The era of our lives: The memory of Korsakoff patients for the first Covid-19 pandemic lockdown in the Netherlands

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ABSTRACT

Memories for worldwide and emotional events (such as 9/11) are more vividly relived and recalled than memories for everyday events. Previous studies have shown that flashbulb memories of a single event enhanced the memory strength in severe amnesia. It is currently unknown whether macro-events that stretch out over longer periods of time (weeks, months) strengthen memory even further. Our aim was therefore to investigate to what extent patients with severe amnesia, due to Korsakoff`s syndrome (KS), were able to relive the first Covid-19 lockdown in the Netherlands, and whether experienced emotions enhanced reliving of the participants. We included 22 KS patients and 24 age-, education-, and gender-matched healthy controls. Covid-19 related memories were assessed by measures of autobiographical memory specificity, phenomenological reliving, emotional intensity and semantic-and episodic knowledge about the first lockdown in March 2020 – May 2020 in the Netherlands. Although amnesia patients remembered significantly fewer autobiographical details regarding the Covid-19 lockdown than healthy controls, one fourth of the KS patients recalled specific events. Amnesia patients reported levels of emotional intensity equivalent to those in the control group. Stronger autobiographical reliving was associated with higher emotional intensity. Both amnesia patients and healthy controls had higher recall of episodic than semantic lockdown related information. In conclusion, results demonstrate that information for macro-events can still be memorized and relived, most specifically when emotional valence is high, even by highly amnestic patients.

1. Introduction

Korsakoff`s syndrome (KS) is a neuropsychiatric syndrome caused by thiamine deficiency and concomitant alcoholism leading to lesions in the diencephalon. KS is characterized by severe anterograde and retrograde amnesia (Arts, Walvoort, Kessels, 2017). Memory impairments in patients with KS are associated with a difficulty in retrieving contextual information, and a difficulty in remembering where, when and how a memory was acquired, typically regarded as a deficit in episodic memory. Memory deficits are also present in their autobiographical memory (El Haj & Nandrino, 2017).

In spite of the severe memory impairments found in KS patients, not all events are forgotten. Multiple studies have found a relationship in amnesic patients between emotionally charging of events and the ability to recall them. Emotionally charged memories are often assessed in experimental setups by asking details on flashbulb memories. Flashbulb memories are detailed and vivid

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autobiographical memories for surprising and emotionally arousing, public events (El Haj et al., 2016a), for example memories for the terrorist attacks on 9/11/2001. More than half of the KS patients remembered 9/11, and some had strong flashbulb memories regarding the event (Candel et al., 2003). Moreover, emotions seems to enhance the autobiographical memory through activating the ability to remember thoughts and feelings associated with the original 9/11 event. This could imply that emotion plays an important role in the recall of autobiographical memories in KS patients (El Haj & Nandrino, 2017). Moreover, in a recent case study by Gandolphe & El Haj (2018) a male patient with KS also had vivid emotional recall of the terrorist attack in Paris 2015, although memory for the semantic contents of the event was not fully intact (see Table 1).

Amnesic patients show higher recall of memories for emotional and arousing events regarding episodic details compared to semantic information, but their amnesia is often more of an episodic nature than a semantic. A possible explanation for this apparent contradiction could be that for an emotional event outside the laboratory with widespread media coverage, such as the September 11th attacks, cognitive deficits can be partially overcome (Budson et al., 2004). Memories for high emotional and public events as such may elicit improved recall of episodic and autobiographical details in amnesic patients (Candel et al., 2003; Budson et al., 2004; El Haj et al., 2016a; El Haj et al., 2016b; Luchetti & Sutin, 2017; El Haj & Nandrino, 2017; El Haj & Nandrino, 2018).

One development that has shocked our public and personal lives at an universal scale is the emergence of the Covid-19 pandemic in 2019. The social restrictions have had a substantial impact on inpatient and outpatient diagnosed with amnesia, with cancelations or postponement of outpatient visits starting at the beginning of March 2020 in The Netherlands and other European countries (). The Covid-19 era does not concern a singular event but rather a large period of time, or what Gardner (2009) calls a macro event. It is important to examine whether KS patients living as inpatients in a specialized facility, can remember the Covid-19 pandemic due to this macro event being important, emotional, public and having widespread media-coverage.

Research on the connections between memory, emotion and worldwide events, especially macro events, is very scarce in patients with KS. Therefore, the current study focused on whether and how KS patients remember the first Covid-19 lockdown in the Netherlands in March 2020. In particular we attempted to investigate various aspects of declarative memory for the Covid-19 era (autobiographical, semantic and episodic memory). Additionally, we examined to what extent KS patients could recall phenomenological characteristics of a memory related this lockdown to measure the amount of autobiographical reliving. Qualitative analyses were used to express the differences in recalled information regarding the first Covid-19 Lockdown.

2. Methods

2.1. Participants

In this study, 22 patients diagnosed with KS participated. They were all inpatients of Korsakoff Center 'Slingedael', Rotterdam, The Netherlands; a specialized long-term care facility for KS patients. All patients fulfilled the criteria for KS described by Kopelman (2002) and the DSM-5 criteria for alcohol-induced major neurocognitive disorder of the amnestic-confabulatory type (APA, 2013). The patients were in the chronic, amnestic stage of KS. None of them were in the Wernicke Encephalopathy phase. All patients were at least sober for six months, and testing was conducted after at least six months post-Wernicke Encephalopathy; to assure a stable cognitive state. KS patients and healthy controls had a comparable age, gender and educational level. Also, 24, gender-, age-, and education-matched healthy controls participated in the study. General cognitive functioning, as indicated on the TICS-M was lower in KS patients than healthy control subjects (see Table 4). There were no statistically significant group differences regarding age, sex and education level between KS patients and matched healthy controls. Level of education was assessed according to the Dutch education classification system by Verhage. It consists out of seven categories,'1′ being the lowest (primary school) and '7′ the highest (academic degree) (Bouma et al., 2012).

Participants did not receive financial compensation for their participation. Informed consent was obtained for all participants. Ethical approval was obtained by the Ethics Review board of the Faculty of Social and Behavioral Sciences of Utrecht University. Data collection took place in December of 2020.

2.1.1. Procedure

The KS patients were individually interviewed at the KS care facility. Informed consent was obtained at the start of the interview. The interview was conducted inside a testing room without distractions.. The control group was individually recruited trough

Table 1
Demographic Characteristics of KS Patients (KS) and Healthy Controls (HC).

	KS (n = 22)	HC (n = 24)	Statistics
Gender (m: f)[a]	15: 7	14: 10	$U = 292.00$, $z = 0.68$, $p = .500$
Age (*M, SD*)[b]	65.23 (8.39)	59.12 (13.83)	$t(44) = 1.83$, $p = .076$
Education level (*M, SD*)[c]	4.23 (1.48)27.27	4.50 (1.10)36.88	$U = 293.00$, $z = 0.67$, $p = 0.480$
TICS-m	(5.20)	(1.45)	$U = 528.00$, $z = 5.83$, $p < .001$

[d]Cognitive skills (TICS-m).
  [a] Gender ratio male: female.
  [b] Age in years.
  [c] Educational level was assessed in seven categories: one, primary school; seven, academic degree (Verhage, 1964).

Facebook and through personal connections. The controls and patients participated voluntarily. The controls were interviewed by telephone due to the Covid-19 restrictions from the government at that moment. The informed consent was read aloud and obtained orally. All participants had to respond to the questions asked by the experimenter. The memories were written down word for word by the experimenter. In both controls and patients, scaled questions (see Table 2 and Table 3) were circled by the experimenter. Open questions (see Table 4) were written down by the experimenter. If an answer was vague or needed more elaboration, the experimenter asked the participant to explain or clarify their answers. Further instructions were provided if the participant experienced any difficulties with the subjective ratings or questions.

2.1.2. Design

The total interview took about 20 min to complete and consisted out of 40 questions. Question 1–17 measured the amount of phenomenological reliving, question 18–22 measured emotion valence, question 23–30 measured the episodic memory, question 31–38 measured semantic memory and question 39–40 measured emotion for the first lockdown. Questions were assessed using a directive interview technique. The initial responses of the patients and controls were written down. There was a small delay between every question because the answers had to be written down.

The sub-questionnaires in this interview examined to what extent KS patients were able to remember the first Covid-19 lockdown by measuring different types of the declarative memory. These measured the autobiographical memory, episodic memory and semantic memory. Autobiographical memory specificity was assessed through the Autobiographical Memory Interview (AMI), to measure if KS patients are able to recall a specific memory related to the Covid-19 lockdown. Phenomenological reliving of that memory was assessed through a questionnaire based on the Autobiographical Memory Questionnaire (AMQ), to measure how many details KS patients could recall of that memory. Semantic and episodic memory was examined through questions based on the studies of Candel et al. (2003) and Budson et al. (2004), measuring personal and factual knowledge about the first Covid-19 lockdown. Together they will provide a deeper understanding of the memory for the Covid-19 era in KS patients.

2.1.3. Materials

2.1.3.1. Cognitive impairment.
The Modified Telephone Interview for Cognitive Status (TICS-M) was used to screen cognitive deficits of the participants. The TICS-M has high sensitivity and specificity and is a reliable and valid method for detecting cognitive impairment (Fong et al., 2009; Seo et al., 2011). The TICS-M has a cut off score of < 34 for Mild Cognitive Impairment and < 28 for dementia. A specific advantage of the TICS-M over regular screening methods was that the.

Dutch Covid-19 measures could be more easily managed (1.5 m distance) than in case of other screening methods.

2.1.4. Autobiographical memory specificity

To examine autobiographical memory, participants were asked to describe a personal memory of an event related to the first Covid-19 lockdown within a time frame of 2 min. This time frame was chosen to avoid redundancy or distractibility and is found sufficient for autobiographical recall in prior research regarding individuals with Alzheimer's disease (El Haj & Nandrino, 2018). Participants had to specify their memory as much as possible to see if Korsakoff patients could still generate specific autobiographical memories in relation to this macro-event. Memory specificity was rated on a scale of 0 to 4 based on the AMI (Kopelman, 1994; Levine, Svoboda, Hay, Wincour, & Moscovitch, 2002; El Haj & Nandrino, 2018). These four points measure to what extend both groups can recall specific memories. Four points were given if the event of the memory was specific, vivid, provided details and lasted no longer than 24 h. 3 points were assigned if the event of the memory lasted less than 24 h and situated in time and space without details. 2 points were given

Table 2
Variables of Phenomenological Reliving.

Variable	Description of Rating Scale
Reliving	I feel as though I am reliving the original event
Back in Time	As I remember the event, I feel that I travel back to the time when it happened
Remember/know	I can actually remember the event rather than knowing that it happened
Real/imagine	I believe the event in my memory really occurred in the way I remember it and that I have not imagined or fabricated anything that did not occur
See	As I remember the event, I can see it in my mind
Hear	As I remember the event, I can hear it in my mind
Talk	As I remember the event, I or other people are talking
Emotion	As I remember the event, I can feel the emotions I felt then
Importance	This memory is significant for my life
Impact	The event from the memory has made a lot of impact
Rehearsal	Since it happened, I have thought about this event
Rehearsal	Since it happened, I have talked about this event with others
News rehearsal	Since it happened, I have watched the news about Covid-19
Place	I can recall the place where it occurred
Time	I can recall the time (day/month/year) when it occurred
Own perspective	I remember the event from my own perspective
Other perspective	I remember the event from another perspective

Table 3

Variables Used to Measure Emotion.

1. How sad do you feel when you remember the event?
2. How angry do you feel when you remember the event?
3. How much fear do you feel when you remember the event?
4. How happy do you feel when you remember the event?

Table 4

Episodic and Semantic Knowledge Variables about the first lockdown in March 2020.

Semantic Knowledge
1. In which month did the first quarantine period start?
2. Who was the minister that spoke about the lockdown during the press-conference?
3. What happened with sports during this quarantine period?
4. Which product got massively hoarded during the first quarantine period?
5. At what time did that press conference start?
Episodic Knowledge
1. Where were you (on March 12, 2020) when the minister told that the Netherlands was about to go into lockdown?
2. What where you doing when you heard the news about the lockdown?
3. With whom where you when the heard the news?
4. How did you hear the news about the lockdown (radio, television, etc.)?
5. How where you feeling when you heard the news about the lockdown?

if the memory was a macro or repeated event but contained details. 1 point was given if the memory was a macro or repeated event without any details. 0 points were assigned when there was no memory at all. In earlier research this interview had a high reliability between 0.83 and 0.86 and is considered to be a valid instrument for measuring episodic memory richness (Kopelman, 1994; Levine et al., 2002).

2.1.5. Phenomenological reliving

Phenomenological reliving of an autobiographical memory related to the first Covid-19 lockdown was assessed through an adapted version of the AMQ (Rubin et al., 2003; El Haj & Nandrino, 2017). Questions about space, importance, rehearsal and perspective were added to provide more knowledge about these components of reliving (see Table 2). The Cronbach's alpha showed a reliability of 0.86, indicating high internal consistency. The translation of the AMQ into the Dutch language was done by a professional translator of the Utrecht University to achieve higher translation validity. Validity of the ratings were established by asking participants to provide specific information about that memory if not given during the AMQ. Questions were scored on a seven-point Likert scale from 1 (not at all), 3 (vague), 5 (clear) tot 7 (as clearly as if the event was happening now). A seven-point Likert scale was chosen to measure the participants true subjective evaluation (Finstad, 2010). A high score indicated a high level of phenomenological reliving for a memory, thus, indicating higher reliving of the a memory related to the first Covid-19 lockdown (see Table 5).

2.1.6. Emotion

We added four questions about emotion related to the first Covid-19 lockdown to the interview. Although the AMI has one question about emotion in it, we wanted to get more insight into memory and emotion related to the first Covid-19 lockdown in the Netherlands and know what type of emotion predicts higher recall. Emotional intensity of a memory related to the first wave of Covid-19 was measured through four questions on a seven-point Likert scale (see Table 3). The following emotions were included: sad, anger, happy, fear. These four emotions had been chosen given their generality. Emotion for the first lockdown in March 2020 was assessed with an open question followed by a seven-point Likert scale.

2.1.7. Semantic content and episodic context memory

Semantic and episodic memory regarding the first lockdown in March 2020, due to the Covid-19 pandemic, were assessed through 10 questions (see Table 4). The period of the first lockdown was chosen due to the amount of impact this period had on our society. These questions were all based on recall of events. The maximum score for semantic and episodic memory are each 10 points, indicating high recall of knowledge about the first lockdown.

Table 5

Frequencies of Memory Specificity from KS Patients (KS) and Healthy Controls (HC).

	KS (*n* = 22)	HC (*n* = 24)
No memory or general information	2	
Repeated or extended event without details	8	
A repeated event that situated in a time and space with details	6	2
A specific event (<24 h) without details	1	6
A specific event (<24 h) that was enriched with details	5	16

2.1.8. Confabulations

KS patients are known to confabulate, since confabulations are a diagnostic criterium for KS. Confabulations are exaggerated, fantasized or untrue stories that KS patients use to fill the holes they cannot remember. These confabulations do not happen on purpose, but are the result of specific brain damage). Four control questions, based on the Dalla Barba (Dalla Barba et al., 2020), were included in this questionnaire to control for the severity of confabulations; namely:

1. What was the color of the shirt of the sign language interpreter during the Covid-19 press conferences?
2. Who succeeded the king when he was infected with Covid-19?
3. Can you remember what you did March 12th?
4. What did you do when the air raid siren went off, because of the Covid-19 lockdown?

The right answer to these questions would be: 'I don't know' or 'did that really happen?" If KS patients respond with concrete answers to these questions, it could be likely they were confabulating. Furthermore, these questions gave an indication to whether the patients confabulated on the other questions as well. Scoring went be as follows: '0′ for a wrong answer, '1′ for a vague or almost correct answer, '2′ for a right or precise answer and 'c' for confabulations. Results of KS patients scoring more than two 'c's had to be investigated thoroughly. If the answers to those and other questions were strongly of confabulatory nature, the participant was removed, because of the confabulations influencing the recall of the events too much. We discuss the extent of confabulations in severe KS in our discussion section.

2.1.9. Data analysis

All test scores were compared between KS patients and the controls. Memories were transformed into specificity scores and internal and external details. Internal details are details related to the episodic memory (the main event itself, time, place, perception, thoughts/emotions). External details are related to semantic memory or other events (external events, semantic information, repetition and other statements). Each part of a sentence was transformed into points following the description of Levine et al. (2002) and the categories were each transformed into a sum of scores per participant. Higher scores of internal details indicate higher episodic re-experiencing of a memory (Levine et al., 2002). A 2 × 2 mixed model ANOVA measured the differences between the two groups and amount of internal and external details, with details (internal and external) as the within-subjects variable and group (KS group and controls) the between-subjects factor. The assumptions for a 2x2 mixed model ANOVA were not violated. Due to violation of the assumption of normality and the assumption of homogeneity of variances, the non-parametric Mann-Whitney U test was applied to measure the differences between the groups on memory specificity and memory details. All scoring was performed by the experimenter. An independent rater, blind to diagnosis and study hypotheses, co-scored all transcripts. Interrater reliability was established using the intraclass correlation coefficient (absolute agreement) and was high across both conditions (internal details, r = 0.76, p <.001; external details, r = 0.87, p <.001) The scores reported in this paper are the means of the scores given by the experimenter and by the independent observer.

Emotional intensity was measured by the sum of scores of the four emotions (emotional intensity overall). Mann-Whitney U tests were then used to compare the scores on emotional intensity overall and the emotions separately between the two groups. A Kendell's tau-b correlation was used to examine the relation between phenomenological reliving and emotion.

Episodic and semantic knowledge scores were composed into a sum of scores for both knowledge types after the correction for possible confabulations. A Mann-Whitney U test was applied to measure the differences in knowledge scores between the participant groups. A Kendell's tau-b correlation was used to examine the relations between episodic/semantic knowledge and emotion for the first lockdown; exposure to news and episodic/semantic knowledge. More Kendell's tau-b correlations were used to examine cognitive skills and memory specificity; cognitive skills and phenomenological reliving. A bivariate Pearson's correlation coefficient was used to measure the relation between cognitive skills and phenomenological reliving. All correlations were two-tailed.

3. Results

3.1. Severe confabulations

Four questions were included in the interview to assess confabulation tendencies (see Methods). Two KS patients were removed from further analysis by reason of severe confabulations (possibly indicating psychosis/ severe lack of reality filtering), as indicated by three or four severe confabulations on the four questions (see also the discussion section). Answers on these control questions and other questions of the semantic/episodic knowledge questionnaire were abnormal and out of context as well. Examples of such answers were:

Patient X: I do not remember what I had to do" / "I was watching the outside world."
Patient Z: "I was eating those chips, you know the orange ones. They are called Cheeto's." / "I remember it was announced on Monday when the alarm always goes off, Corona was announced. Every first Monday of the month".

3.1.1. Autobiographical recall and phenomenological reliving

KS patients (*Mdn* = 2.00) showed significantly lower scores on memory specificity than the controls (*Mdn* = 4.00), (*U* = 414.00, *z* =

3.58, $p <.001$, $r = 0.53$), suggesting that KS patients have a less specific autobiographical memory for a memory related to the first wave of the Covid-19 pandemic (see Table 2). Furthermore, KS patients ($M = 4.11$, $SD = 1.08$) recalled less phenomenological characteristics than the controls ($M = 5.51$, $SD = 0.67$) This difference (23.90, 95 % CI [–33.17, −14.62]), was significant ($t(44) = -5.23$, $p <.001$, $d = 1.56$) and represented a large effect, suggesting that KS patients have reduced memory reliving for a memory related to the Covid-19 pandemic than the controls.

3.2. Internal and external details

There was a significant main effect of recalled internal and external details ($F(1, 44) = 29.03$, $p <.001$, $\eta_p^2 = 0.61$) with more internal details recalled than external details in both participant groups. There was another significant main effect of group on the overall amount of recalled details ($F(1, 44) = 14.43$, $p <.001$, $\eta_p^2 = 0.25$) with the control group reporting more details overall. There was no interaction of recalled details for a memory related to the first wave and group ($F(1, 44) = 1.59$, $p =.215$, $\eta_p^2 = 0.04$). Suggesting that the number of recalled details did not depend on the participant group.

A follow-up analysis on internal details indicated that healthy controls ($M = 7.96$, $SD = 2.42$) recalled more internal details than the KS group ($M = 5.64$, $SD = 2.99$). This difference (-2.32, BCa 95 % CI [-3.926, -0.718]), was significant ($t(44) = -2.92$, $p <.01$, $d = 0.85$). Both groups preferred event details over other internal details (see Fig. 1) and there was a significant difference in the amount of recalled event details between the KS group and control group ($U = 364.50$, $z = 2.27$, $p <.05$, $r = 0.33$). More significant differences were found for time ($U = 407.00$, $z = 3.59$, $p <.001$, $r = 0.53$) and place ($U = 172.50$, $z = -2.27$, $p <.05$, $r = -0.33$). KS patients scored lower on time and higher on place than the control group (see Fig. 1). No significant differences were found for perception ($U = 316.50$, $z = 1.55$, $p =.121$, $r = 0.23$) and thought/emotion either ($U = 330.50$, $z = 1.51$, $p =.131$, $r = 0.22$), indicating that both groups recalled the same amount of these details (see Fig. 1).

A follow-up analysis on external details indicated that healthy controls ($Mdn = 3.50$) recalled more external details than the KS group ($Mdn = 2.50$). This difference was significant ($U = 352.50$, $z = 1.98$, $p <.05$, $r = 0.29$). Out of the external details, semantic information was the most recalled external detail in both groups. Significant differences between KS patients and the control group were found for semantic information ($U = 350.50$, $z = 2.02$, $p <.05$, $r = 0.30$) and external events ($U = 347.50$, $z = 2.10$, $p <.05$, $r = 0.31$.). The control group reported higher scores on both details (see Fig. 1). No significant differences were found between the groups for repetition ($U = 233.00$, $z = -0.95$, $p =.34$, $r = -0.14$) and other ($U = 252.50$, $z = -0.29$, $p =.77$, $r = -0.04$). Indicating that both groups did not differ on these recalled details (see Fig. 1). KS patients ($M = 0.69$, $SD = 0.25$) and the controls ($M = 0.71$, $SD = 0.16$) did not significantly differ in internal-to-total detail ratios ($t(44) = -0.38$, $p =.706$, $d = 0.10$). These results suggest that both groups generated a similar amount of internal and external details. Both groups scored close to 1, indicating episodic re-experiencing in both groups.

3.3. Phenomenological reliving

KS patients scored quite high on the individual questions realness ($M = 5.82$, $SD = 1.56$), belief ($M = 6.73$, $SD = 0.77$), visual imagery ($M = 4.73$, $SD = 2.05$), spatial imagery ($M = 5.77$, $S = 1.77$) and perspective ($M = 6.64$, $SD = 1.18$), indicating high reliving of these phenomenological characteristics. Furthermore, no significant differences were found between KS patients and the control group on realness ($U = 289.00$, $z = 1.13$, $p =.261$, $r = 0.17$), importance ($U = 321.50$, $z = 1.29$, $p =.196$, $r = 0.10$) and perspective ($U = 246.00$, $z = -0.68$, $p =.499$, $r = 0.19$), indicating that both groups had similar scores on these questions.

There was a positive and strong correlation between cognitive skills and memory specificity ($\tau(46) = 0.54$, $p <.001$). Cognitive skills had a strong and positive relation for phenomenological characteristics as well ($r(44) = 0.71$, $p <.001$). These correlations suggest that higher cognitive skills result in higher recall of specific memories and higher reliving.
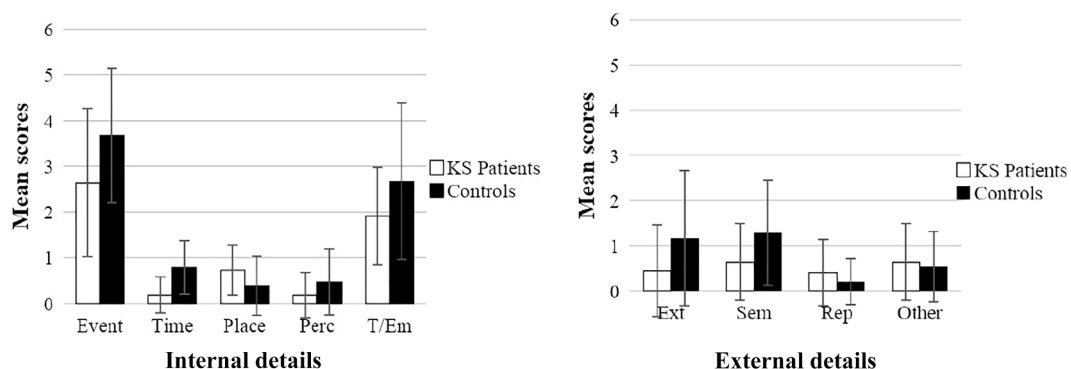

Fig. 1. *Mean Scores of Generated Internal and External Details for a Memory Related to the First Wave of Covid-19 by KS Patients and Controls. Note.* Internal details: Event; Time; Place; Perc = perception; T/Em = thought/emotion. External details: Ext = external event; Sem = semantic; Rep = repetition; Other.

3.4. Emotion and memory

Correlations were statistically non-significant for the following emotions: anger ($\tau = 0.07$, $p =.563$), happy ($\tau = 0.07$, $p =.575$) and fear ($\tau = 0.16$, $p =.168$)., suggesting that there were no relations between these emotions and phenomenological characteristics of a memory related to the Covid-19 pandemic. The correlation between sad and phenomenological characteristics was positive and moderate ($\tau(46) = 0.34$, $p <.01$). Also, a significant moderate and positive relation was found between emotional intensity overall for a memory related to the first wave and phenomenological characteristics ($\tau(46) = 0.32$, $p <.01$), suggesting that more emotional intensity overall and the emotion sad lead to higher reliving of a memory related to the first wave of the pandemic.

There was a significant, positive and moderate correlation between internal details and emotional intensity overall ($\tau(46) =.28p$ $<.01$), suggesting that when participants reported more internal details of a memory related to the first wave, they felt stronger emotions to that memory. However, there was no significant correlation between external details and emotional intensity overall ($\tau(46) = 0.20$, $p =.069$), suggesting that external details does not have a relation with emotional intensity overall.

3.4.1. Semantic versus episodic knowledge

The total of correct answers of episodic knowledge in KS patients ($Mdn = 7.00$) was significantly lower than the control group ($Mdn = 9.50$), ($U = 467.00$, $z = 4.55$, $p <.001$, $r = 0.67$). Also, KS patients ($Mdn = 5.00$) scored significantly lower for semantic knowledge than the control group ($Mdn = 10.00$), ($U = 441.00$, $z = 3.99$, $p <.001$, $r = 0.59$). These results suggest that KS patients are impaired with respect to episodic and semantic memory compared to the controls for the first lockdown. The difference of accurately recalled information between the two memory types was the largest in the KS group.

The relation between exposure to news about the Covid-19 pandemic and semantic knowledge was positive ($\tau(46) = 0.33$, $p <.01$). Suggesting that more rehearsal of information about the Covid-19 pandemic leads to higher recall of semantic knowledge.

3.4.2. Emotional intensity

Overall, KS patients reported, slightly, lower scores of emotion for a memory related to the first wave of the pandemic than the control group (see Fig. 2). When looking at the emotions separately, we neither observed significant differences between the two groups for sad ($U = 334.00$, $z = 1.76$, $p =.079$, $r = 0.26$), happy ($U = 290.00$, $z = 0.68$, $p =.500$, $r = 0.10$), angry ($U = 288.50$, $z = 0.60$, $p =.551$, $r = 0.09$) and fear ($U = 310.00$, $z = 1.14$, $p =.256$, $r = 0.17$). These results suggest that KS patients showed a similar ratings of emotion to their memory as the control group. However, the scores of emotional intensity overall (sum of emotional intensity) for a memory related to the first wave significantly differed between the KS group ($Mdn = 7.50$) and the control group ($Mdn = 10$), ($U = 365.50$, $z = 2.24$, $p <.05$, $r = 0.33$). Suggesting that KS patients scored lower emotional intensity overall than the control group. As for the emotional intensity for the first lockdown itself scores did significantly not differ between KS patients patients ($Mdn = 5.00$) and the control group ($Mdn = 5.00$), ($U = 310.50$, $z = 1.05$, $p =.295$, $r = 0.15$). Suggesting that KS patients had a normal emotional response for the first lockdown (see Fig. 2).

4. Discussion

The aim of this study was to investigate whether patients with severe amnesia due to KS could remember the first Covid-19 lockdown in The Netherlands, and whether they had comparable emotions and reliving of memory recall as healthy controls.
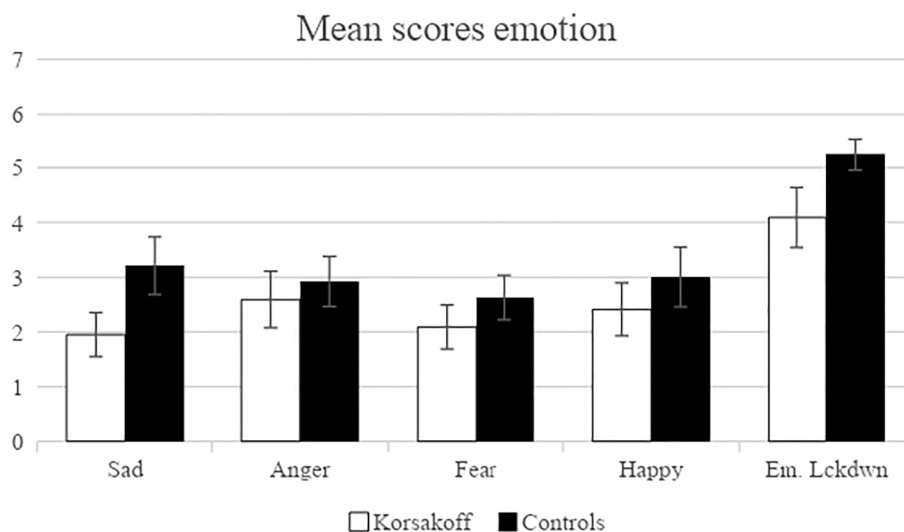
Fig. 2. *Mean Scores Emotional Intensity of KS Patients and Controls. Note.* Mean scores with standard deviation of emotion on a 1 (low)- to 7 (high)-point scale: sad, anger, fear, happy, Em. Lckdown = emotion for the first lockdown in March 2020. Error bars are standard error of the mean.

While KS patients had worse memory recall regarding the Covid-19 measures, many patients still had vivid reliving of memories despite the severe amnesia. Semantic information was also relatively preserved in KS. There were no differences between KS patients and healthy controls on impact, realness and reversed perspective which are important factors for reliving an event (Greenberg, & Knowlton, 2014). In patients, memory specificity was lower than healthy controls.

4.1. Memory specificity and reliving

Lower specificity of memory implies that KS patients are less able to recall a specific and detailed memory related to the first Covid-19 lockdown. Although, five of the twenty KS patients described a detailed, specific episodic memory; twenty patients were not able to describe with such detail. Memory for a worldwide, public and emotional event may be more enriched with episodic details than regular events. KS patients with more intact cognitive abilities were able to retrieve more specific memories and recalled more details, as indicated by a correlation between the cognitive screening instrument TICS-M and the Covid-19 memory recall. Our results are in line with earlier findings of Kessels & Kopelman, 2012; and the two studies performed by El Haj and colleagues (El Haj & Nandrino, 2017; El Haj & Nandrino, 2018) showing that KS patients still have spared abilities to recall emotional events. In contrast to these studies, here one-fourth of all patients had normal memory specificity, with both earlier studies finding generally compromised memory scores without preservations. Importantly, our results and that of El Haj & Nandrino (2018) highlight that patients diagnosed with KS still can have a strong subjective experience regarding the past, particularly when emotional valence is high. In our study, another one-fourth described a memory that lasted longer than 24 h but still contained details and situated in time and space. This result could be explained by the possible influence of the emotional impact of the global pandemic, and also the effects of the strong impact on memory preservation in severe amnesia patients. It might be that the Covid-19 lockdown was of more emotional relevance for the patients than 9/11 or the Paris terrorist attacks.The latter two were events that could be considered to be more removed from one daily' lives.

4.2. Semantic and episodic memory

KS patients scored relatively well on the semantic questions, with all patients scoring at least one point on semantic recall about the first lockdown in March 2020. This is consistent with several earlier studies indicating preserved flashbulb memory in KS (Tulving et al., 1991; Waring et al., 2014). In line with the study of Candel et al. (2003) and Janssen et al. (2022) we found that although KS patients scored lower than the healthy control group on semantic information of a specific event, the KS patients still had some preserved ability to remember the event. The results of our study add to the indication that KS patients can recall information without very specific cues for emotional and public events that are often repeated in the news following a media event such as terrorist attacks. The KS patients were also able to learn new information independently regarding the Covid-19 lockdown.

Another finding was that KS patients were able to retrieve more episodic than semantic knowledge about the lockdown. Interestingly, both groups remembered more episodic than semantic knowledge and this difference was the largest in KS patients. However, KS patients still performed worse than the control group. This result is in line with other studies (Mori et al., 1999; Budson et al., 2004; Waring et al., 2014) who affirm greater contribution of emotional-based networks like the amygdala when storing and retrieving episodic information for high emotional and worldwide events. The relative sparing of the amygdala within KS may account for the retained emotional memory in KS patients (Candel et al., 2003; Gandolphe & El Haj, 2018).

4.3. Emotion and memory

Emotion plays a pivotal part in the autobiographical and episodic memory system. Emotions activate thoughts and feelings associated with an event, which facilitates the retrieval of emotional memories (El Haj & Nandrino, 2017). Our results showed that the emotional intensity for an autobiographical memory was related to higher reliving in KS patients and healthy controls. Moreover, sadness was related to a stronger sense of reliving as well. These findings are in line with several studies (Candel et al., 2003; Budson et al., 2004; El Haj et al., 2016a; El Haj et al., 2016b; Luchetti & Sutin, 2017) stating higher reliving for emotional memories. Higher emotional intensity for a memory related to the first wave of Covid-19, led to more reliving of that memory. In addition, higher recall of internal details was related to higher emotional intensity which indicated that emotion is related to the active recall of episodic memories. The results show that despite the introspection difficulties and confabulations, patients with KS can experience some authentic subjective experience of the past when the emotional intensity of that memory is high (El Haj & Nandrino, 2018). This research offers an alternate view on the general consideration that KS patients suffer a diminished subjective experience. KS patients could benefit from highly emotional authentic subjective experiences (El Haj & Nandrino, 2018).

KS patients and the control group reported similar levels of emotions individually for a memory related to the first lockdown. We observed similar results on emotion for the first Covid-19 lockdown, suggesting that KS patients have preserved emotional feelings toward this worldwide and public event and their memories (Gandolphe & El Haj, 2018). The case study by Gandolphe & El Haj (2018) on the Paris attacks reported a comparable finding in one KS patient. These results confirm that for a daily life affecting period, extending beyond the laboratory, such as the Covid-19 pandemic, deficits in emotional processing can be overcome in KS patients. This result provides new knowledge about the emotional intensity of memories of KS patients having the same emotional response as controls for this worldwide event.

4.4. Memory details

One of the contributions of the present study was to acknowledge that such phenomena still hold for emotionally challenging events, such as the first wave of covid-19. However, the generated internal details show that KS patients are still able to re-experience an autobiographical memory, but this re-experience is still more reduced than in healthy controls. Better episodic re-experiencing of a memory was correlated with more internal than external details. In our study, KS patients provided less internal details to their memory related to the first Covid-19 lockdown than the control group. Murphy et al. (2008) found that KS patients and patients with other cognitive impairments recall more external details than the controls for a memory in the past year. In contrast, the internal to total ratio score was quite low in our patients. A possible explanation for the lack of difference in external details between the two groups in our study could be that the control group reported more specific memories containing more details. The control group shared more details along with details non-related to the main event of their memory, whereas the KS group kept close to the main event and describing less enriched memories.

4.5. Confabulations

In our study-two patients with severe confabulations were excluded from further analysis. One reason to do so is that we could not separate actual memories of the Covid-19 lockdown from confabulations based on the regular answers. Because the two patients systematically reported confabulations on the provoked-confabulations questions based on the Dalla Barba list, we excluded them from further analysis (Dalla Barba et al., 2020). There is no consensus on indexing the severity of confabulations within a clinical context objectively, because some patients do not confabulate on the Dalla Barba questionnaire, but confabulate based on proxy-based reports (Rensen, Oudman, Oosterman, Kessels, 2020).

5. Conclusion

To conclude, despite the lower memory scores than the controls, KS patients were still able to recall and relive events from the first wave of the Covid-19 pandemic in March 2020 – May 2020. Some of these memories were enriched with internal memory details stating higher episodic re-experiencing for this worldwide and emotional event. Higher emotional intensity was related to a more thorough level of autobiographical reliving in both KS patients and the controls. Furthermore, the amount of episodic information was more spared than semantic information of this major event, suggesting that KS patients are able to retrieve and learn new episodic and semantic information independently. In addition, new semantic information can be learned by the help of accidental rehearsal and emotional load, however the amount of recall is also related to spared cognitive and memory functioning. This study adds new evidence that despite the severe and clear memory impairments, episodic and semantic information about major, worldwide events can still be memorized in KS patients and that associated emotions may corroborate the recall of the events.

Authorship contributions

E.D. Herrmann: Conceptualization, Methodology, Visualization, Investigation, Data curation, Writing- Original draft preparation, Formal analysis. **A. Postma:** Visualization, Conceptualization, Validation, Writing - Review & Editing, Supervision. **E. Oudman:** Supervision, Conceptualization, Resources, Visualization, Writing - Review & Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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