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The use of videos in road safety training: Cognitive and emotional effects

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ABSTRACT

The aim of the study was to evaluate the use of videos in educational programs for improving road safety. Particularly, we evaluated the cognitive and emotional effects of viewing videos taken from cameras placed along Italian highways and showing car crashes or traffic flow images.

One hundred and seventy students from the Sapienza University of Rome participated in the study as volunteers. Each participant was randomly assigned to one of three experimental groups ("Video", "Video plus commentary", "Written Description"). Results showed that the overall emotional activation was significantly higher in the two conditions that employed live video (both with and without verbal explanations). However, scores on the Information dimension were significantly higher in the conditions that contained only verbal descriptions or that combined video and verbal explanations. Results of this experiment suggest that live videos of car crashes have the primary feature of inducing a high emotional activation (especially when they represent action scenes, as car crashes) that can be modulated by co-occurring verbal explanations. When these videos are not integrated by an appropriate verbal explanation, they can be experienced as not fully instructive.

1. Introduction

In recent years, the development of new technologies has led to an increasing use of motion pictures in educational and professional settings. Especially, there has been a growing interest in tools that supposedly support learning processes through visual experiences (i.e., video-tapes, video-games, simulators, etc.). Usually, the aim is to involve participants in forms of experience-based learning, capitalizing upon the perceptual and executive functions engaged during the interaction. Being aware of their potential educational value, Italian Police has begun to use live crash videos recorded through highway cameras for road safety education interventions at school. These videos show typical car accidents, and are usually supported by a verbal description of their causes and the correct behaviours to be engaged in each situation. Though interesting, the use of live videos has been almost always based upon common sense considerations, without any testing of the efficacy of the messages, and of their cognitive and emotional consequences. Here we report the results of a study aimed at investigating the effects of viewing live crash videos, and the role of the verbal descriptions and comments as emotional modulators.

A number of studies have tried to assess the benefits and limitations of videos. Indeed, live videos have been proved effective in several settings: for training of healthy or disabled adults (Keen et al., 2007; Macurik et al., 2008; Gelman and Tasone, 2006), in educational settings to promote specific types of learning (Kern, 1978; Turner and Lair, 1969; Lane, 1998; Zeedyk and Wallace, 2003; Marshall, 2006) and enhance the cooperative behaviours (Lonnecker et al., 1994), as a clinical tool (Supinski, 1999; Beitman and Dogmi, 1999), to improve the performance in sports (Farrow et al., 1998), and for interventions against the abuse of recreational drugs (Dusenbury et al., 2003).

Two features of live videos seem to mediate their efficacy. The first is that motion pictures, given their close approximation to reality, can generate forms of learning from experience because viewers may feel as they were living real events. The second is that they can operate as emotional activators, with relevant consequences for motivational guidance.

Indeed, studies that have investigated the efficacy of live videos have been almost always inspired by social-cognitive theories, grounding upon key concepts such as "modelling" and "learning-by-doing". The term modelling was proposed by Bandura (1986) to indicate the activation of a complex set of perceptual, attentional, and memory processes that leads to the internalization of the reference models (Bandura et al., 1963). Instead, the basic premise of

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learning-by-doing (Dewey, 1938), or learning through experience, is that learning can be facilitated by the personal involvement and active participation. People learn more if they are involved and have a way of interacting during the learning process (Aldrich, 2005).

The activating and engaging properties of the videos are well documented in the literature as well. Particularly, learning modalities akin to learning-by-doing are frequently used, especially in education. The aims range from the prevention of risky conducts and academic failures (Wilczenski and Coomey, 2007) to the promotion of health and well-being (Durlak and Celio, 2008); from the improvement of athletic performance (Erickson et al., 2008) to motor rehabilitation (Hawkins et al., 2008), in line with the idea that perceptive-motor learning develops through a continuous exchange of inputs and outputs with the outside world (Antinucci, 2001).

It is also well known that videos can facilitate the emotional involvement into the depicted scene, sometimes to an extremely intense degree. Whereas the possibility of soliciting emotions is a central feature of entertainment media such as television, cinema, and videogames (Tan, 1996, 2008; Tan and Frijda, 1999), it has been known since Berlyne (1960, 1965) that providing pleasant and stimulating contexts can also significantly improve learning (Litman, 2005). For instance, interest and curiosity represent forms of intrinsic motivation (Deci and Ryan, 1985) that make a learning task pleasant to perform, and promote the achievement of better results.

Whereas a number of features suggest that including car crash videos in road safety education programs could be useful, to the best of our knowledge no experimental study has so far investigated the emotional effects of viewing live crash videos. To investigate this issue, though, comparing the effects of viewing live crash videos to the effects of being exposed to a verbal description of them is not sufficient, because the two conditions differ for a number of features. For instance, their format (visual vs verbal), and the amount of information delivered (higher in the live crash videos, lower and more focused in the verbal description) are clearly different. Thus, in the present study we compared different conditions in which participants were presented with videos showing either live car crashes or simple traffic scenes, with a high or low emotional load. The videos were viewed, in one condition, without any additional information, and in a second condition with verbal comments and explanations given at the end of the video presentation (the comments were provided by an Italian Police officer). Participants in a third condition were only given a written verbal description of the same scenes. It worth noting that we did not add control conditions such as showing irrelevant videos with verbal descriptions of the target scenes, or videos depicting a target scene with irrelevant verbal descriptions, as they imply delivering incongruent messages that would make any sound interpretation of the results impossible. Indeed, we aimed at comparing the effects of "pure" verbal information (of the kind people read on the newspapers, for instance) against those of visual information (of the kind people are exposed to when viewing movies, for instance).

The comparison among the conditions we chose still allows an in-depth evaluation of the type and amount of emotional activation induced by live videos of car crashes, as well as an assessment of the mediating functions of the verbal descriptions.

2. Method

2.1. Participants

One hundred seventy students (93.4% females) from the Sapienza University of Rome participated in the study as volunteers. Participation to the study was advertised during class time. Participants' mean age was 23 years (SD = 6.45) and ranged from 19 to 56 years. All of them had normal or corrected-to-normal vision, and were naïve with respect to the purposes of the study.

2.2. Stimuli

Stimuli were video-clips of real car crashes and scenes of traffic flow that occurred on Italian motorways, and the written verbal descriptions of the same scenes. The videos-clips were drawn from continuous video recordings from the police control cameras located along the motorway system in Italy. They were edited in order to have approximately the same duration (about 30 s), and were homogeneous regarding the camera position, the time of the day, and the general atmospheric conditions and visibility. Eight video-clips, 4 depicting car crashes and 4 depicting traffic scenes, served as stimuli. The video-clips depicting car crashes did not show the victims, or any detail that would allow the people involved to be identified. The videos were different with regards to their supposed emotional load: namely, two videos showed severe car accidents (high intensity), two videos showed light car accidents (low intensity), two videos showed scenes of heavy traffic flow (high intensity), and two videos showed scenes of light traffic flow (low intensity). All the videos were mute. A short description of the scenes represented in four of the videos is reported in the Appendix.

A short text was created for each video, verbally describing the same scene. All the verbal descriptions were approximately 340 words in length, and were printed on 35 rows. An Arial 14 font, black on a white background was used.

2.3. Procedure

The study was run at the General Directorate of the Italian Traffic Police. Each participant was randomly assigned to one of three experimental groups. The participants in the first group ("Video", $N = 56$) viewed the series of 8 video-clips, without any verbal comment or description; the participants in the second group ("Video and commentary", $N = 63$) viewed the same video-clips, but after each video a police operator gave a standardized commentary (90 s) about the depicted scene (e.g., causes of the car crash, description of the traffic flow); the participants in the third group ("Written Description", $N = 51$) read a written description of the same scenes depicted in the video-clips, without any voice comment. The participants in each group sat in an auditorium, in front of a large screen where the video-clips and the written descriptions were projected.

Immediately after each video or written description presentation, the participants rated the videos and descriptions by filling in a Semantic Differential Scale, and their own affective status and self-appraisal by filling in the B66 scale (Bonaiuto et al., 1992).

2.4. Measures

Semantic Differential Scale. An ad hoc Semantic Differential Scale (Osgood et al., 1957) was created by the Authors. It was composed of 21 adjectives aimed at evaluating the stimuli (videos and written descriptions) along the emotional (e.g., anxiety inducing vs calming), aesthetic (e.g., beautiful vs ugly), and cognitive (e.g., interesting vs not interesting) dimensions. The adjectives were randomly listed on the left side of the questionnaire and their matched antonyms were listed on the right side. Participants were asked to rate on a 7-point Likert scale how well each adjective pair described the video or the written description they had just viewed. The positive and negative adjectives were equally distributed on the left and right side of the questionnaire.

B66 self-appraisal scale (reduced version) (Bonaiuto et al., 1992). Whereas the Semantic Differential Scale was aimed at measuring

how participants judged the content of the stimuli, the B66 self-appraisal scale was aimed at assessing the emotions they felt as a consequence of viewing the scene. The scale was composed of 40 adjectives and their antonyms (e.g., happy vs unhappy). The participants were asked to rate on a 7-point Likert scale how well each adjective pair described their own feelings at that moment. The positive and negative adjectives were equally distributed on both the left and right side of the questionnaire.

2.5. Statistical analyses

Ratings on the items from the two questionnaires were firstly submitted to exploratory factor analysis (Principal Axis method, Oblimin rotation) in order to identify their underlying dimensions. Factor scores for each dimension were then computed both as the average ratings on the items belonging to that dimension, and through the traditional regression method. They were then analyzed through Group (video, video and commentary, written description) by Scenario (car crash vs traffic flow) by Intensity (high vs low) mixed factorial designs of analysis of variance. The Newman–Keuls test was used for simple effects and post hoc pairwise comparisons. Notably, the same analyses on the average scores and on the factor scores computed with the regression method yielded the very same results. Thus only the former will be discussed here.

3. Results

3.1. Exploratory factor analyses

3.1.1. Semantic Differential Scale

The subjective ratings concerned how the participants judged the stimuli. In order to identify the dimensions underlying their judgements, separate Principal Axis Factor analyses (oblimin rotation) were firstly run on the participants' ratings, one for each experimental condition. As the four solutions were identical, a final analysis was run on the collapsed data. The Kaiser–Meyer–Olkin index of sampling adequacy was 0.945, suggesting that factor analysis is appropriate. The scree-test suggested a three-factor solution that accounted for 57.4% of the total variance. The first factor, accounting for 26.6% of the variance, was related to the Informational value of the stimuli (for instance, adjectives such as "useful" and "informative" saturated on this factor). The second factor, accounting for 12.5% of the variance, was related to the Aesthetic value of the stimuli (for instance, adjectives such as "beautiful" and "attractive" saturated on this factor). The third factor, accounting for 18.26% of the variance, was related to the Affective value of the stimuli (for instance, adjectives such as "reassuring" and "calming" saturated on this factor). All the adjectives showed a primary loading higher than 0.329, ranging from 0.329 to 0.928. The Informational and the Affective factors were negatively correlated ($r = -0.36$). These results show that the participants judged the stimuli along three separate, albeit not independent, dimensions related to their Affective, Informational, and Aesthetic values. It is worth noting that the Affective dimension refers to the affective value of the stimuli, as judged by our participants, not to how our participants felt after viewing the stimuli. Scores on the Aesthetic factor were not further analyzed, as the aesthetic value of the stimuli is not the primary interest of the present study.

3.1.2. B66 self-appraisal scale

The subjective ratings concerned the effects of the stimuli upon the participants, as they were judged by the participants themselves. In order to identify the dimensions underlying such a judgement, separate principal axis factor analyses with oblimin rotation were run on the ratings, one for each experimental condition. Also in this case, the four factor solutions were identical, and thus a single final analysis was run on the collapsed data. The Kaiser–Meyer–Olkin index of sampling adequacy was 0.967, suggesting also in this case that factor analysis can be properly used. The scree-test suggested a three-factor solution that accounted for 53.1% of the total variance. The first factor, accounting for 26.6% of the variance, was related to Positive Mood (for instance, adjectives such as "calm" and "peaceful" saturated on this factor); the second factor, accounting for 8.3% of the variance, was related to Negative Emotions (for instance, adjectives such as "tired" and "exhausted" saturated on this factor); the third factor, accounting for 12.7% of the variance, was related to Positive Emotions (for instance, adjectives such as "happy" and "joyful" saturated on this factor). All the adjectives showed a primary loading higher than 0.30, ranging from 0.30 to 0.89. The Positive Mood dimension was positively correlated with the Positive Emotions dimension ($r = 0.66$), and negatively correlated with the Negative Emotions dimension ($r = -0.40$). The Positive and Negative Emotions dimensions were also negatively correlated ($r = -0.38$). Also in this case, results suggest that participants judged their reactions to the stimuli along a Positive Mood, a Positive Emotions, and a Negative Emotions dimension.

3.2. Analysis of variance

The effects of Group, Scenario, and Intensity were analyzed through separate analyses of variance on the factor scores computed for each dimension described above. All the tests were corrected for the alpha inflation (Bonferroni correction).

3.2.1. Informational dimension (Semantic Differential Scale)

The analysis of variance showed significant main effects of Group, Scenario, and Intensity ($F_{2,167} = 32.10$, $p < 0.001$; $F_{1,167} = 184.63$, $p < 0.001$; $F_{1,167} = 50.61$, $p < 0.001$, respectively), as well as significant Group by Scenario, Group by Intensity, and Group by Intensity by Scenario interactions ($F_{2,167} = 41.75$, $p < 001$; $F_{2,167} = 24.62$, $p < 0.001$; $F_{2,167} = 5.28$, $p < 0.001$, respectively). The main effects were due to participants rating the videos presented alone as less informative compared to both the same videos presented with a verbal commentary and the written descriptions alone (Table 1 and Fig. 1). Furthermore, participants rated the descriptions of car crashes as more informative than the descriptions of traffic flow scenes, and the descriptions of high intensity scenes as more informative than low intensity scenes (Table 1 and Fig. 1).

More interestingly, the Newman–Keuls test of the second order interaction showed that whereas participants rated the videos of car crashes, both when viewed alone and with the verbal commentary, as more informative than the traffic scenes, and the high intensity scenes as more informative than the low intensity scenes ($p < 0.001$ in all cases), participants who only viewed the written descriptions rated those describing car crashes as more informative than those describing traffic flow scenes ($p < 0.001$), but did not differentiate in terms of emotional load (Table 1 and Fig. 1). The different patterns of effects of videos and verbal descriptions confirm that they are not only due to the contents (crashes vs traffic flow), but also to the medium used.

3.2.2. Affective dimension (Semantic Differential Scale)

The analysis of variance showed significant main effects of Scenario and Intensity ($F_{1,167} = 207.87$, $p < 0.001$; $F_{1,167} = 115.13$, $p < 0.001$, respectively), as well as significant Group by Scenario, Group by Intensity, Scenario by Intensity, and Group by Intensity by Scenario interactions ($F_{2,167} = 12.28$, $p < 0.001$; $F_{2,167} = 20.40$, $p < 0.001$; $F_{1,167} = 4.31$, $p < 0.05$; $F_{2,167} = 3.56$, $p < 0.01$, respectively). The main effects were due to participants rating the car crashes as

Table 1
Mean factor scores on the Information and Affective dimensions of the semantic differential scale as a function of the Experimental Group, Scenario, and Intensity. Standard errors are reported in parenthesis.

Group	Scenario	Intensity	Information dimension	Affective dimension	*N*
Video plus commentary	Crash	Severe	1.66 (0.10)	−1.11 (0.09)	63
		Light	1.12 (0.12)	(0.61 (0.08)	63
	Traffic	Severe	1.04 (0.12)	(0.35 (0.07)	63
		Light	0.62 (0.11)	0.27 (0.09)	63
Video only	Crash	Severe	0.98 (0.11)	(1.11 (0.09)	56
		Light	0.55 (0.13)	(0.50 (0.09)	56
	Traffic	Severe	(0.12 (0.13)	0.01 (0.07)	56
		Light	(0.74 (0.11)	0.25 (0.09)	56
Written description	Crash	Severe	1.33 (0.12)	(0.65 (0.10)	51
		Light	1.14 (0.14)	(0.48 (0.09)	51
	Traffic	Severe	0.86 (0.14)	(0.18 (0.08)	51
		Light	1.31 (0.12)	(0.23 (0.10)	51

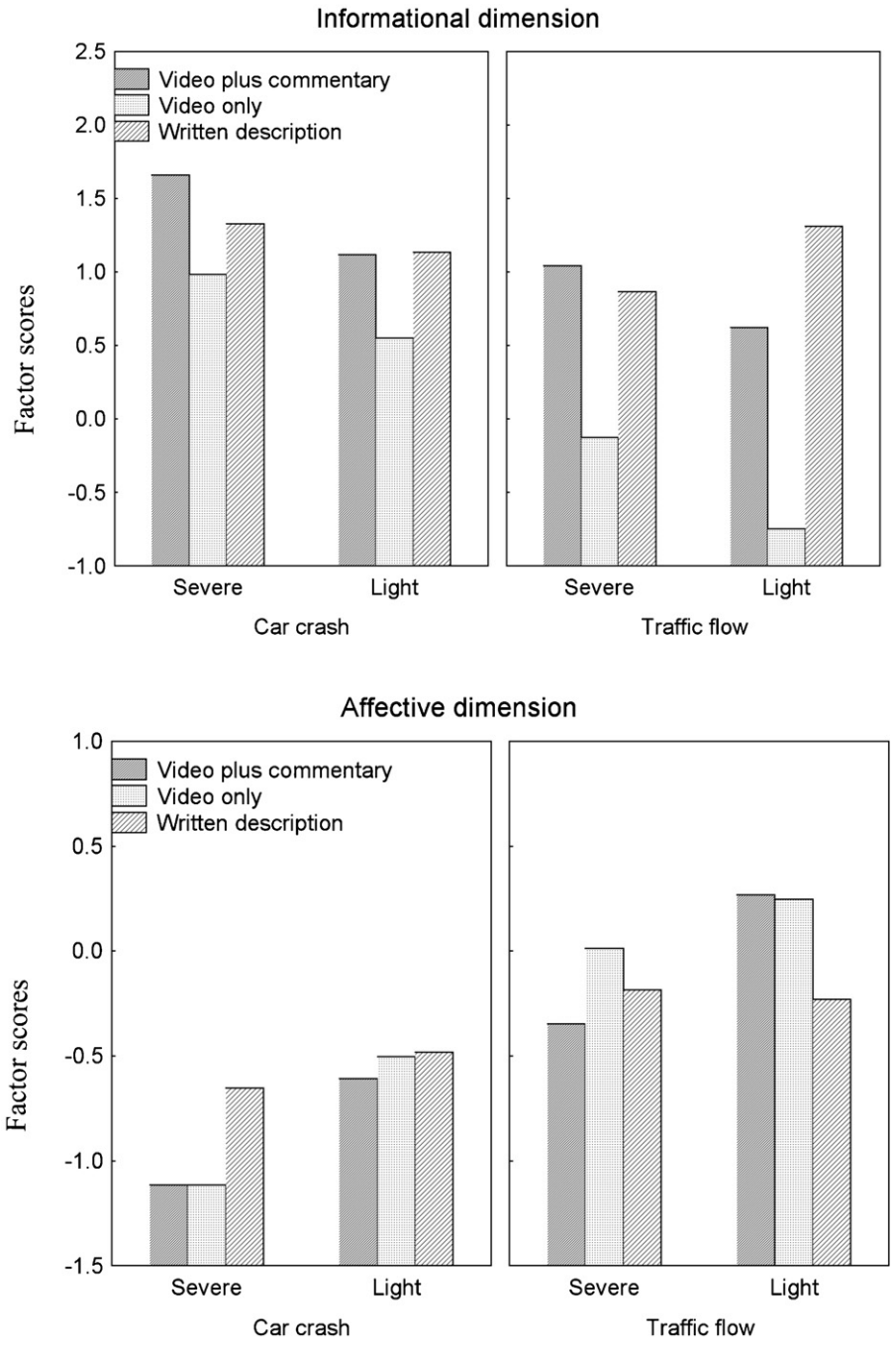

Fig. 1. Mean factor scores on the Information and Affective dimensions of the Semantic Differential Scale as a function of the Experimental Group, Scenario (Car crash, Traffic flow), and Intensity (Severe, Light).

Table 2
Mean factor scores on the Positive Mood, Negative Emotions, and Positive Emotions dimensions of the B66 scale as a function of the Experimental Group, Scenario, and Intensity. Standard errors are reported in parenthesis.

Group	Scenario	Intensity	Positive Mood	Negative emotions	Positive emotions	*N*
Video plus commentary	Crash	Severe	0.25 (0.11)	0.25 (0.12)	0.12 (0.09)	63
		Light	0.42 (0.11)	0.09 (0.12)	0.20 (0.08)	63
	Traffic	Severe	0.29 (0.11)	0.36 (0.12)	0.10 (0.08)	63
		Light	0.63 (0.11)	0.02 (0.12)	0.40 (0.08)	63
Video only	Crash	Severe	0.48 (0.12)	0.06 (0.13)	0.18 (0.09)	56
		Light	0.70 (0.11)	−0.10 (0.13)	0.39 (0.09)	56
	Traffic	Severe	0.62 (0.12)	0.08 (0.13)	0.31 (0.09)	56
		Light	0.31 (0.12)	0.66 (0.13)	0.07 (0.09)	56
Written description	Crash	Severe	0.30 (0.12)	0.30 (0.13)	0.20 (0.10)	51
		Light	0.00 (0.12)	0.73 (0.13)	−0.07 (0.09)	51
	Traffic	Severe	−0.01 (0.13)	0.71 (0.14)	−0.04 (0.09)	51
		Light	0.60 (0.12)	−0.17 (0.13)	0.36 (0.09)	51

inducing less positive emotions than the traffic flow scenes, and the high intensity scenes inducing less positive emotions than the low intensity scenes (Table 1 and Fig. 1).

The Newman–Keuls test of the second order interaction showed that these effects are shown by the participants who viewed the videos, either alone or with the commentary, but not by the participants who viewed the written descriptions. Indeed, the latter rated the descriptions of car crashes as less positive than the descriptions of traffic flow scenes ($p < 0.001$), but did not differentiate in terms of emotional load (Table 1 and Figure 1). Also in this case, the different patterns of effects of videos and verbal descriptions confirm that they also are due to the medium used, and not only to the specific contents (crashes vs traffic flow).

3.2.3. Positive Mood dimension (B66 scale)

The analysis on the Positive Mood scores showed a significant main effect of Intensity ($F_{1,167} = 19.31$, $p < 0.001$) and significant Group by Scenario, Group by Intensity, Scenario by Intensity first order interactions ($F_{2,167} = 10.40$, $p < 0.001$; $F_{2,167} = 11.08$, $p < 0.001$; $F_{1,167} = 5.77$, $p < 0.01$, respectively), as well as a significant second order interaction among all the factors ($F_{2,167} = 26.67$, $p < 0.001$).

Post hoc comparisons through the Newman–Keuls test showed that participants in both the Video plus verbal commentary and Written description groups rated their mood as more positive after having been presented with the light rather than with the heavy traffic scenes ($p < 0.05$). Instead, participants who viewed the videos alone rated their mood as more positive after having been presented with the heavy rather than the light traffic scenes ($p < 0.05$) (Table 2 and Fig. 2). Apparently, some amount of "action" should be present in a video when it is presented alone in order to induce a Positive Mood. However, a verbal description of the video contents is sufficient to counteract such an effect.

With regards to the effects of car crash scenes the participants in the Video and Video plus verbal commentary groups rated their mood as more positive after viewing light rather than severe car crashes ($p < 0.05$). On the contrary, participants who only viewed the written descriptions rated their mood as more positive after severe rather than light car crashes ($p < 0.05$). Also, participants who viewed videos of car crashes alone rated their mood as more positive than both participants who viewed either the videos of car crashes with a verbal commentary and the written descriptions of the same videos ($p < 0.05$ in all cases) (Table 2 and Fig. 2). Overall, the participants who were presented with videos without a verbal commentary rated their mood as more positive than participants presented with both the video and the verbal commentary, independently of the severity of the car crash. Thus, even in this case the verbal commentary appears to modulate the emotional effect of the visual presentation of a scene.

3.2.4. Negative Emotions dimension (B66 scale)

The analysis on the Negative Emotions scores showed significant main effects of Scenario ($F_{1,167} = 4.41$, $p < 0.05$) and Intensity ($F_{1,167} = 19.31$, $p < 0.001$), as well as significant Group by Scenario, Group by Intensity, Scenario by Intensity first order interactions ($F_{2,167} = 46.97$, $p < 0.001$; $F_{2,167} = 25.50$, $p < 0.001$; $F_{1,167} = 7.00$, $p < 0.001$, respectively), and a significant second order interaction among all the factors ($F_{2,167} = 35.58$, $p < 0.001$).

Post hoc comparisons through the Newman–Keuls test showed the same effects described above for the Positive Mood, obviously reversed. Indeed, participants in both the Video plus verbal commentary and Written description groups rated their negative emotions as more intense after having been presented with heavy rather than light traffic flow scenes ($p < 0.05$). Instead, participants who were presented with the videos alone rated their negative emotions as more intense after having viewed light traffic than heavy traffic scenes ($p < 0.05$) (Table 2).

With regards to the effects of car crashes, participants in the Video and Video plus verbal commentary groups rated their negative emotions as more intense after severe rather than light car crashes ($p < 0.05$). Instead, participants who viewed only the written descriptions of these scenes rated their negative emotions as more intense after light rather than severe car crashes ($p < 0.05$) (Table 2). Finally, participants who viewed videos of car crashes with or without commentary rated their negative emotions as less intense than participants who viewed the written descriptions of the same scenes ($p < 0.05$ in all cases) (Table 2). Overall, the general pattern of the results for the Negative Emotions dimension

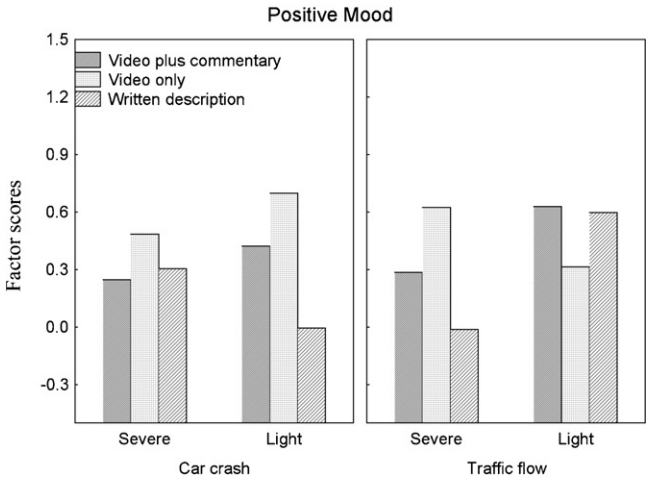

Fig. 2. Mean factor scores on the Positive Mood dimension of the B66 scale as a function of the Experimental Group, Scenario (Car crash, Traffic flow), and Intensity (Severe, Light).

resembles that of the Positive Mood dimension, obviously inverted. Once again, the verbal commentary is able to modulate the emotional effect of the visual presentation of a scene.

3.2.5. Positive Emotions dimension (B66 scale)

The analysis on the Positive Emotions scores showed a significant main effect of Intensity ($F_{1,167} = 13.16$, $p < 0.001$) and significant Group by Scenario, Group by Intensity, Scenario by Intensity first order interactions ($F_{2,167} = 9.41$, $p < 0.001$; $F_{2,167} = 7.88$, $p < 0.001$; $F_{1,167} = 4.97$, $p < 0.01$, respectively), as well as a significant second order interaction among all the factors ($F_{2,167} = 23.67$, $p < 0.001$).

Post hoc comparisons showed that participants in both the Video and verbal commentary and Written description groups rated their emotions as more positive after having viewed videos depicting light traffic rather than heavy traffic flow scenes ($p < 0.05$) (Table 2). Participants who viewed the videos without the verbal commentary, instead, rated their emotions as more positive after having viewed videos depicting heavy traffic than light traffic scenes ($p < 0.05$) (Table 2).

With regards to the effect of car crash videos and verbal descriptions, participants in the Video and Video plus verbal commentary groups rated their emotions as more positive after having viewed videos showing light rather than severe car crashes ($p < 0.05$). Instead, participants who viewed only the written descriptions of these scenes rated their emotions as more positive after having viewed descriptions of severe than light car crashes ($p < 0.05$) (Table 2). Even in this case, the general pattern of the results resembles those described above. Once again, the verbal commentary modulates the emotional effect of the mere visual presentation of a scene.

4. Discussion and conclusion

The results of the present study showed several aspects worth to mention. First, it was found that the emotional activation was significantly higher in the two conditions that employed live videos (both with and without verbal descriptions), compared with the condition wherein the participants only read the verbal description of the accidents. This finding, that supports the conclusions of previous studies, was confirmed by the analyses on all the three factors of the B66 scale ("Positive Mood", "Positive Emotions" and "Negative Emotions"). The direction of the differences for the activation of negative emotions was opposite to that of positive emotions (i.e. the activation of negative emotions was higher when only the verbal descriptions were given). Therefore, live videos are more likely to trigger positive feelings, as well as feelings of general interest. This result extends to live videos of car crashes those reported by several Authors who showed that videos are emotional activators (Gerbner, 1972; Liebert et al., 1973; Greenfield, 1984; Hubert, 1991; Meisel, 1998).

It is worth noting, though, that the amount of emotional activation did not depend only on the communication medium, but also on the specific content. For example, the probability of emotional activation was higher when the videos contained action scenes, like car crashes, whereas it was low when they involved light flowing traffic situations. In these latter conditions, verbal descriptions may be even more activating than videos. Thus, videos cannot be considered as non-specific emotional "activators": instead, it is their specific content that determines the likelihood that emotions arise.

It is also interesting that our participants distinguished the affective value of the stimuli (measured through the Semantic Differential Scale) and the effects of the stimuli on their own affective state (measured through the three factors of the B66 scale). For instance, participants could rate a video as having a high probability of activating emotions in other people, without attributing those emotions to themselves. Thus, it seems important to distinguish the processes underlying the evaluation of the subjective emotional condition ("how I feel") and the "objective" judgments of external events, like car crashes ("how much an experience is emotionally activating"). Likely, the former type of appraisal might be based primarily on embodied information, whereas the latter might be based on abstract knowledge and contextual information.

The amount of emotional activation induced by the verbal descriptions was generally lower than that obtained by the crash videos. Verbal descriptions appeared to be modulators, as they reduced the emotional arousal when the video represented car crashes, while maintaining a sufficient level of activation when the light flowing traffic situations were shown (e.g., when the video alone has a low activating power). Hence, the activation evoked by verbal descriptions seems more stable and less dependent on their specific contents (car crash or traffic flow).

Different results were found about the first dimension of the Semantic Differential Scale, which indicates the "informational value" attributed to the videos and verbal explanations. The scores on this dimension were high in the conditions that included only the verbal descriptions or that combined the video and the verbal commentary, whereas they were low when only the videos were employed. Therefore, our participants believe that the videos alone are not sufficiently instructive, and that the verbal descriptions are necessary to yield a sufficient informative value, for instance by explaining the dynamics of crash accidents. In general, their role is to attenuate the emotional impact of live images, but also to enrich them with contextual information.

The results of the present study suggest that the visual representations are not always more informative than the verbal representations, contrary to what most theories about the role of the visual and verbal codes would predict, such as the dual coding theory (Paivio, 1986; Clark and Paivio, 1991). Our results are not compatible with any simple explanation based upon the differences (format or involvement). Instead, our outcomes are coherent with studies showing that, at least in adults, the information presented through the verbal code (e.g., newspapers) are often better understood and remembered than the information presented through the visual code (e.g., movies) (DeFleur et al., 1992, Furnham and Gunter, 1985). The Authors suggested that the advantages of the verbal code might be due to the deeper and self-paced processing of the information that the verbal material allows. Interestingly, children seem to show the opposite pattern, as they have been found to understand and remember movies better than written text (e.g., Gunter et al., 2000).

In summary, the results of the present study show that live videos of car accidents have the primary property of evoking higher emotional activation (especially when they represent action scenes, like crashes), which can be modulated by co-occurring verbal explanations. However, if videos are not integrated by verbal explanations, they can be experienced as not fully instructive. It is worth to mention, however, that our sample is almost exclusively composed of female participants, thus whether our results generalize to males cannot be established and require further investigations. Still, our results have strong implications for road safety education programs. The use of video clips when dealing with road safety may be very appropriate for introductory courses, for dealing with complex issues and specific situations. However, their role seems to be limited to inducing emotions and interest, and they should be presented with verbal information to gain a full advantage in education contexts.

Appendix A.

A.1. Video showing a severe car crash

The pictures show an Italian motorway with regular traffic, a clear sky and good visibility. The stretch of motorway shown is curved, divided into two carriageways, each with two lanes, and separated by a central reservation. The left carriageway is characterised by a narrowing due to a worksite, with the hard shoulder closed off by New Jersey (cement blocks typically used on motorways as traffic islands, or to prevent access to forbidden areas). After some moments of no traffic, a group of vehicles arrives, but one car continues on a straight trajectory with no apparent reason, impacting first with the road signs and then with the New Jersey protecting the worksite. The impact is extremely violent.

A.2. Video showing a light car accident

The video shows a motorway next to a tollbooth. The weather is calm with good visibility. The stretch of road is flat and straight with the two carriageways divided by a central reservation. After having passed the tollbooth, the driver of a car stops without warning by the entrance to a junction, probably uncertain as to which road to take. The driver in the car behind isn't able to stop in time and hits the first car. A short queue forms behind these cars.

A.3. Video showing a heavy traffic scene

The pictures show a motorway composed of two carriageways separated by a central reservation of New Jersey cement blocks. Each carriageway has three lanes, with the hard shoulder and anti-noise barriers on the side. The road is long, flat straight. The weather is calm and visibility good. The traffic is composed of many cars and industrial vehicles that proceed slowly.

A.4. Video showing a flowing traffic scene

The stretch of road captured by the camera is typical of a motorway composed of two carriageways separated by a double barrier central reservation. The road gently curves toward the left, slightly downhill with grassy and raised terrain on each side. The road condition is good with very few industrial vehicles, buses and cars.

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