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CASE REPORT

Extreme Fragmentation in the Rey-Osterrieth complex figure test: a neuropsychological case study of a patient with anorexia nervosa

Eyal Heled · Dan Hoofien · Eytan Bachar · Eitan Gur · Richard P. Ebstein

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Introduction

Global processing (GP) relates to the ability and natural tendency to integrate perceived single elements in a context of meaning [1]. Low GP was found to be highly associated with anorexia nervosa (AN), showing impairment in currently ill AN patients [2].

Various cognitive tests such as object assembly, overlapping figures test, and the Rey-Osterrieth Complex Figure Test (ROCFT) are used to assess perceptual integration, by evaluating global information processing. The ROCFT particularly is considered to evaluate visuo-spatial and visuo-constructional abilities [3]. Osterrieth [4] has suggested a method for scoring the level of performance in each stage separately according to presence and accuracy measures. In addition, others have developed methods of assessing abilities such as organization, planning, and fragmentation [2, 5].

Most of the studies that employed the ROCFT found no significant difference in the copy accuracy between AN groups and healthy controls [6, 7], while few did show difficulty in this stage [8]. In addition, AN patients were found to use less effective strategy methods in the copy condition, showing a tendency to poorly integrate the figure which, however, did not affect memory recall [6, 7]. Others did illustrate poor recall of the figure [2].

The current study attempts to present an unusual case of reproduction of the ROCFT in the three stages, by a patient suffering from AN. The point of emphasis is her severe fragmentation, exhibiting low GP. Furthermore, it also aims to test the relationship between low GP and other cognitive abilities as part of a wider battery. This will help to understand the specificity of GP in relation to other cognitive abilities.

Case report

KM is a 19-year-old woman, suffering from AN of the binge/purge subtype. She is right-hand dominant with 12 years of education. Her body mass index (BMI) at the time of the study was 17.42. She was hospitalized for a few weeks at the Adult Eating Disorders Department of Sheba Medical Center. She did not suffer from any psychiatric disorders at that time, due to pharmacotherapy, as diagnosed by the department's psychiatrist. Her disorder began at age 13 following ballet trials she attempted and failed. She was hospitalized for 6 months. Since then she has been exhibiting a relapsing–remitting pattern of the disorder. From a young age KM lived at a boarding school. At age 14.5 she developed bulimia nervosa, which

E. Heled (✉)
Day Treatment Rehabilitation Unit,
Sheba Medical Center, Ramat Gan, Israel
e-mail: eyalheled@gmail.com

E. Heled · D. Hoofien · E. Bachar
Department of Psychology, Hebrew University,
Jerusalem, Israel

E. Bachar
Department of Psychiatry, Hadassah University Medical Center,
Jerusalem, Israel

E. Gur
Department of Eating Disorders, Sheba Medical Center,
Ramat Gan, Israel

R. P. Ebstein
Department of Psychology, National University of Singapore,
Singapore City, Singapore

deteriorated over time until at the age of 16.5 her symptoms reached their worst, namely, vomiting approximately 11 times a week, taking a few dozen Lexadine pills a day. She drank 16 cups of coffee a day and applied enemas several times as well. Her binging behavior was also very severe (e.g., eating frozen food or flour), at a frequency of ten times a week. The symptoms lasted 2 years and when she reached a BMI of 27.79 she began to lose weight again. At age 17.5 she reached her lowest BMI of 15.25 for a few weeks, retaining the binge/purge pattern albeit losing weight. She was hospitalized in the adult ward when nearly 19 years old with a BMI of 17 and overall good physical condition (pulse rate—78, blood pressure—118/84, body temperature—37.5 °C). She was admitted to cope with her eating habits and emotional problems. While hospitalized she failed to comply with the program's rules and regulations and would vomit and exercise whenever possible, despite staff warnings of a potential discharge from the ward. After one and half months she was discharged with a BMI of 19 and active symptoms.

KM had past diagnoses of panic disorder without agoraphobia, addiction to tranquilizers such as Clonex (at age 16) for a few months, and suffered major depression episodes. She has been treated with the following drugs: Thiamine 100 mg, Caltrate 600 mg, Ferrous calcium citrate 100 mg, Risperdal 1 mg, and Flutine 20 mg a day.

Methods

Participants

KM was compared to five currently ill women diagnosed with AN and five healthy control women. The AN participants were recruited from the Sheba Medical Center's Adult Eating Disorders Department. They were all 19 years old with 12 years of education. Two of them were diagnosed as binge/purge subtype and three were restrictive. Their mean BMI at the time of the study was 17.4 (SD = 0.08). Mean illness duration was 2.3 years (SD = 1.39) and mean age at onset was 16.08 (SD = 1.96). In addition, their mean nadir BMI was 15.82 (1.68) and finally four were right-handed and one had left-hand dominance. They were treated with antidepressants such as Flutine and Cipralex.

The healthy controls were all 19 years old with 12 years of education, and all except one were right-handed. They were recruited by notices on college campuses and advertisements in the local community, and screened for a history of abnormal eating behavior by telephone. All controls had a normal BMI (M = 23.77, SD = 2.93), with no personal history of mental or neurological disorders or any permanent medication use. The diagnosis was made using the expanded version of the Structured Clinical Interview for DSM-IV [9] (SCID-I).

Instruments

We used a comprehensive neuropsychological battery of tests which was chosen on the basis of their validity for Hebrew speakers, qualitative analysis design, and as being verbal/visual domain specific (see: Strauss et al. [3] for detailed instructions of the tests):

The Rey Auditory Verbal Learning Test

The test requires participants to recall a list of 15 words, then recall another 15-word list, an immediate recall trial of the first list, and a long-delay recall trial followed by a recognition trial. The variables selected for this study were the number of words recalled in trial 7, 8, and in the recognition stage.

Delis–Kaplan Executive Function System: Sorting Test

In phase one the participant is asked to sort two sets of cards into two equal groups of three cards each and to describe the common feature of each group (up to eight correct possibilities). In phase two, the examiner sorts the card groups according to all eight sorting variations and the participant is asked to identify and give an accurate description of each group. The variables used were: total confirmed correct sorts and free sorting description score.

Trail Making Test

In Part A the participant is required to draw lines that connect consecutive digits, printed in a scattered pattern on a page, as fast as possible without lifting the pen. In Part B she is required to connect sequences of letters and digits alternatively (i.e., 1-A-2-B and so on). The completion time of each part was recorded.

Word fluency test

Participants are asked to provide as many words as possible within 60 s, beginning with each of three letters—bet (/b/), gimel (/g/), and shin (/š/) (phonemic test), and each of three categories—fruits and vegetables, animals and vehicles (semantic test). The total number of words produced in each test was measured.

Five Point Test: modified version

The participants are required to connect five dots with straight lines only, on a sheet of paper containing 40

squares with five dots arranged in each, in 3 min (in the original version two or more dots must be connected). No repetition of figures is allowed. The number of unique designs was counted.

Rey-Osterrieth Complex Figure Test

In the first stage, participants are required to accurately copy a complex figure and to immediately reconstruct it from memory. After a delay of 20–30 min they are required to recall the figure again. The copy and memory scoring was based on Osterrieth's [4] method, adding a fragmentation measure from the Boston Qualitative Scoring System (BQSS) [5].

Procedure

All participants were informed of the research procedure and they provided written informed consent. The assessment was conducted in one meeting, administered by a certified neuropsychologist, and the order of the tests was as follows:

1. Word Fluency Test
2. Rey Auditory Verbal Learning Test
3. Delis Kaplan Executive Function System Sorting Test
4. Rey Auditory Verbal Learning Test—Delayed memory
5. Rey-Osterrieth Complex Figure Test—Copy and immediate memory
6. Trail Making Test
7. Five Point Test
8. Additional questionnaires
9. Rey-Osterrieth Complex Figure Test—Delayed memory

Results

The performance of KM on the three stages of the ROCFT was shown to be very fragmented with a significant difficulty in perceiving the figure as a whole (See Fig. 1). Indeed, when asked to copy the figure as best as she can, she looked at it and said: "One figure? I see a lot of figures here". KM showed no specific pattern of detail production while drawing the figure, in each of the stages. 'Testing of the limits' performed at the end revealed that she was able to detect the whole figure but only when it was pointed out to her.

To analyze the results we used Crawford and Garthwaite's [10] independent sample t test modification method (two tailed). It enables comparison of a single subject with a small group, offering an estimate of the rarity or abnormality of the individual score and avoiding the inflation of type I error rate.

The analysis comparing KM's performance with the controls on the ROCFT showed significant results in the copy ($t(4) = 33.8, p < 0.01$), immediate ($t(4) = 9.33, p < 0.01$), and delayed ($t(4) = 9.64, p < 0.0001$) stages. A comparison between KM and the ill patients yielded similar results in the copy ($t(4) = 7.36$, $p < 0.001$), immediate ($t(4) = 4.10$, $p < 0.05$), and delayed ($t(4) = 3.6, p < 0.05$) stages. In all, KM performed worse than the comparison groups.

Scrutinizing the *fragmentation* variable of KM and the control group yielded significant results ($t(4) = 6.08$, $p < 0.01$), showing that KM (fragmentation = 0) performed worse than controls (M = 3.6, SD = 0.54). On the other hand, comparison between KM and the ill patients yielded non-significant results, however, with a clear trend ($t(4) = 1.58$, $p = 0.07$).

Furthermore, to investigate the specificity of low GP, other cognitive abilities were tested. In relation to the controls the analyses show only two significant variables. Namely, the Rey Auditory Verbal Learning Test (RAVLT) variable of short-term memory ($t(4) = 2.95$, $p < 0.01$), with KM exhibiting a lower score (T7 = 8) than controls (M = 13.4, SD = 1.67), and the recognition variable of the RAVLT ($t(4) = 5.33, p < 0.01$), with KM showing a lower score (recognition = 11) than controls (M = 14.33, SD = 0.57).

Additionally, testing the other cognitive variables, no difference was found among the currently ill patients compared to KM's performance (see Table 1 for the neuropsychological tests scores).

Discussion

In the current study we describe the case of KM—an AN patient who exhibited unusual performance on the ROCFT. We aimed to show the extent that this deficiency can reach and to raise the question of the specificity of functioning with regard to GP. Our results show that the performance of KM on the ROCFT, is worse than that of healthy controls and currently ill AN patients. When the method offered by BQSS [5] for assessing fragmentation was applied, only the controls were significantly different from KM, together with a trend of difference between KM and the AN patients ($p = 0.07$). Finally, most of the comparisons between KM and the two groups on other cognitive tests showed non-significant results, aside from the short-term memory and the recognition trials in the RAVLT, where KM performed worse than controls.

The tendency of AN patients to fragment a neutral visual stimulus as a result of poor ability to see the stimulus as a whole was shown previously [2]. Nevertheless, this is

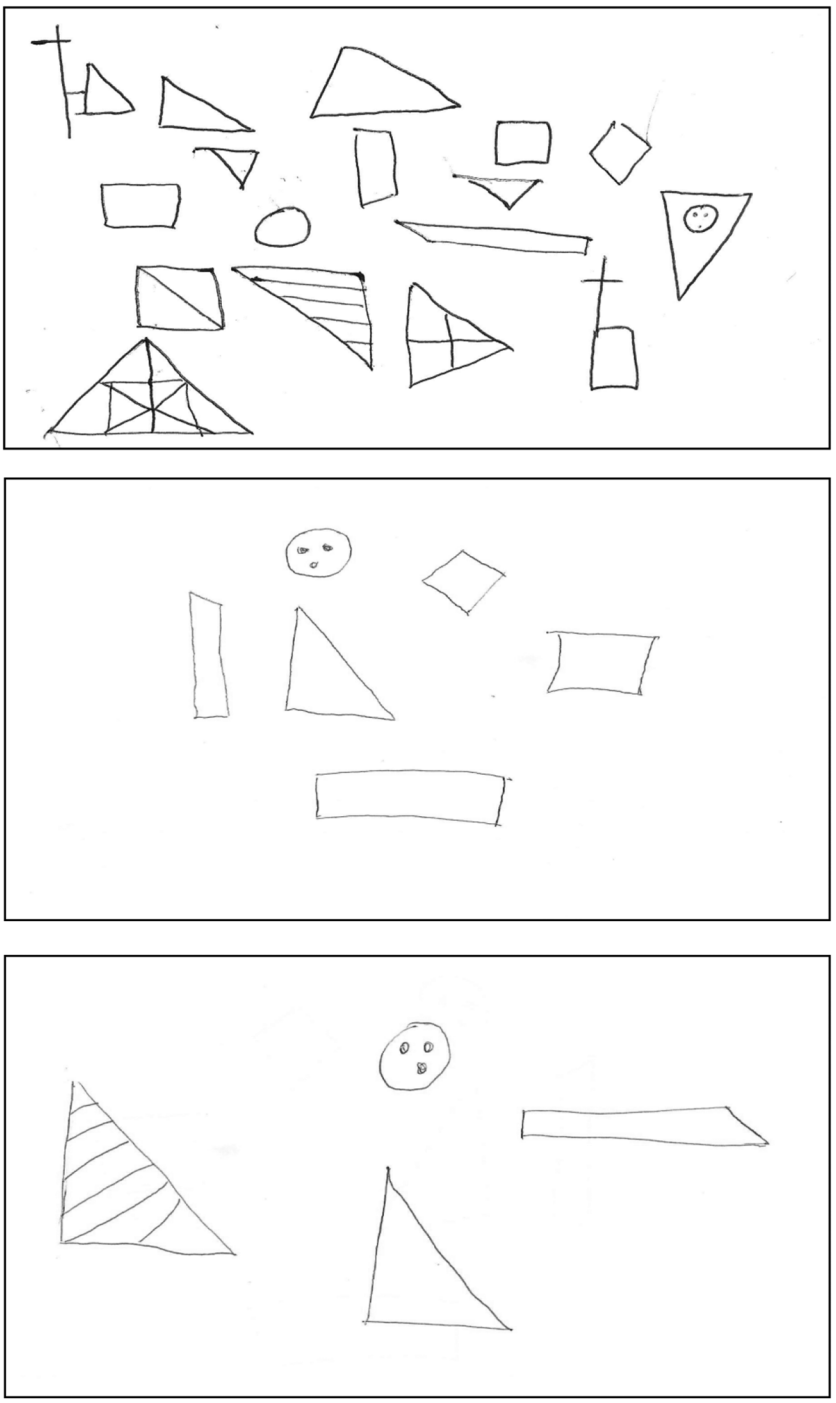

Fig. 1 KM's performance in the three stages of the Rey-Osterrieth complex figure test

the first study that showed the radical proportions the fragmentation can reach, indicating difficulties in planning and organization as well. The fact that KM's low GP was evident in the copy task and not only in the memory tasks, and that her verbal memory was relatively intact, indicates that her deficit was rooted in visuo-spatial abilities rather than memory functions.

It seems that KM found it difficult to see the figure as a whole, and could detect only the sub-figures that compose it (as she herself stated). This presentation resembles that of patients with right hemisphere damage who show impairment in GP [11], i.e., the overall shape is represented independently of its parts, thus suggesting a problem with visuo-spatial processing.

Table 1 Neuropsychological tests scores (means and standard deviations) of KM, currently ill patients and healthy controls

Variable	KM	AN Patients ($N = 5$)	Controls ($N = 5$)
RAVLT			
Trial 7	8	11.4 (1.94)	13.4 (1.67)*
Trial 8	9	10.6 (2.79)	12.4 (2.07)
Recognition	11	14.02 (1.09)	14.33 (0.57)*
D-KEFS sorting test			
Total confirmed correct sorts	8	10.2 (3.19)	12.5 (2.08)
Free sorting description score	37	33.4 (8.32)	45.8 (2.39)
TMT a (sec.)	29.00	33.39 (11.58)	22.4 (3.64)
TMT b (sec.)	70.00	57.29 (34.39)	52.4 (14.97)
Fluency test			
Phonemic	28	39.4 (10.28)	34.8 (15.29)
Semantic	53	54.4 (7.63)	58.6 (11.14)
5 point test—unique designs	9	11.8 (4.49)	22.2 (7.04)
ROCFT			
Copy	3.5	30.6 (3.36)*	33.8 (0.83)*
Short term	1	23.3 (4.96)*	28.5 (2.69)*
Long term	0.5	18.9 (4.66)*	28.3 (2.63)*
Fragmentation	0	2.2 (0.83)	3.5 (0.54)*

* $p < 0.05$

AN Anorexia Nervosa, *RAVLT* Rey Auditory Verbal Learning Test, *D-KEFS* Delis Kaplan Executive Function System, *TMT* Trail Making Test, *ROCFT* Rey-Osterrieth Complex Figure Test

The finding that AN patients did not differ from KM on the BQSS fragmentation measure can be explained by the fact that BQSS scores range from 0 to 4, thus creating a low variability in such a small sample, and by noting that AN patients have low GP too, although the performance of KM was even lower.

Consequently, it seems that beyond the known evidence of the low GP of AN patients, this case presentation demonstrates that it is somewhat distinguished from other cognitive deficiencies. Following Danner et al.'s [6] notion that neuropsychological impairments do not seem to be a unified characteristic in AN, but rather a feature of a certain proportion of them, KM's case shows that it is also a question of extent. Among patients who show difficulty in this domain, some would constitute an extreme manifestation. Therefore, an inquiry addressing the factors underlining this presentation is plausible.

KM did not differ from controls on most of the other cognitive abilities that were tested, and not at all as compared to currently ill patients. Evidently, KM showed that her extreme performance was not only a result of poor integration ability (no problem in comprehension was detected), but also was isolated from other cognitive abilities that were mostly preserved. Thus, it may indicate specificity of low GP, which does not mean that other cognitive abilities are not impaired in AN, but rather that some patients are more inclined to it. Therefore, in a way, may explain the relatively inconsistent findings of this impairment. Indeed, there may be other factors that could have influenced the performance of KM (e.g., concomitant lifetime diagnoses of other psychiatric disorders and addiction). However, both the cognitive abilities and her demographic data do not imply on the occurrence of such deviation.

To conclude, KM's extreme manifestation is a severe case of low GP in AN patients. We believe that although it does not represent all patients suffering from AN, low GP may be represented in a radical proportion. Additionally, low GP may also be rooted in the AN cognitive profile much more than other cognitive deficiencies. Further research could test the relation between the severity of the low GP ability and cognitive remediation therapy outcomes.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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