



Consistency of memory for emotionally arousing events: A review of prospective and experimental studies

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Abstract

Although emotionally arousing events are more memorable than ordinary daily life events, the nature of memories for emotionally arousing events is widely debated. On the one hand, researchers consider memories for highly emotional events as malleable and subject to distortion, while on the other hand these memories are perceived as both indelible and consistent over the lifetime. Up till now, a systematic comparison of research findings on consistency of memory for emotional events is lacking. This paper is the first effort to summarize available studies on consistency of memory for emotionally arousing events and to address methodological limitations and suggestions for future research as well. In general, findings show that quality of the selected studies is sufficient to good, with studies with victims of assault and studies on war-exposure reaching higher quality scores than studies on flashbulb memories and experimental memory studies. Victims of assault or war-exposure tend to amplify their memories for the event, while results from flashbulb memory research and experimental research suggest that memory for emotional events is either stable or diminishes over time.

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1. Introduction

Although it is generally acknowledged that an event is more accurately and more vividly remembered when it is emotionally arousing (Bremner, Krystal, Charney, & Southwick, 1996; Rolls, 1990), differences in opinion about the nature and recall of memories for traumatic events remain. The nature of memories for traumatic events is widely debated in the popular and scientific literature.

On the one hand, researchers consider memories for traumatic events as both indelible and accurate over the entire lifetime (Bohannon, 1988; Brown & Kulik, 1977; Conway et al., 1994; Pillemer, 1984), while on the other hand such events are also perceived as malleable and subject to substantial distortion and alteration (Southwick, Morgan, Nicolaou, & Charney, 1997). According to Mechanic, Resick, and Griffin (1998), for example, emotional memories can be subject to failed, confabulated, or incomplete recall.

These different viewpoints reflect two distinctive concepts of how the brain stores memories. The first view is the so-called ‘static view of memory’, stating that the brain stores memories of an event like a time capsule or videotape. Despite the time that elapses, all memories will be accurate, stable, and unchanged from their original occurrence. The second concept is referred to as the ‘dynamic view of memory’. According to this view, memories can change over time and they are influenced by new events. Recollections of the original event can change over time. They can be incomplete, distorted, or even more complete (Zola, 1998). Support for the assumption that memories for trauma are indelible and consistent over time mainly seems to come from research into “flashbulb memory”. “Flashbulb memories” are remarkably vivid, detailed, and accurate recollections of the circumstances in which one first learned of an unexpected and shocking event, like the death of Princess Diana or the assassination of President Kennedy. Those flashbulb memories resemble a “photographic print”, complete with extreme detail (Brown & Kulik, 1977). Memory for these types of events is usually persistent and accurate, although some distortion can occur (Christianson, 1989; Neisser & Harsch, 1992; Schacter, 1996). Experimental research into emotion and memory also shows that memory for emotionally arousing events is generally accurate, with distortions occurring at the level of peripheral details instead of central aspects of an event (Cahill & McGaugh, 1995; Christianson, 1992; Heuer & Reisberg, 1990).

The notion of a number of authors that memory for trauma is malleable and subject to distortion is mainly based on experimental research into inaccuracies in the recall of neutral information, the misinformation effect and other memory errors, e.g., source monitoring errors, time-slice errors, and false childhood memories (Hyman & Loftus, 1998; Loftus, 1993, 2003; Loftus & Ketcham, 1994). The underlying assumption of their theoretical approach is that deficits in recalling traumatic events are attributed to the same processes of decay and interference as are deficits in memories for neutral information and ordinary events. Moreover, proponents of this viewpoint state that memory distortions can be induced by giving false post-event information. According to Hyman and Pentland (1996), even entire scenes of stressful events can be fabricated and inserted into autobiographical memory. Studies of real-life traumatic events also indicate that memories of these events are malleable and subject to substantial distortion (Fergusson, Horwood, & Woodward, 2000). However, there are also indications that these memories are generally persistent and often impressively accurate (Goodman et al., 1999).

A growing number of studies has investigated the extent to which people are consistent in their recall of a specific event over time. Among these studies, different terms and definitions are used to indicate consistency of memory. Sometimes, the term “accuracy” is used interchangeably with consistency. However, they refer to different concepts. A report can be highly consistent over time without necessarily being accurate. Consistency of memory can best be described as the same information being

reported at different points in time. Responses are also consistent even though no information at all can be remembered at different points in time. Inconsistency can be defined as a change in responses between reports over time. Here, a distinction can be made between omission errors, referring to a reduction in information in reports compared to previous reports, and commission errors, referring to an increase in information over time. In order to assess (in)consistency, assessments using exactly the same instrument should be performed on at least two different occasions.

As opposed to consistency, accuracy can be defined as the agreement between recall and an objective record or facts of what has occurred. In order to assess accuracy, an ‘objective’ assessment of facts has to be available, allowing verification of reported facts, which is in line with the definition by Fivush (1993): “Accuracy is the agreement between the individuals recall and either an objective record of the event or social consensus from other participants of the event as to what occurred” (p. 22).

In sum, although a high degree of inconsistency in recall does not support the notion that memory for traumatic events is indelible, both clinical and experimental research findings suggest that memories of emotionally arousing events are often well retained. Moreover, there is little basis in supposing that they are less susceptible to distortion than are memories of neutral information or ordinary events (Zola, 1998). Individuals seem to gradually recall traumatic events in the course of time because information about the event is available but often not directly accessible (Brewin, Dalgleish, & Joseph, 1996; Melchert & Parker, 1997). In the absence of empirical evidence for real-life traumatic events, however, it remains undecided whether inconsistencies always imply inaccuracy in recall of memory for real-life traumatic events.

Apart from conceptual problems, research has pointed out that other factors may influence consistency. One factor concerns the severity of the traumatic event. Those persons who suffer from more exposure to severe trauma may encode or retrieve information during the trauma differently (Foa, Molnar, & Cashman, 1995; Van der Kolk & Fisler, 1995) and are at higher risk for the development of PTSD at a later stage than those exposed to less severe trauma (Bremner & Brett, 1997; Koopman, Classen, & Spiegel, 1994; Marmar et al., 1994). Recollections of severe trauma are expected to be more consistent than less severe trauma (Krinsley, Gallagher, Weathers, Kutter, & Kaloupek, 2003). Another factor is the degree of involvement in the traumatic event. Events that are experienced directly by victims have found to be more consistently remembered than events that are experienced without personal involvement, for example, witnessing a crime. Furthermore, there appears to be a relation between psychological and psychiatric symptoms experienced at the time of, or shortly after an emotionally arousing event and inconsistency. Posttraumatic stress symptoms and peritraumatic dissociation in reaction to a traumatic event appear to be associated with amplification of memory following the event (Mechanic et al., 1998; Southwick et al., 1997; Wyshak, 1994). With regard to the nature of the information recalled, there are indications for a higher degree of consistency for the central core of information compared to specific details (Schacter, 1996). Another factor is the developmental phase in which the event to be remembered occurred. There are indications for more inconsistent memory reports when the events are experienced at a younger age (Ghetti, Goodman, Eisen, Qin, & Davis, 2002). Ultimately, the length of time between occurrence of an emotionally arousing event and first assessment of recall, as well as the time between first and subsequent assessments may also have an influence on the degree of consistency of reports of the event (Winningham, Hyman, & Dinnel, 2000).

The aim of this paper is to systematically screen and review available studies focusing on consistency of memories with regard to emotionally arousing negative events. Examining the available evidence, each of the studies will be reviewed according to aspects that have shown to be related to consistency of memory

for emotionally arousing events. Although the nature and recall of traumatic memories is widely debated, a systematic screening of the literature and comparison of research findings on consistency of memory is lacking. Also, relatively few studies have been conducted including samples of victims of a stressful or traumatic event. Prior to comparison of the study findings, the methodological quality of the studies will be systematically screened. Specific methodological problems will be discussed, followed by recommendations for future studies in this area. Implications for clinical and legal practice will be discussed as well.

2. Methods

2.1. Literature search

A literature search was carried out using the following electronic bibliographic databases: PsycINFO: 1887 to 2004, MEDLINE: 1966 to 2004, and Current Contents: 1995 to 2004. A computer search was carried out, using a wide range of key words¹ to indicate consistency of memory for emotionally arousing events. Reference lists of available reviews and studies were screened as well.

2.2. Inclusion criteria

Study reports were included if the following inclusion criteria were met: (a) The features of the event studied had to be either in line with criterion A of the DSM-IV definition: “a person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others” (American Psychiatric Association, 1994, p. 427), or presence of an emotionally arousing negative event without specific reference to the DSM criterion; (b) differences in reports of a traumatic event had to be assessed on at least two different times. Inconsistency of recall was operationalized as the total number of responses that changed from time 1 to time 2.

2.3. Grouping of studies

Specific groups of victims or samples or differences between types of events, and situations in which the event occurred were used as a basis to categorize the different studies. The first cluster (A) comprised studies of victims of sexual and physical assault; the second cluster (B) comprised studies of war-zone exposure; the third cluster (C) comprised studies of flashbulb memories and the fourth group (D) comprised experimental studies including both victims and non-victims.

2.4. Quality assessment

In order to compare the results of the different studies, their methodological quality should be taken into account. Quality of the studies included in this review was rated by two independent reviewers (AvG, EA). Cohen's κ was used to assess the agreement between the two reviewers and was found to be

¹ Keywords used in the literature search: consistency, stability, accuracy, reliability, narrative, discrepancies, change, autobiographical memory, retrospective, recall, memory, account, report, recollections, and flashbulb memory.

0.80. We formulated four criteria in order to rate the quality of the method used to examine consistency of memory. These were:

- (1) Operationalization of consistency of memory: If consistency of memory was clearly operationalized, the study received a score of 1. If no clear operationalization was provided, a score of 0 was given.
- (2) Selection of the sample: Representative samples received a score of 1. If no representative sample was used, a 0 score was given.
- (3) Type of assessment of memory of the event: (a) If data were primarily collected through interviews in a face to face setting, the publication received a positive score. If data were collected through self-report questionnaires, a 0 score was given. (b) If a standardized procedure was used, including the use of similar instruments at first and later assessments, the publication received a positive score, if no standardized procedure was used, a 0 score was given. (c) If data were collected through validated instruments, the study received a positive score. If no validated instrument was used, a 0 score was given. If criteria a, b, and c were all rated positive, a score of 1 was given. If only one criterion was rated positively, the publication received a score of 0.33, if two were rated positive, a score of 0.66 was given.
- (4) Appropriate statistical analyses: If statistical analyses were used appropriately, without violation of the assumptions of statistical tests, and if important parameters were reported, a score of 1 was given. If statistical analyses were used inappropriately, i.e., if assumptions were violated, the publication received a 0 score.

For each study report, a total quality score was calculated based on the number of criteria that were fulfilled. All four criteria could receive a total score of 1, so quality scores ranged from 0 (lowest quality) to 4 (highest quality).

3. Results

3.1. *Studies included in the review*

Thirty-seven studies were identified through the combined search strategies and found to be eligible for inclusion in the study. The identified studies were grouped according to the criteria described in the Method section. Table 1 summarizes the clusters of studies included in the review, details of the design, methods, and sample. For each of the studies, the research quality was assessed according to the criteria described above. The total quality score of the studies varied from 1.33 to 4, with an average of 3. The earliest study was published in 1984 and the most recent study was published in 2004.

3.2. *Studies including victims of assault*

Studies included here comprised victims of childhood sexual abuse, recent sexual abuse, or physical maltreatment. Seven papers were included in this cluster, comprising eight separate studies. The overall quality of the studies in this cluster was high ($M=3.5$), with three studies scoring positive on all four criteria. Four studies were given a score of 3.66 and one study obtained a score of 1.33. In four out of

Table 1
Methodological aspects and quality of the studies by cluster

Author(s), year	<i>N</i>	Population	Response, first assessment (%)	Response, second assessment (%)	Age	% men	Method of assessment, interview(I)/self-report(S)	Interval event, first assessment	Interval, time 1, time 2	Quality
<i>Cluster A victims of assault</i>										
Foa et al., 1995	14	Sex. assault	n.a.	n.a.	30.1	0	S+I	4.85 years	1 month	1.3
Mechanic et al., 1998	92	Rape	n.a.	n.a.	29.2	0	S+I	2 weeks	2.5 months	4
Goodman et al., 1999	50	Abuse	80	92.6	39.9	42	I+S	–	2 weeks	4
Fergusson et al., 2000	1265	Cohort	78	n.a.	21	50.2	I	Min. 2 years	3 years	4
Zoellner et al., 2001	30	Assault	n.a.	n.a.	31.4	0	I+S	10.13 days	10 weeks	3.6
Zoellner et al., 2001	60	Assault	n.a.	n.a.	31.4	0	I+S	31.67 days	86.13 days	3.6
Ghetti et al., 2002	222	Abuse	n.a.	n.a.	7.3	45	I	–	3 days	3.6
Aalsma et al., 2002	217	Abuse	n.a.	48.9	17	17	S	–	7 months	3.6
<i>Cluster B war-zone exposure</i>										
Wyshak, 1994	30	Refugees	n.a.	n.a.	44.3	40	S	–	1 week	3
Southwick et al., 1997	59	Gulf War	95	n.a.	29.9	78	S	1 month	2 years	3.6
Roemer et al., 1998	460	Somalia	n.a.	n.a.	26.7	92	S+I	1 year	21.3 months	3.6
Niles et al., 1999	38	Vietnam	n.a.	34.3	39.7	100	S+I	30 years	4–8 years	4
King et al., 2000	2942	Gulf War	n.a.	22	30.2	92	S	5 days	18–24 months	3.6
Bramsen et al., 2001	137	Cambodia	55	30	29.1	97	S	2.5 years	9 months	3.3
Herlihy et al., 2002	39	Refugees	n.a.	90.7	39.5	53.5	I+S	–	3–32 weeks	3
Wessely et al., 2003	2370	War veterans	n.a.	78	30–44	78.7	S	5.5 years	3 years	3.6
Krinsley et al., 2003	76	Vietnam	n.a.	88.4	49	100	S+I	30–39 years	2–7 days	4
<i>Cluster C flashbulb memories</i>										
Pillemer, 1984	121	Assassination attempt Reagan	45	47	39	49	S+I	1 month	6 months	2.6
McCloskey et al., 1988	45/27	Challenger	90	7	n.a.	n.a.	S	3 days	9 months	2.3
Christianson, 1989	40	Olof Palme	n.a.	10	37.8	50	I	42 days	12 months	3.6

Neisser & Harsch, 1992	44	Challenger	n.a.	41.5	Students	47	S	1 day	30 months	2
Norris & Kaniasty, 1992	65	Hurricane Hugo	70	18	44	n.a.	I	6 weeks	9 months	2.6
Schwarz et al., 1993	12	School shooting	80	50	n.a.	n.a.	S	5 months	12 months	1.6
Weaver, 1993	22	Bombing Irak	n.a.	18	19–23	n.a.	S	2 days	3,12 months	1.6
Conway et al., 1994	396	Thatcher	n.a.	n.a.	Students	n.a.	S	24 days	12 months	2.6
Neisser et al., 1996	76/41/44	Earthquake	n.a.	26.2/13.2/ 31.9	Students	n.a.	S	2/3/15–21 days	18 months	3.3
Christianson & Engelberg, 1999	203	Estonia	n.a.	32	n.a.	59.6	I	1 day	12 months	3.6
Schmolck et al., 2000	63	O.J. Simpson verdict	n.a.	60	Students	52	S	3 days	15,32 months	2.6
Winningham et al., 2000	65	O.J. Simpson verdict	n.a.	n.a.	Students	12	S	5 h/1 week	8 weeks	2.6
Curci et al., 2001	124/105	Death of Mitterand	n.a.	34.5	28.4/34.5	29.2/48.3	S	1–2 months	1 year	2.3
Hornstein et al., 2003	66/49	Diana	100	76/53	Students	29/30	S	1 week	3–18 months	2.3
Talarico & Rubin, 2003	54	September 11	n.a.	n.a.	18.7/17.8/ 19.1	22/33/22	S	1 day	1,6,32 weeks	2.3
Smith et al., 2003	93	September 11	n.a.	n.a.	19.3	25.8	S	1 week	6 months	2.6
Tekcan et al., 2003	483?	September 11	n.a.	n.a.	28.89	35?	S	3 days	6,12 months	2.6
Lee & Brown, 2003	142	September 11	n.a.	n.a.	Students	?	S	4–24 h/ 10 days	7 months	2.6
<i>Cluster D experimental studies</i>										
Fisher & Cutler, 1995	33	Students	n.a.	n.a.	Students	n.a.	S	40 min	5 days	2.3
Fisher & Cutler, 1995	27	Students	n.a.	n.a.	Students	n.a.	S	20 min	2 days	2.3
Fisher & Cutler, 1995	135	Students	n.a.	n.a.	Students	n.a.	I	1–3 days	2 weeks	2.3
Fisher & Cutler, 1995	85	Students	n.a.	n.a.	Students	n.a.	I	1–2 days	1 week	2.3
Brewer et al., 1999	62	Students	n.a.	n.a.	24.8	30.6	S	–	2 weeks	2.6
Candel et al., 2004	52	Students	n.a.	79	20	11.5	S	–	3–4 weeks	2.3

eight studies, the victims were all female. The majority of studies used standardized interview measures for the assessment of consistency of memory. The time period between the index event and time 1 ranged from 10 days to 4.85 years. The interval between time 1 and time 2 varied from 3 days to 36 months, with an average interval of 6.6 months. For detailed information on the methodological aspects of the studies, see also [Table 1](#).

Although studies used different terms to indicate consistency, the primary focus of all eight studies was to examine consistency of memory for the index event over time. All studies found discrepancies in reports of the index event over time.

In their study, including female rape victims, [Mechanic et al. \(1998\)](#) found that, while memory deficits were common 2 weeks following the assault (32%), memory for details of the index event improved significantly over a 3-month period ($p < 0.05$). Only 16% reported significant amnesia 3 months after the rape experience.

[Fergusson et al. \(2000\)](#) found that reports of childhood physical and sexual abuse were unstable and inconsistent over time ($p < 0.01$). Half of those who reported abuse at one assessment failed to report it at another one. Inconsistency was unrelated to the respondent's psychiatric status. The results from [Aalsma, Zimet, Fortenberry, Blythe, and Or \(2002\)](#) showed that stability of reports of childhood sexual abuse (CSA) by adolescents was poor. Fifty-eight percent reported no abuse at both points in time, 20% reported CSA on both occasions, while 22% were inconsistent reporters of CSA. According to [Ghetti et al. \(2002\)](#), children's reports of sexual abuse were more consistent than were reports of physical abuse. The memories of older children were more consistent compared to those of younger children ($p < 0.01$) and reports of sexual abuse from girls were more consistent than reports from boys ($p < 0.01$).

[Goodman et al. \(1999\)](#) interviewed men and women with a serious mental illness about adult physical and sexual abuse, childhood sexual abuse, and PTSD symptoms. They found that reports of abuse were fairly consistent, with women being even more consistent than men. Men showed a tendency to report significantly less experiences of sexual abuse since age 16 and sexual abuse in the past year at the second assessment than at the first one ($p < 0.05$). Both men and women were consistent in their reports of the severity of PTSD symptoms.

3.2.1. *Studies including a psychotherapeutic intervention*

Intervention studies differ from the studies above, because the effect of the intervention can be of influence on consistency of memory. [Zoellner, Sacks, and Foa \(2001\)](#) conducted two studies among female victims of recent assault. The results of study 1 indicate that memory of the fear associated with the assault remained stable, while memory of general emotional intensity and memory of dissociative intensity for the traumatic event changed over time ($p < 0.06$), reflecting a trend that did not reach statistical significance. The second study compared treatment seeking assault victims, with either acute or chronic PTSD symptoms. Victims diagnosed as having acute PTSD reported a decrease in memory for emotional and dissociative intensity for the index event ($p < 0.05$), while victims with chronic PTSD reported an increase in memory for general emotional and dissociative intensity of the index event 12 weeks after the initial report ($p < 0.05$). According to [Foa et al. \(1995\)](#), narratives of rape tended to become longer from pre- to post-treatment assessment ($p < 0.08$), reflecting a trend. Furthermore, the percentage of aspects representing actions and dialogue decreased ($p < 0.06$) and the aspects representing thoughts and feelings increased 18 weeks after the initial report ($p < 0.05$). This increase in organization of the narratives was related with an improvement in depression after treatment ($p < 0.02$). However,

reliability and validity of the findings of the latter study is questionable since most of the quality criteria were not fulfilled.

3.3. *Studies of war-zone exposure*

Studies included here comprised war veterans and mainly male subjects. Nine studies fulfilled the inclusion criteria. Two studies included soldiers that served in peace-keeping missions, two studies included Gulf War veterans, one study included both Gulf War and Bosnia veterans, two studies included refugees, and two studies included Vietnam veterans. The quality scores of the papers in this cluster were generally high ($M=3.5$); all papers were given a score of 3 or higher. One study scored positive on all criteria, five studies received a score of 3.6, and one study received a score of 3.3. Detailed information on methodological aspects of the studies is presented in [Table 1](#). Most studies used self-report questionnaires to assess consistency of memory for the index event. Men were over represented in most studies, ranging from 40% to 100%. The length of time between the index event and time 1 ranged from 5 days to 39 years, which is an extremely wide range. The interval between time 1 and time 2 varied from 1 week to 79 months, with an average interval of 23.3 months.

All nine studies described changes in reports of war-zone exposure over time. Three studies also found an interaction between PTSD symptom severity and amplification of memory. According to [Niles et al. \(1999\)](#), most reports of trauma exposure are relatively stable over time. However, in their study with treatment seeking Vietnam veterans, some participants showed dramatic changes in report over time. [Southwick et al. \(1997\)](#) found that recollections of combat-related events were not stable over time ($p<0.02$). Eighty-eight percent of Gulf War veterans changed at least one of their responses over time. Seventy percent of the respondents recalled an event at time 2 they had not reported at time 1, while 46% reported an event at time 1 and failed to mention it at time 2. According to [Southwick et al. \(1997\)](#), inconsistency of memory for combat exposure appeared to be significantly associated with PTSD symptoms ($p<0.002$). Respondents with higher PTSD scores 2 years after their return from the Gulf War tended to amplify their memory for combat exposure. [King et al. \(2000\)](#) also found that reports of war-zone stressor exposure appeared to be vulnerable to some shifts over time. In accordance with the findings of [Southwick et al. \(1997\)](#), most changes in answers in their study were of the no to yes type. The total number of changes in report of stressor exposure from time 1 to time 2 was modestly associated with PTSD symptom severity at time 1 and time 2 (0.14, 0.24, $p<0.001$). Results from [Roemer, Litz, Orsillo, Ehlich, and Friedman \(1998\)](#) also support the dynamic view of memory. They found that memories of war-zone exposure were not fixed or indelible, but that they were variable over time. Soldiers who had served in the peace-keeping mission in Somalia reported a significant increase in the frequency of war-zone exposure ($p<0.001$) over a 1–3-year period. PTSD symptom severity at follow-up, in particular intrusive symptoms, appeared to be significantly associated with change in reports of war-zone exposure ($p<0.01$). [Wessely et al. \(2003\)](#) also found inconsistency in reported military hazards over time. They found that Gulf War veterans showed an increase in reports over time ($p<0.01$), while soldiers who served in Bosnia showed no significant increase of memory over time.

[Bramsen, Dirkzwager, van Esch, and van der Ploeg \(2001\)](#) found that 88% of the peace-keepers changed at least one answer from time 1 to time 2 on a 16-item trauma checklist, although none of the participants showed an increase in the number of reported events over time. Also, inconsistency in

reports of exposure to stressful events was not significantly associated with PTSD symptom severity, which is in contrast with findings from previous studies by Southwick et al. (1997), Roemer et al. (1998), and King et al. (2000).

Wyshak (1994) examined refugees from Southeast Asia in a psychiatric clinic about traumatic events and psychiatric symptoms. Results showed that number of traumatic events reported increased slightly but not significantly from time 1 to time 2. Psychiatric symptom scores increased significantly from time 1 to time 2 ($p < 0.05$). Number of traumatic events reported was positively correlated with both PTSD-related symptoms and non-PTSD-related symptoms at time 1 ($p < 0.003$, $p < 0.007$). A remarkable finding is that those who were inconsistent in their reports of the traumatic events showed less severe symptoms over time ($p < 0.009$). According to Herlihy, Scragg, and Turner (2002), discrepancies in the reports of asylum seekers were common. They interviewed Kosovan Albanians and Bosnians about a traumatic event and a non-traumatic event twice over a period of 3 to 32 weeks. Results show that discrepancies were found for all participants. More discrepancies were found in the peripheral details than in central details ($p < 0.05$). Also, the length of time between the interviews and posttraumatic stress symptoms was significantly related to the number of discrepancies. Participants with high levels of posttraumatic stress at time 1 showed more discrepancies when the time between interviews became longer ($p < 0.05$). Krinsley et al. (2003) interviewed male Vietnam veterans twice on exposure to traumatic events. Results showed that average number of reported times being exposed to traumatic events increased significantly from interview 1 to interview 2 ($p < 0.05$). Only 11% reported the same number of events on both occasions, whereas 38% reported fewer events over time and 51% reported more events. In addition, events that were directly experienced were more consistently remembered than events that were experienced from a witness perspective. Also, more severe traumatic events were remembered more consistently. With regard to the period in life in which the event occurred, results showed that the number of reported events from adulthood and childhood both increased over time, but only childhood events showed a significant amplification from T1 to T2 ($p < 0.05$).

3.4. *Studies of flashbulb memories*

Studies included in this cluster comprised studies of flashbulb memories. All studies included unexpected events that were experienced by or known to a large group of people. However, there was considerable diversity with regard to the types of events included, which limited a strict comparison of the research findings. Eighteen studies were included in this cluster. The studies were grouped into three categories according to similarities of the nature of the events: (1) assassination attempts, (2) disasters, and (3) public persons. Eventually, two studies that could not be included in one of the three categories were classified as (4) ‘other’ studies, of which the results are described separately.

The overall quality of the research papers in these clusters was relatively low ($M = 2.5$), due to the frequent use of self-report questionnaires and student populations. Quality scores ranged from 1.6 to 3.6, with only three studies obtaining a score higher than 3 (see also Table 1). The studies in this cluster differ from the studies in clusters A and B, in that the subjects in the studies in cluster C were often not directly exposed to traumatic events, but they were indirectly confronted with an emotionally arousing negative event, e.g., obtaining information on an assassination of a celebrity or disaster, through the media. The majority of studies used self-report questionnaires to assess consistency of memory. Most subjects

included in these studies comprised either students or community samples. The time period between the initial event and time 1 varied from 1 day to 5 months. The interval between time 1 and time 2 varied from 1 week to 30 months.

3.4.1. Assassinations and assassination attempts

Pillemer (1984) found in his study of the 1981 assassination attempt on Reagan that memories for this flashbulb event were highly consistent over a 6-month interval. The intensity of the emotional reaction and the extent to which the event came as a surprise, as reported by the subjects, were significantly associated with consistency of memory ($p < 0.04$).

In contrast, Christianson (1989) reported that memories for assassination of the Swedish Prime Minister Olof Palme were significantly ($p < 0.001$) reduced over time. Eighty percent of the subjects showed consistency over time with respect to the central aspects of the event. Regarding specific details, only 53% of the subjects' recollections were consistent.

3.4.2. Disasters

McCloskey, Wible, and Cohen (1988) found that flashbulb memories for the explosion of the space shuttle challenger were quite consistent over time, although they were also subject to normal forgetting and inaccuracies. Over a 9-month retention interval, 60.7% of the responses were consistent, 5.6% of the responses were inconsistent, 8.4% were not remembered at time 2, 6.5% of the responses were more specific, and 18.7% were more general. Neisser and Harsch (1992) also questioned participants on their memories for the explosion of the challenger. Most subjects told the same stories at time 1 (1 day) and time 2, with an average interval of 2.5 years. However, most of these memories were not very consistent, since they showed major discrepancies between the recall and the original report. Over 25% of the subjects were inconsistent on all questions. In their study, Norris and Kaniasty (1992) found that self-reports regarding Hurricane Hugo were remarkably stable over a 9-month period. Eighty-eight percent of the responses were the same at time 1 and time 2. According to Christianson and Engelberg (1999), recall of the Estonia ferry disaster was fairly inconsistent. After 6 months, subjects were able to recall the central aspects of the event to some degree (69%), but they showed considerable loss of memory for specific details (47%).

Neisser et al. (1996) studied recollections of three groups of informants—two in California and one in Atlanta—regarding the 1989 Loma Prieta earthquake in California. Results showed that personal involvement appeared to be predictive of greater consistency. The Californians' recall (99%, 96%) was more consistent than the recollections of the inhabitants of Atlanta (55%).

Talarico and Rubin (2003) studied the consistency of memories for the terrorist attacks of September 11th and of an everyday event. Results indicated that both the flashbulb and everyday memories show a decline over time. However, subjects had more confidence in their flashbulb memories. In another study on consistency of memory of September 11th, Smith, Bibi, and Sheard (2003) found that Canadian Psychology students' autobiographical memory for details when learning about the event was significantly ($p < 0.001$) more consistent (65.3%) than their memory for the emotionally arousing event itself (30.9%). These findings were confirmed by Tekcan, Ece, Gulgoz, and Er (2003) who investigated consistency of memory following the event of 11th. Consistency of autobiographical memory was significantly higher than consistency of memory for event details ($p < 0.01$). Results from Lee and Brown (2003) showed that 66.5% of the participants in their study on September 11 were categorized as having flashbulb memories. Although subjects gave significantly less information at a 7-month follow-

up ($p < 0.01$), most of the reports were partially (12.7%) or completely (75.5 %) consistent, only few reports were completely inconsistent (11.8%).

3.4.3. Public persons

In a study on the acquittal of O.J. Simpson, [Winningham et al. \(2000\)](#) found that memory reports after an 8-week interval were less consistent when the first report followed within 5 h of the acquittal than when the report was delayed (1 week after the event) ($p < 0.02$). According to [Schmolck, Buffalo, and Squire \(2000\)](#), recollections of the O.J. Simpson trial were more accurate at a follow-up after 15 months (50%) than after 32 months (29%). However, this difference was not significant. [Conway et al. \(1994\)](#) found that memories of U.K. citizens for the resignation of Margaret Thatcher were fairly consistent over time, while memories of a non-U.K. group were not. Over 86% of the U.K. citizens had flashbulb memories, compared to 29% of the none-U.K. group 1 year following the event. The level of importance attached to the event and the level of affective responses were significantly associated with the formation of flashbulb memories ($p < 0.01$). Also, [Curci, Luminet, Finkenauer, and Gisle \(2001\)](#) found that memory for the death of former French President Mitterrand remained more stable over time for French people compared to those with Belgian nationality ($p < 0.001$). Although both groups showed impaired memories over time, the French were also more confident about their recollections of flashbulb memory attributes.

[Hornstein, Brown, and Mulligan \(2003\)](#) examined US student's flashbulb memories concerning the death of Princess Diana. The results showed that the reports were both accurate and consistent over an 18-month interval. Emotional intensity and rehearsal (talking about the incident) were both related to accuracy.

3.4.4. Other studies

[Weaver \(1993\)](#) found that psychology students' memories of both the bombing of Iraq in 1991 and a personal event were subject to normal forgetting. These memories were not very accurate following a 3-month delay, but showed little change from 3 months to a year. Confidence levels for memories of the circumstances when learning about the bombing of Iraq were significantly higher ($p < 0.05$).

[Schwarz, Kowalski, and McNally \(1993\)](#) found in their study on a manmade disaster that all self-reports of school personnel after a school shooting were subject to change over time. Subjects showed either a decrease or an increase in reported information over a 12-month period. Decreases were more common. An increase in reported information appeared to be associated with more PTSD symptoms at initial assessment ($p < 0.01$), while a decrease appeared to be associated with a reduction in symptoms of anxiety and depression and an improvement of self-confidence ($p < 0.04$).

3.5. Experimental studies

Studies included in this cluster comprised experimental studies. Three studies were included in this cluster. The quality scores were rather low (2.3) and were the same for all three studies. All studies included a student population.

In a study by [Brewer, Potter, Fisher, Bond, and Luszcz \(1999\)](#), 62 undergraduate students were asked to watch a video, showing a bank robbery. They completed a questionnaire 1 h after watching the video. Two weeks later, respondents were interviewed again using the same questionnaire. Except two, all respondents reported contradictory information.

In their experiment, [Candel, Smeets, and Merckelbach \(2004\)](#) showed female students an emotional fragment of the movie “American History X”. Students were asked to provide a detailed written account of the movie fragment on two different occasions, immediately afterwards and 3 to 4 weeks later. The mean number of discrepancies between the two accounts was 6.13 (S.D. 2.41, range 2–13). Results show that inconsistencies were not related to accuracy of the testimonies.

[Fisher and Cutler \(1995\)](#) performed four experiments with undergraduate students to explore the relationship between consistency and accuracy of eyewitness testimony. Overall, the average proportion of consistent statements was 76%. In accordance with [Candel et al. \(2004\)](#), consistency of reports was not found to be predictive of accuracy.

4. Discussion

The current review first of all shows that worldwide relatively few studies have been conducted on consistency of emotionally arousing events. Moreover, with exception of the studies of flashbulb memories, the studies in all other categories have been published in recent years, which is surprising considering the ongoing discussion about the nature and recall of memories for traumatic events over the last decennia. This might be partly explained by progress of scientific research in this area, where initially, research into memory processes underlying the recall of neutral events was expected to provide answers that could be generalized to the recall of emotionally arousing events. Research evidence, however, has revealed that both emotional reactions at the time of occurrence of an event and present mood may distort memories of the event ([McNally, 2003](#)). The current review is the first effort to investigate this issue in detail by screening and comparing available studies.

Results of this review show that overall quality of the studies varied from sufficient to good, ensuring the reliability and validity of the outcomes of most of the studies included. The quality scores of both studies with assault victims and victims of war-exposure were high, in contrast with the overall quality of the flashbulb studies and experimental studies. In the flashbulb memory cluster, as well as in the experimental cluster, criteria for the selection of the sample, use of interview measures, and use of a standardized instrument were often not fulfilled.

Furthermore, all studies in cluster C (flashbulb memories) showed either fairly consistent memory reports over time or a tendency towards a decline in memory reports (normal forgetting), while in clusters A (victims of assault) and B (war-zone exposure) amplification of memory was more common with nine studies finding an increase in memory reports for the initial event. In cluster D (experimental studies), all studies found inconsistency of memory reports. The differences between the clusters in the degree and direction of inconsistency can be partly explained by the nature of the traumatic event, the extent of involvement, and the amount of psychological or psychiatric symptoms present.

With regard to these factors of influence to consistency, results show that, although studies included in this review were all focussing on consistency of memory, the concept of consistency was not always clearly distinguished from the concept of accuracy, due to the absence of operational definitions for both concepts. It is generally known that “accuracy” of memory for emotionally arousing events is difficult to establish, because detailed objective reports of the traumatic event are often not available. Instead of assessing accuracy, research has indicated that it has been more feasible to compare memory reports obtained soon after the event with reports obtained at a second point in time after the event. “Consistency is better measurable and is a necessary (though not sufficient) condition for accuracy” ([Talarico & Rubin,](#)

2003, p. 455). According to McNally, “consistency of reports over time has served as a proxy measure for memory accuracy” (p. 49).

From this review, it appears that the degree of involvement in and the severity of emotionally arousing events tends to be associated with greater consistency over time or amplification of memory (Neisser et al., 1996). In line with these findings, results from the study of Krinsley et al. (2003) show that full-fledged traumatic events were more consistently remembered. Studies including victims who were personally involved in or directly exposed to the negative event revealed a different pattern than flashbulb studies or experimental studies, in which subjects were not personally involved in an emotional event. Instead of consistent responses or a decline in memory over time, their memory reports showed an amplification of memory.

Van der Kolk and Fisler (1995) already provided evidence for the fact that the emotional intensity of an emotionally arousing event interferes with the construction of a coherent narrative of what happened. Gradually, individuals seem able to recall more information about the event, which apparently is available but not directly accessible. Irrespective of the level of arousal during encoding, presence of PTSD and dissociative symptoms or current mood may also influence the consolidation and retrieval of memories for the traumatic event (McNally, 2003). Of those studies that looked at the relation of symptoms of PTSD and/or dissociation and inconsistency, the majority showed that an increase in PTSD symptoms was significantly associated with inconsistency of reports. Respondents with more PTSD symptoms were more likely to amplify their memory for the emotionally arousing event (King et al., 2000; Roemer et al., 1998; Schwarz et al., 1993; Southwick et al., 1997; Wyshak, 1994; Zoellner et al., 2001). Non-PTSD-related symptoms were also found to be related to the amount of reported information (Herlihy et al., 2002). Thus, trauma-related symptoms are negatively influencing the consistency of memory of a traumatic event over time. With regard to the nature of reported information, memory of stressful events appears to be more extensive than memory of non-stressful events; especially the central and critical details are better remembered, but not the peripheral details (Bremner et al., 1996). Of those studies who investigated differences between consistency of reports of central and peripheral information, all found that central aspects of the event were more consistently remembered than the specific details (Christianson, 1989, 1992; Herlihy et al., 2002).

The period in life in which a traumatic event occurs tends to be associated with memory inconsistency. Krinsley et al. (2003) and Ghetti, Goodman, Eisen, Qin, & Davis (2002) found that events occurring at a younger age are associated with less consistent memory reports. This effect may be partly explained by the long time period between the event and follow-up assessments.

The studies in this review used different time-periods between occurrence of the event and baseline assessment, and between baseline and second assessment to assess consistency over time. Overall, it appeared that the degree of consistency increased with a longer time period between the event and first assessment, and decreased as the time period between first and subsequent assessments became longer.

According to Winningham et al. (2000), the consistency of memories of flashbulb events depends on the point in time when the initial memory report of the event was obtained. A longer delay between a flashbulb event and the initial report appears to be associated with greater consistency of memory. Herlihy et al. (2002) and Schmolck et al. (2000) mention that not only the interval between the initial event and the first assessment matters, but that the length of time between baseline and second assessment also influences consistency of reports. They found that, when more time elapsed between assessments, reports became less consistent.

4.1. Methodological considerations

Although overall quality of the studies appeared to be sufficient or good, we identified a number of shortcomings among the studies, limiting a strict comparison of the findings. A common problem concerns the fact that consistency of memory was often not defined and measured in a standard way across all studies. Many studies used self-report questionnaires to assess consistency and some studies failed to use the same questionnaire at follow-up, which makes it almost impossible to assess consistency of memory over time. Often, no details were provided on the psychometric quality of the used instruments. Also, different coding systems were used to compare memory reports over time.

Overall, the majority of studies included small samples, which often did not appear to be representative. In the category of experimental studies, only three studies were identified, limiting generalization of the outcomes. In some of the clusters, especially in cluster A and cluster B, either women or men were overrepresented.

A specific characteristic of flashbulb memory studies, which is absent in the other clusters, is the important role of the media. Therefore, it is likely that flashbulb memories are partly determined and probably strengthened over time by contacts with newspapers, internet, and television (Winningham et al., 2000).

4.2. Implications for clinical and legal practice

In cases where an individual has been personally affected by a stressful or traumatic event, the absence of a complete reconstruction of the event in the first phase after the event is likely to be related to the emotional reactions at the time of the event and/or at later points in time when the event is discussed again. On the basis of the review, it can be concluded that it is likely that additional details of an emotionally arousing event may be remembered at a later stage. It is, however, unlikely that an individual will not remember the event at all or that the information concerning the event will be entirely distorted at a later stage. If an individual is not able to remember certain details at one point in time, it is recommended to address this again, at a later stage. When this is done, it is very important, both in clinical and in legal practice, to avoid the use of suggestive questions. Using standard and non-suggestive questions will enhance the consistency of reports (Krackow & Lynn, 2003).

Results of this review have implications for legal practice. Memory is a reconstructive process, which is prone to errors. Therefore, we cannot fully rely on its accuracy, completeness, and consistency. Eyewitness testimonies completed in situations where a victim is showing emotional reactions may not be entirely reliable. Testimonies completed at an early stage following a crime may be incomplete and inaccurate, in particular with regard to important details of an event. However, reports of criminal events can be highly consistent over time, without necessarily being accurate. Therefore, one has to be cautious using consistency as an indicator of accuracy and drawing conclusions from a single testimony (Morgan et al., 2004; Porter, Spencer, & Birt, 2003).

With regard to clinical practice, results indicate that therapists are not able to draw conclusions about the occurrence or accuracy of traumatic events in a patient's history. Fortunately, in most professional guidelines of memories of traumatic events, this limitation is acknowledged and therapists are advised to refrain from conclusions about the veracity of memories of trauma in clinical and legal settings (Health Council of the Netherlands, 2004).

4.3. Recommendations for future research

Assessment of accuracy of memory is complex and often consistency is used as a proxy measure for accuracy. Therefore, future studies on consistency of memory should include operational definitions of consistency. The methods used to assess consistency vary considerably across the different studies, thus limiting the possibilities to conduct more quantitative meta-analyses. Standardized measures for the assessment of consistency of memory are needed. Furthermore, use of interview measures to assess reports of an emotionally arousing event instead of self-report questionnaires is recommended. It is generally believed that interview measures are more reliable and more valid than self-report questionnaires (Dohrenwend, 1973; Southwick et al., 1997). More research is needed to investigate inconsistency of memory over time in more detail. For example, a distinction may be made between differences in consistency of reports of central and peripheral information and objective versus subjective aspects of an event. Inconsistencies may also be specified in omission and commission errors. In order to determine the association between consistency and accuracy, prospective studies are required addressing both concepts.

According to McNally (2003), not only mood at the time of occurrence of the event, but also at the time of reporting the event or discussing the event may influence the consistency of the reported information. Therefore, assessment of stress- or trauma-related psychological reactions, psychiatric symptoms, as well as general mood assessments should be carried out when investigating consistency of memory. Future studies should also take into account critical periods in which the diagnosis of trauma-related disorders are determined, such as acute stress disorder, which is being assessed within 1 month following an event, and PTSD, which is assessed within 3 months. The influence of specific psychological and psychiatric symptoms, such as dissociative and PTSD symptoms on the recall and consistency of memories of emotionally arousing events, so far has not been fully explained by experimental studies among non-victims. Even though in a number of these studies arousal of stress was generated in an artificial way, it is impossible, due to justifiable ethical limitations, to fully replicate traumatic stress in a laboratory (Terr, 1991). Therefore, studies should consider including both victims and non-victims in experimental studies assessing general information processing aspects as well as specific recall processes for traumatic events.

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