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## Shorter communication

## Eye movements reduce vividness and emotionality of “flashforwards”

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## ABSTRACT

Earlier studies have shown that eye movements during retrieval of disturbing images about past events reduce their vividness and emotionality, which may be due to both tasks competing for working memory resources. This study examined whether eye movements reduce vividness and emotionality of visual distressing images about feared future events: “flashforwards”. A non-clinical sample was asked to select two images of feared future events, which were self-rated for vividness and emotionality. These images were retrieved while making eye movements or without a concurrent secondary task, and then vividness and emotionality were rated again. Relative to the no-dual task condition, eye movements while thinking of future-oriented images resulted in decreased ratings of image vividness and emotional intensity. Apparently, eye movements reduce vividness and emotionality of visual images about past and future feared events. This is in line with a working memory account of the beneficial effects of eye movements, which predicts that any task that taxes working memory during retrieval of disturbing mental images will be beneficial.

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## Introduction

In recent years, increasing attention has been directed to the role of mental imagery in psychopathology. Intrusive memories of traumatic events are hallmark symptoms of PTSD. Such memories typically take the form of vivid visual images (e.g., Ehlers et al., 2002), but may involve other senses (e.g., witnesses of a train crash suffered from auditory images of the crash and victims; Engelhard, van den Hout, Arntz, & McNally, 2002). Spontaneous vivid images from earlier adverse events occur in several disorders, including depression, OCD, panic disorder, social phobia, and bulimia nervosa (e.g., Engelhard, Arntz, & van den Hout, 2007; see Hackmann & Holmes, 2004).

How does one recover from such disturbing images? Cognitive approaches to PTSD (e.g., Brewin, 2001; Ehlers & Clark, 2000) suggest that when sensory representations of an adverse event are recoded into meaning-based representations, their vividness will be reduced and the associations between trauma cues and fear responses will be loosened. Cognitive-behavioral therapies (CBT), which usually entail prolonged and repeated exposure to painful memories and address personal meanings of the event and its aftermath, are effective for PTSD (e.g., Rothbaum, Meadows, Resick, & Foy, 2000). Yet there are drawbacks: patients may be unwilling to

confront traumatic memories for long periods of time (e.g., Arntz, Tiesema, & Kindt, 2004).

Meta-analyses (e.g., Bisson et al., 2007) have shown that chronic PTSD is also effectively treated with eye movement desensitization and reprocessing (EMDR), which aims to *directly* reduce the vividness of traumatic memories. Shapiro (1989) developed EMDR, and argued that lateral eye movements facilitate cognitive processing of traumatic memories. Briefly, in the basic EMDR protocol (Shapiro, 2001), a client is asked to hold an unpleasant memory in mind while a set of about 20 eye movements is elicited by having the client follow a side-to-side motion of the therapist's index finger. The client then reports current sensations, cognitions, and affect. Sets of eye movements are repeated until the client reports minimal distress related to the memory. Next, the client is instructed to rehearse a positive cognition related to the target memory. Research has shown that lateral eye movements, indeed, reduce the self-rated vividness and emotional impact of unpleasant autobiographical memories (Andrade, Kavanagh, & Baddeley, 1997; Barrowcliff, Gray, Freeman, & MacCulloch, 2004; Gunter & Bodner, 2008; Kavanagh, Freese, Andrade, & May, 2001; Kemps & Tigge-mann, 2007; Maxfield, Melnyk, & Hayman, 2008; Van den Hout, Muris, Salemink, & Kindt, 2001). Practice guidelines (e.g., NICE, 2005) consider CBT and EMDR to be treatment-of-choice for PTSD.

However, EMDR has been the subject of much debate about theoretical weaknesses (e.g., Herbert et al., 2000; Muris & Merckelbach, 1999; Russell, 2008). It is unclear *how* eye movements might produce benefits, and some scholars have concluded that EMDR

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yields its effects due to exposure, which is inherent to memory retrieval (see Russell, 2008). Yet, this explanation is at odds with laboratory research showing that, at least among healthy persons, eye movements result in less vivid and emotional autobiographical memories, but merely recollecting memories for a similar short time does not (e.g., Andrade et al., 1997; Van den Hout et al., 2001; Maxfield et al., 2008).

Interestingly, recent findings provide a fresh perspective on the mechanisms involved in reducing the vividness of upsetting memories. An elegant series of experiments was conducted by Gunter and Bodner (2008) with healthy participants who retrieved negative autobiographical memories (cf. the protocol of Van den Hout et al., 2001) under various conditions. Three accounts of how eye movements might produce positive effects were critically tested. First, an investigatory-reflex account claims that eye movements produce a state of deep relaxation and/or increased attentional flexibility. This account was not supported, because eye movements only produced benefits when memories were held in mind during, and not after, the movements, and eye movements increased arousal. Second, an interhemispheric-communication account posits that eye movements increase communication between the left and right brain hemispheres, thereby enhancing the ability to remember an aversive event while not being negatively aroused. This account was not supported, because vertical and horizontal eye movements produced similar benefits compared to a 'just retrieval' condition. Finally, the findings did support a working memory account.

The working memory account (Andrade et al., 1997; Gunter & Bodner, 2008) posits that beneficial effects occur because during retrieval, the two tasks (keeping the mental image in mind and making eye movements) compete for limited working memory resources. Due to limited resources, images will become less vivid, and this reduced vividness is thought to cascade into reduced emotionality. There are two working memory accounts (see Gunter & Bodner, 2008): one posits that eye movements interfere because they selectively load the visuospatial sketchpad, and another that eye movements simply serve as a demanding task that loads executive resources. The first account implies that mental visual images will only be affected by selectively taxing the visuospatial sketchpad, and not by non-visuospatial tasks. The second account implies that any task that taxes central executive resources will have the same effects as eye movements. Data seem to support the last position: not only do eye movements have beneficial effects, but so do other distractor tasks that do not seem to tax the visuospatial sketchpad, like auditory shadowing (Gunter & Bodner, 2008) and mental arithmetic (Van den Hout et al., in press). Interestingly, and in line with working memory theory, the smaller individuals' working memory span, the larger the effects of auditory shadowing on vividness and emotionality of memories (Gunter & Bodner, 2008), and the more working memory is taxed during mental arithmetic, the more vividness and emotionality are reduced (Van den Hout et al., in press).

So far, studies have mainly focused on disturbing images of past events. However, some psychopathology-relevant mental images represent *future-oriented* images. This has been found, for instance, for OCD (Speckens, Hackmann, Ehlers, & Cuthbert, 2007), depression (Holmes, Crane, Fennell, & Williams, 2007; Reynolds & Brewin, 1998), panic disorder (Ottaviani & Beck, 1987), and hypochondriasis (Wells & Hackmann, 1993). For example, some individuals with depression or PTSD suffer from future-oriented images that represent an elaboration of a specific personal memory. One person nursing a sick relative imagined him deteriorating further or dying, and a person who had had one stroke imagined having another one (Reynolds & Brewin, 1998). Another study (Holmes et al., 2007) found that depressed and formerly suicidal patients in remission

reported having experienced suicide-related mental images during crisis that, echoing flashbacks in PTSD, appeared like "flashforward" to suicide, like acting out future suicidal plans or being dead. Just like flashbacks, these images were described as possessing sensory qualities, being real and compelling, and rich in detail. Panic patients may also suffer from images about future events, like seeing oneself faint or having a heart attack (Ottaviani & Beck, 1987), and individuals with hypochondriasis may suffer from spontaneous images about disease and death (Wells & Hackmann, 1993).

The working memory account implies that the past or future-oriented nature of images is irrelevant to the effects of eye movements (and other tasks that tax working memory) on the vividness and emotionality of these images. If images are activated while working memory is taxed, limited resources will compete and the image will be stored as less vivid/emotional. The aim of this study was to examine whether eye movements, indeed, reduce vividness and emotionality of visual images about feared future events, compared to a no dual-task (exposure only) condition, in a non-clinical sample under controlled conditions.

## Method

### Participants

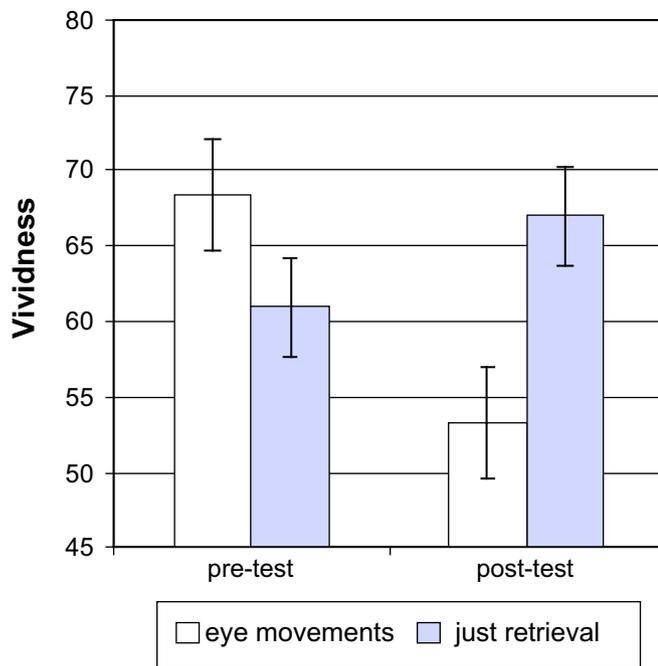
A total of 28 undergraduate students (19 women) from Utrecht University participated for course credit or a financial reward. Their mean age was 21 years ( $SD = 2.28$ ). Individuals were not included if they were familiar with EMDR.

### Materials and procedure

Participants were tested individually using the protocol of Van den Hout et al. (2001), which was slightly modified to the retrieval of an image of a feared future event. After giving written informed consent, they were asked to select two negative visual images about events they feared might happen to them in the future and that had an emotional impact on them. Particular care was taken to identify future-oriented anxiety-provoking visual images that did not represent events that had actually happened to participants in the past. Based on a pilot study of 10 students, some examples were given (e.g., having a black-out during a presentation, being at a funeral, being hit by a car). Participants were told to choose images that were not too emotional (e.g., "if a loved one is very ill right now, it would be better not to imagine attending his/her funeral"). They wrote down a label for each image, and ranked the images in terms of their unpleasantness. Half of the images were randomly assigned to the 'eye movements' condition and half to the 'exposure only' condition, with the most unpleasant images equally represented in both conditions. The order of the two conditions was counterbalanced across participants.

Before each condition, the experimenter said "Form an image of ... (label) now. Remember where it happens, who is present, and anything else you can think of. Bring it to mind as vividly as if it were happening right now". Participants were asked to recall the image for 20 s and rate its vividness and emotional intensity on two 100 mm visual analogue scales (VASs) that ranged from 0 = not vivid at all (unpleasant) to 100 = extremely vivid (unpleasant). They were also asked to rate how difficult it was to retrieve this image on a 100 mm VAS (0 = not difficult at all, 100 = extremely difficult).

In each condition, participants were seated in front of a computer screen at a distance of about 45 cm. They were instructed to hold the image in mind for 4 trials of 24 s each, with a 10-s break between trials. In the eye movements condition, participants were told to keep their heads still and move their eyes



**Fig. 1.** Vividness ratings (mean  $\pm$  sem) for eye movements and just retrieval conditions.

to focus on a 1 cm white circle, which blinked from one side of the screen 21.5 cm across to the other side at a rate of about 1 movement per s, while keeping the image in mind (cf. Gunter & Bodner, 2008; based on Van den Hout et al., 2001). This smooth pursuit eye movement procedure is consistent with the basic EMDR protocol (Shapiro, 2001). During the no-dual task condition, there was no simultaneous distracting task; participants were instructed to keep their eyes open and watch the centre of the screen, while keeping the image in mind. Afterwards, participants retrieved the image again, and rated its vividness and emotional intensity on the VASs (cf. Van den Hout et al., 2001).

#### Statistical analysis

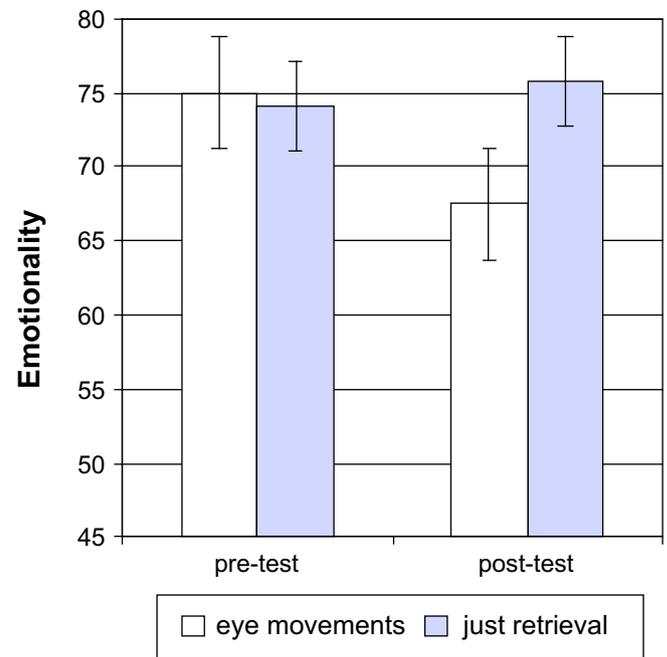
To test whether the conditions showed a differential effect, vividness and emotionality ratings were subjected to a two-way ANOVA with Condition (eye movements, exposure only) and Time (pre-test, post-test) as within-subjects factors.

#### Results

All participants reported spontaneous, unpleasant visual images of feared future events, and most were rich in detail (Appendix). About 25% of images were related to death of a loved one, 16% to a disease of oneself, and 13% to disease of a loved one. Other images included problems at school or financial problems (11%), accident (9%), disaster or assault (7%), and becoming homeless (2%). The ratings of how difficult it was to retrieve the image did not significantly differ between the eye movement condition ( $M = 31.71$ ,  $SD = 19.97$ ) and exposure alone condition ( $M = 36.68$ ,  $SD = 21.53$ ),  $t(27) < 1$ .

The mean vividness and emotionality ratings are depicted in Figs. 1 and 2. Paired  $t$ -tests showed that there were no significant differences between the two conditions in baseline vividness,  $t(27) = 1.59$ ,  $p > .05$ , and baseline emotionality,  $t(27) < 1$ , scores.

The ANOVA for vividness ratings showed no significant main effects for Condition,  $F(1, 27) < 1$ , and Time,  $F(1, 27) = 2.01$ ,  $p > .05$ , but the crucial Condition  $\times$  Time interaction was significant,  $F(1,$



**Fig. 2.** Emotionality ratings (mean  $\pm$  sem) for eye movements and just retrieval conditions.

$27) = 24.31$ ,  $p < .001$ . Paired  $t$ -tests showed that vividness ratings decreased over time for the eye movement condition,  $t(27) = 3.35$ ,  $p < .01$ , while they tended to increase for the no-dual task control condition,  $t(27) = 2.00$ ,  $p = .056$ .

The ANOVA for emotionality ratings also did not show significant main effects for Condition,  $F(1, 27) = 1.29$ ,  $p > .05$ , and Time,  $F(1, 27) = 2.57$ ,  $p > .05$ , but, again, the Condition  $\times$  Time interaction was significant,  $F(1, 27) = 6.18$ ,  $p = .02$ . Paired  $t$ -tests showed that emotionality ratings decreased over time for the eye movement condition,  $t(27) = 2.51$ ,  $p = .02$ , but remained unchanged for the control condition,  $t(27) < 1$ .

#### Discussion

The findings fit nicely with earlier laboratory studies showing that eye movements during recall of unpleasant personal memories result in decreases in ratings of image vividness and emotional intensity (e.g., Andrade et al., 1997; Gunter & Bodner, 2008; Kemps & Tiggemann, 2007; Maxfield et al., 2008; Van den Hout et al., 2001). The present study extends these effects to upsetting visual images about feared future events: eye movements, compared to a no-dual task control condition resulted in significant pre-post reductions in image vividness and emotional intensity.

It seems unlikely that the findings may be explained by extinction due to unreinforced exposure to upsetting images: exposure without eye movements did not reduce image vividness and emotionality, and even resulted in a slight increase in vividness. Earlier studies have also shown that when participants focus on visual images of past events, without making concurrent eye movements, there is either no effect (e.g., Andrade et al., 1997; Gunter & Bodner, 2008) or an opposite effect of increased ratings of image vividness (e.g., Maxfield et al., 2008; Van den Hout et al., 2001, 2009). Note that the duration of the recall was 96 s in total, and habituation after such a brief exposure may not be expected (for overview of studies, see Marks, 1987; p. 267–273).

The findings are also inconsistent with the view that eye movements are beneficial because they restore an imbalance in the nervous system caused by a traumatic event (Shapiro, 1989). This view is

problematic (e.g., Muris & Merckelbach, 1999), and cannot account for the present data concerning future-oriented images, which, according to the participants, were unrelated to past traumatic events.

The working memory theory provides a fresh perspective about the way eye movements may yield beneficial effects. It suggests that eye movements are helpful because they tax working memory during recall. The retrospective or prospective nature of images is irrelevant to the effects of eye movements (and other tasks that tax working memory) on image vividness and emotionality. If images are activated while working memory is taxed, limited resources will compete and the image will be stored as less vivid/emotional. The implication of this theory is that any intervention that taxes working memory during image retrieval is effective, and a dose–response relationship may be logically inferred: the stronger the working memory taxing, the stronger the reductions in vividness/adversity. However, as suggested by Gunter and Bodner (2008), a task that is extremely taxing may prevent holding an image in mind, thereby preventing benefits. Thus, the relationship between working memory taxing and reduced vividness may represent an inverse U-curve.

In line with working memory theory, it has been found that vividness of negative images is also reduced by secondary tasks that tax working memory during recall, but do not involve horizontal eye movements, like vertical eye movements, auditory shadowing, copying a complex figure (Gunter & Bodner, 2008), articulatory suppression (Kemps & Tiggemann, 2007), and mental arithmetic (Van den Hout et al., *in press*). Similarly, recalling scenes from a previously-seen film with traumatic content while playing a taxing computer game (tetris), reduced intrusive memories of the film in the subsequent week (Holmes, James, Coode-Bate, & Deeprose, 2009). Secondary tasks that are not taxing, like simple finger tapping, do not seem to have beneficial effects (Van den Hout et al., 2001), whereas slightly positive effects (though less than the effects of eye movements) have been reported after *complex* tapping (Andrade et al., 1997). Gunter and Bodner (2008) reasonably argue that the difference between the tapping effects reported by Van den Hout et al. (2001) and Andrade et al. (1997) is due to more taxing of working memory during complex tapping than during simple tapping. Likewise, Lilley, Andrade, Turpin, Sabin-Farrell, and Holmes (2009) did not find beneficial effects of simple counting (counting from 1 upwards) in a clinical sample, whereas Van den Hout et al. (*in press*) found beneficial effects of more complex counting (subtracting 2 from 1000 or 7 from 1000 downwards) in a non-clinical sample.

Working memory theory not only has implications for understanding and applying the *technique*, but also for the *indication* of EMDR and related interventions that tax working memory. The implication is that they degrade not only trauma-related retrospective memories, but also negative images about potential future events. Such negative images are observed not only in PTSD, but also, for instance, in depression (Holmes et al., 2007; Reynolds & Brewin, 1998), panic disorder (Ottaviani & Beck, 1987), and hypochondriasis (Wells & Hackmann, 1993).

The beneficial effects of eye movements extend beyond the dual task: after eye movements and exposure only, the image was retrieved again and rated for vividness and emotionality. Why do the effects persist beyond the session of working memory taxing? There are at least two possibilities. As argued by Gunter and Bodner (2008), it is possible that the nature of the memory trace remains unaffected, but that “meta-cognitive” appraisals are affected. During eye movements, individuals may experience that image retrieval is less aversive than expected. This may modify negative appraisals of the image, while its nature is unaffected. Appraisals of intrusive images are thought to be crucial in the maintenance of several psychopathological conditions (e.g., Ehlers & Clark, 2000; see Hackmann & Holmes, 2004). Second, memories are labile when they are recalled (Ressler & Mayberg, 2007) and, due to the intervention, visual images may become transformed during reconstruction from memory due to changed semantic encodings. The memory trace *itself* should then be affected. We did not collect any information on meanings associated with images in this study, and were therefore unable to test the hypothesis about images becoming transformed by changes in semantic encodings. Clearly, the possible mechanisms of action await future research.

Working memory theory and the present findings provide a consistent rationale for using working memory taxing during mental imagery of feared future events. Whether or not the findings may be generalized to patients suffering from such intrusive images awaits future clinical research. In sum, this study provides preliminary evidence for the effects of eye movements in the degradation of visual images about feared future events.

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## Appendix

Mental images reported by the participants for each condition.

Person	Control	Eye movements
1	I'm filling shelves in a grocery store without any future perspectives, because I failed in university.	Mom's in the hospital with bruises after she's been hit by dad. <sup>a</sup>
2	I'm on the plane to Florida. Suddenly, there's severe turbulence and I realize the plane will crash.	I make a bad fall while skiing and tear my knee ligament.
3	I'm walking home alone at night and a group assaults me.	I see my child dying after a prolonged disease. <sup>b</sup>
4	The doctor tells me that I've got a severe disease and won't recover from this.	My parents have died and the funeral service is very intense. I'm standing at the grave with my brother and sister.
5	I'm acutely ill and am lying in a hospital bed.	I'm on a bus that crashes and see one of the passengers dying.
6	Mom gets seriously ill and has been admitted to the hospital. She looks terrible.	I check the grades of my last final, and find out that I blew the test.
7	I'm cycling in a dark alley, and am attacked.	My parents get very ill and die. I'm standing by their grave.
8	After my interview for an internship, the director says I'm rejected.	The police on my doorstep tell me my boyfriend got killed.
9	I have to give an important speech, but have lost my text, and really don't know what to say.	I get critically ill and lie down in a hospital bed.
10	I'm driving my car, and see a car approaching me fast and crashing into my car.	I am seriously ill and lie in a hospital bed, and find out there's no chance to recover.
11	During my exam to get my driver's licence, I approach a cross-road and don't see another car approaching. The instructor jumps on the brakes and I know I failed the test.	I'm giving a speech in front of a large group, and can't remember what to say.

## Appendix (continued)

Person	Control	Eye movements
12	I get seriously ill and am lying on all kinds of machines in the hospital, and it's unknown whether I'll get better.	I'm working on my thesis, which is almost due, but then my computer crashes, and everything's gone.
13	My parents have died and I'm attending their funeral.	My boyfriend tells me the relationship is over.
14	My phone rings and I'm told my boyfriend is in the hospital.	I'm home alone and there's a break-in by a robber.
15	My family takes a plane (without me) that crashes. I'm standing at their funeral service.	There's a terrible flood, and I see people drown.
16	My parents and sister died in a plane crash and I'm at their funeral.	I see on the news that the company I work for has gone bankrupt and realize I'll lose my job.
17	I hear on the phone that my friends have died in a car crash.	My father will lose his kidney and will get very ill. I see him in the hospital on hemodialysis. <sup>c</sup>
18	Someone hits my mom's car. She's covered with blood. It's dark and the headlights are still one.	I fall and dislocate my arm, and am in a lot of pain. My arm is hanging out of its socket.
19	My parents are dying of a disease in the hospital. I'm sitting with them and watch them die.	Due to an environment disaster water has been contaminated. I see people who drank water getting very ill and suffering.
20	I get home and see a blue envelope in the mail. I read that I did something wrong in my tax return and will be severely punished.	I'm in the hospital and a doctor tells me that I have a severe disease. Mom is sitting next to me.
21	I'm on a plane and realize it will crash.	I have become very fat, and know this has been caused by a disease, but don't know which one.
22	Mom dies of a disease, and my dad and me are standing at her funeral.	Due to an oil crisis there is war. I see planes dropping bombs.
23	My brother is admitted to the hospital and is very ill. He's on all kinds of tubes and equipment.	My parents have died and I'm in church at their funeral.
24	Mom has been diagnosed with cancer and gets chemotherapy in the hospital. I watch her and feel very lonely.	Grandma gets very ill, and nothing can be done about it. I see her in the hospital and she looks awful.
25	Dad gets very ill and is admitted to the hospital.	I'm told that our family business is bankrupt and see things being taken away from us.
26	I'm told by phone that I'm fired.	I see my parents severely ill and dying in the hospital.
27	There's a war here, and I see tanks shooting and explosions).	I've lost my job, because my boss has gone bankrupt. People carry out the inventory in boxes. My boss looks desperate.
28	I lose my apartment, and am standing on the street with all my belongings.	I didn't pass my exams, and won't get my diploma. At the graduation ceremony all other students do get their diploma.

<sup>a</sup> The participant indicated there was no history of abuse by her father, but she still had this image it might happen.

<sup>b</sup> This participant had a healthy child.

<sup>c</sup> The participant's father had a kidney transplant a few years ago, and was doing fine.

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