct causal relation to the current state of self and is, therefore, unlikely to be informative about the appearance of the current self (a sticker is unlikely to remain undiscovered on one's head for a whole week!).

Even if the validity of the (short delay) DSR paradigm as a measure of *temporally extended* self-awareness is questionable, the results of the current study still provide valuable insight into the nature of self-awareness in ASD. They provide further evidence that most children with ASD are aware of their physical selves. Nevertheless, it was a striking finding that three children with ASD (but no comparison child) failed live video self-recognition, apparently demonstrating a profound diminution of self-awareness. In typical development, 90% of 3-year-olds pass live self-recognition (Suddendorf, Simmock, & Nielsen, 2007). Thus, on the basis of the verbal mental ages of these children (2.83, 3.83, 3.42 years) one might reasonably expect them to pass.

Finally, it should be highlighted that delayed self-recognition can, at best, only ever hope to directly assess awareness of the self's physical continuity. However, it is awareness of one's mental continuity that is likely to be intimately related to higher cognitive functions such as episodic memory. Perhaps this is the element of self-awareness upon which further research efforts should be focussed.

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Footnotes

(1) It is assumed that this is a typographical error, since this would mean that 12.45 children with ASD passed.

(2) The analysis was also run as a 2 (Group) × 4 (DSR) test, including those children who failed to show mark-directed behaviour ($n = 2$). However, the assumptions of Chi-square were violated and hence the Fisher's exact statistic was appropriate. This test also failed to indicate any significant group differences, Fisher's exact = 4.56, p (two-tailed) = .17, $\phi = .30$.

Table 1

Participant Characteristics

	ASD (*n* = 30, 8 female)		Comparison (*n* = 30, 10 female)	
	Mean (*SD*)	Range	Mean (*SD*)	Range
VMA (years)	6.18 (2.32)	2.83 – 11.33	6.26 (2.11)	3.17 – 10.83
CA (years)	8.99 (3.31)	5.00 – 16.17	8.74 (4.50)	3.58 – 15.67
Verbal IQ	79.10 (16.39)	46 – 117	83.90 (20.79)	39 – 117

Table 2

DSR Performance

Level of prompting	ASD (% of group)	Comparison (% of group)
Fail	2 (7.4%)	0 (0%)
Pass after Prompt 2	8 (29.6%)	9 (30.0%)
Pass after Prompt 1	11 (40.7%)	8 (26.7%)
Pass spontaneously	6 (22.2%)	13 (43.3%)