Original Article

Emotional Tears Facilitate the Recognition of Sadness and the Perceived Need for Social Support

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Abstract: The *tearing effect* refers to the relevance of tears as an important visual cue adding meaning to human facial expression. However, little is known about how people process these visual cues and their mediating role in terms of emotion perception and person judgment. We therefore conducted two experiments in which we measured the influence of tears on the identification of sadness and the perceived need for social support at an early perceptional level. In two experiments (1 and 2), participants were exposed to sad and neutral faces. In both experiments, the face stimuli were presented for 50 milliseconds. In experiment 1, tears were digitally added to sad faces in one condition. Participants demonstrated a significant faster recognition of sad faces with tears compared to those without tears. In experiment 2, tears were added to neutral faces as well. Participants had to indicate to what extent the displayed individuals were in need of social support. Study participants reported a greater perceived need for social support to both sad and neutral faces with tears than to those without tears. This study thus demonstrated that emotional tears serve as important visual cues at an early (pre-attentive) level.

Keywords: tears, crying, emotion, sadness, support

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Introduction

Emotional tears are typical of and unique for humans. Only humans shed tears when they are sad, happy, or otherwise emotionally moved. Remarkably, little is known about the function of emotional tears. In all major textbooks on emotion (e.g. Andersen and Guerrero, 1998; Gross, 2009; Lewis, Haviland-Jones, and Barrett, 2010) one will search in vain for terms like tears, weeping, or crying. This is all the more surprising because in his seminal work *The Emotional Expression of Man and Animals,* Darwin (1872), spent considerable attention to weeping, including its antecedents and the involved facial muscles. Darwin's remarkable conclusion was that emotional tearing served no purpose whatsoever: "We must look at weeping as an incidental result, as purposeless as the secretion of tears from a blow outside the eye, or as a sneeze from the retina being affected by a bright light..." (Darwin, 1872, p. 175). Tears thus were considered an exception to the generally accepted "Darwinian" rule, that all our bodily structures and functions, but also behaviors have contributed to the forwarding of our genes.

In the present contribution, we challenge Darwin's view and investigate the possible social significance of tears. Høgh-Olesen (2010), has described humans as ultrasocial animals; not only do they take care of infants, they look after the sick, disabled and elderly as well. In addition, there is much collaboration also between non-kin. It has been speculated that tears, being an honest and reliable signal of one's feeling and behavioral intentions, might have been instrumental in this development (Walter, 2006). This also raises the question whether emotional tears somehow serve as social bonding devices and, whether, in this capacity, they may have contributed to our social development.

Recently, various (mostly untested) proposals have been put forward as to why humans weep (Vingerhoets, 2013). These ideas generally fall in two categories (Vingerhoets, 2013; Vingerhoets, Bylsma, and Rottenberg, 2009). First, some theorists argue that tears mainly serve an *intra-personal* function: people cry because it facilitates recovery and return to a psychological and physiological homeostasis when distressed or suffering. This function relates back to the classic view that shedding tears is beneficial because it would result in catharsis and emotional recovery, whereas inhibiting one's tears would have negative health consequences, promoting the development of all kinds of psychosomatic disorders (Vingerhoets and Scheirs, 2001). More recently, it has been claimed that the significance of emotional tears rather has to be found in its *inter-personal* effects. More precisely, according to this perspective, shedding emotional tears stimulates caregiving and protective responses from significant others, facilitates social bonding, and reduces interpersonal aggression (Hasson, 2009). Walter (2006) goes even as far to suggest that human tears are responsible for our development into the "ultrasocial" animals we currently are. In his view, tears have contributed and stimulated our empathic abilities and large-scale mutual collaboration with non-kin and strangers.

In sum, there seems to be general agreement for the (ironically anti-Darwinist) hypothesis that one of the most important reasons why human shed emotional tears is that these tears (just as facial pain expressions, see Craig and Badali (2002)) elicit succor from others and promote social bonding. In this view, people in particular cry to express their need for help and when their social belongingness is challenged (Vingerhoets, 2013).

Surprisingly, more systematic empirical tests of this claim have hardly been conducted. Little is known about how individuals process visual cues such as tears and

about their mediating role in terms of emotion perception and person judgments. The empirical record of the (social) functions of crying has been modest until now. Cornelius and coworkers (described in Walter, 2006), and, more recently, Provine, Krownowski, and Brocato (2009) and Zeifman and Brown (2011) have demonstrated that tears are helpful to identify sadness and to perceive a need for succor and comfort. In addition, Hendriks and coworkers (Hendriks and Vingerhoets, 2006; Hendriks, Croon, and Vingerhoets; 2008) reported findings suggesting that crying individuals are perceived as in need of, and thus facilitating emotional support.

In daily life, humans are constantly exposed to multimodal input signals from their environment. Because of its limited processing capacity, the human brain has to focus on emotional signals, such as fear, anger and sadness, that have natural priority over others (Killgore and Yurgelun-Todd, 2004; Vuilleumier, 2002). Ecologically important emotional and social stimuli appear to be processed by a dedicated modular system, operating at a rapid and automatic pre-attentive level (Pessoa and Adolphs, 2010). Even when visual input containing emotional content is not being perceived consciously, it nevertheless appears to induce behavioral and neurophysiological responses that reflect changes in the emotional state of the observer (Tamietto and De Gelder, 2010).

In the aforementioned experiment by Provine and coworkers (2009), the participants' behavior was measured at a conscious attentive level, with presentation times of 5 seconds. Although previous research has demonstrated that sad faces are already being perceived below the threshold of conscious visual perception (Killgore and Yurgelun-Todd, 2004), the potential effect of tears as an additional visual cue at earlier perceptual levels remains to be investigated.

Therefore, in order to test the hypothesis that adding tears to sad faces speeds up recognition of sadness and facilitates the perception of the need for social support already at an early perceptional level, we conducted two experiments in which the influence of tears was measured in terms of identification of sadness and on the perceived need for social support. Based on earlier findings by Provine et al. (2009), we expected to find a similar superior recognition of sadness when tears were present. We furthermore expected to find an increased perceived need for support among people with tearful faces.

Experiment 1: Recognition of Sadness

This study (experiment 1 and 2) was approved by the Review Board of the Communication and Information Sciences Department of Tilburg University.

Materials and Methods

Participants

Thirty first-year psychology students (25 female, mean age = 21) from Tilburg University participated in this experiment. As a reward, they received course credits for their cooperation.

Materials and Procedure

Sixteen pictures of sad (8 female) and 32 (16 female) pictures of neutral faces were selected from the Karolinska Directed Emotional Faces database (KDEF) (Goeleven, De

Raedt, Leyman, and Verschuere, 2008) were selected, on which men and women display either a sad or neutral facial expression. We digitally added tears (running from the eyes down the cheeks) to the sad faces, using Adobe Photoshop. In order to obtain the most naturalistic situation, length, location and pattern of the tears were randomly varied across all individuals. All images were resized to a resolution of 310 x 410 pixels. Thus, 32 sad pictures (16 with tears added, 16 without tears added) and 32 neutral pictures were used in this experiment. All pictures were presented twice, resulting in 128 trials in total.

The experiment was run on a PC (placed in a closed quiet room) on a 19 inch CRT monitor with a 75 Hz refresh rate, using a SVGA graphics card. E-prime software (version 1.2) was being used to present the stimuli. A custom serial response box (Psychology Software Tools, Inc.) was used to record responses. All facial pictures were presented in full color, against a black background.

Participants were sitting on a chair at a distance of approximately 40 cm from the monitor, measured from the forehead to the top of the screen. An adjustable chair was used to ensure a viewing angle of approximately 90 degrees for each participant.
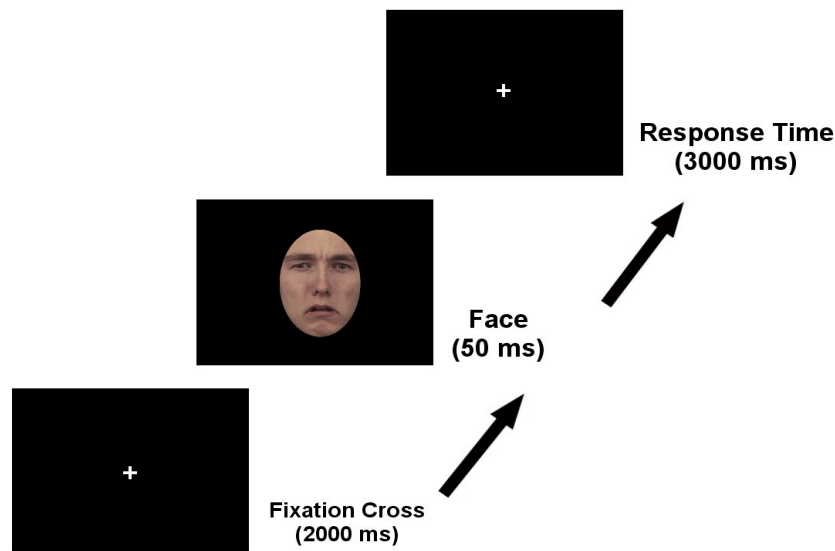
Each trial followed the same experimental sequence, as illustrated in figure 1. First, a white fixation cross was presented for two seconds in the centre of the screen against a black background. Immediately afterwards, a facial picture was presented for 50 milliseconds. Right after this, a three-second response window (again containing a white fixation cross) followed. Participants were instructed to judge whether the depicted person seen on the picture was sad or not by pressing the left response button for "Sad", or the right button for "Not Sad". Participants were instructed to respond as quickly as possible. If no response was given in the three-second time window, the next trial was presented automatically. In order to familiarize participants with the task, a set of practice trials was run before the actual experiment. This set consisted of 8 trials (2 sad faces with tears, 2 sad faces without tears, 4 neutral, all equally distributed among gender). Only during these practice trials, participants received feedback about their performance ("correct response or "incorrect response"). Data from these trials were not included in later analyses. After the experiment, each participant was debriefed and asked whether (s)he had been aware of the presence of tears on the presented facial pictures.

Results and Discussion

The percentages correct scores of the identification task were high in all conditions: 90% (neutral, no tears), 87% (sad, no tears) and 88% (sad, tears). A repeated measures ANOVA (comparing the accuracy scores between the 3 expression conditions) showed no significant differences for correct responses between expression conditions ($F(2,58) = 0.86$, $p > .05$, , $\eta2 = 0.15$). Trials with incorrect responses (overall 11% of all data points) were excluded from further analysis.

Figure 2 displays the mean reaction times for each expression condition for correct responses only. This reveals a clear picture: participants responded slowest to neutral faces without tears, they responded faster when exposed to sad faces with no tears, and fastest for sad faces with tears. A repeated measures ANOVA, with a subsequent LSD post-hoc test revealed a main effect of condition, $F(2,58) = 11.48$, $p < .001$, $\eta2 = .284$. The post hoc test showed that all pairwise comparisons were statistically significant at $p < .05$, whereas the one between neutral and sad with tears, reached a significance level of $p < .001$.
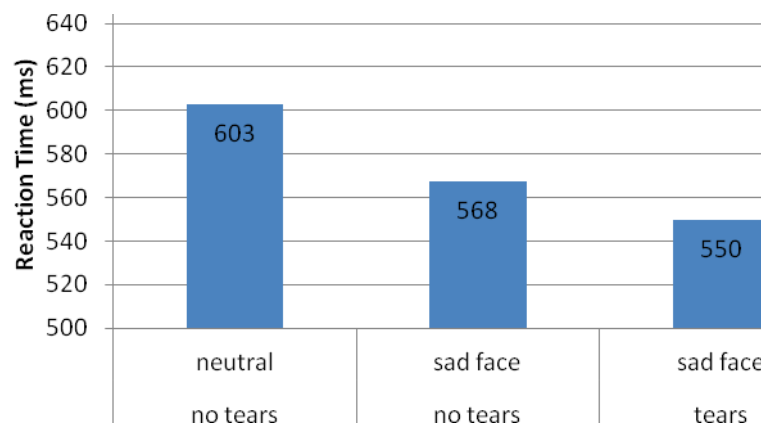
Figure 1. Schematic representation of the trial procedures in experiment 1 and 2. After a 2000 ms fixation period, a facial picture appeared for 50 ms, followed by a 3000 ms response window

During debriefing, only three out of thirty participants reported to have noticed the presence of tears on faces in several trials. These participants were not excluded from analysis.

The results thus demonstrate a significant faster recognition of sad faces with tears compared to those with no tears at a brief exposure time. One could wonder, however, if this effect exclusively applies to emotion recognition or that it also impacts on behavioral tendencies. The question whether adding tears to faces also affects the perceived need of social support, will be addressed in the next experiment.

Figure 2. Mean Reaction Time (in ms) per expression condition ($n = 30$)

Experiment 2: Identification of the Need for Support

For practical reasons, we switched from the three-condition design in experiment 1 (neutral faces without tears, sad faces without tears, sad faces with tears) to a 2 x 2 design in experiment 2 with levels Tears (present or absent) and Face (sad versus neutral).

Materials and Methods

Experiment 2a
Participants
In a pilot study (experiment 2a), 39 first-year psychology students (29 female, mean age = 22) from Tilburg University participated. None of them participated in experiment 1. They all received course credits for their participation.

Materials and Procedure
In experiment 2a, the same set of stimuli was used as in experiment 1. Again, all stimuli were presented twice, resulting in 128 trial presentations in total.

The procedure was the same as in experiment 1, with the same 50 millisecond exposure time. Participants were instructed to indicate to what extent the person on the picture was in need for support. They were asked to press one of five buttons on the response box, according to a continuum ranging from button 1 (most left button) meaning "This person needs no support at all" to button 5 (most right button) meaning "This person needs a lot of support". Participants were asked to respond as quickly as possible, based on their first impression. No practice trials were given this time. Again, participants were debriefed afterwards and checked for the awareness of tears on the faces in the experiment.

Experiment 2b
Participants
In the actual experiment 2b, 26 first-year communication and information science students (11 female, mean age = 21), also from Tilburg University took part. None of them participated in experiment 1 or 2a. Again, they all received course credits for their participation.

Materials and Procedure
For experiment 2b, the same set of sad faces (16 with added tears, 16 without tears) as in experiment 1 were used. In addition, we (randomly) selected 16 of the aforementioned 32 neutral faces (8 female) and added tears digitally in the same manner as described above, resulting in 16 neutral pictures with added tears. Again, all stimuli were presented twice (for 50 milliseconds), resulting in 128 trial presentations in total.
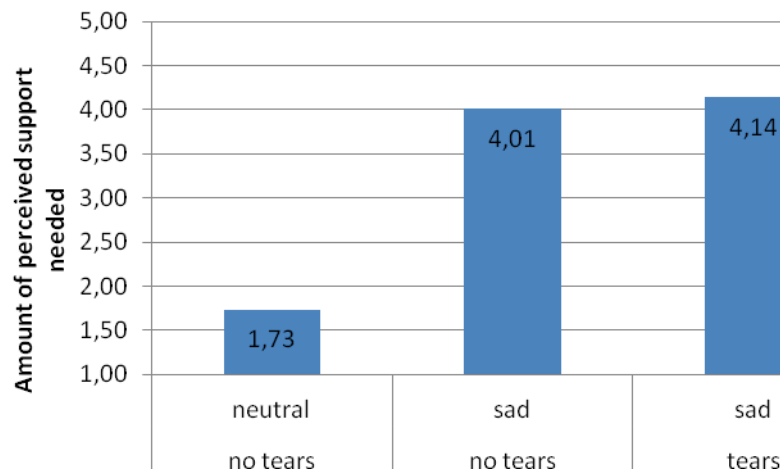
Results and Discussion

Experiment 2a
Figure 3 shows the mean perceived need for support scores of each condition. This yields a clear picture: the least perceived need for support was reported with neutral faces, the most with sad faces with tears. To test for statistical significance, we ran a repeated

measures analysis of variance, which showed a highly significant effect of condition, F $(2,76) = 795.55$, $p < .001$, $\eta2 = .954$. All pairwise comparisons were statistically significant; including the crucial comparison between sad with no tears and sad with tears, which was significant at $p < .01$.
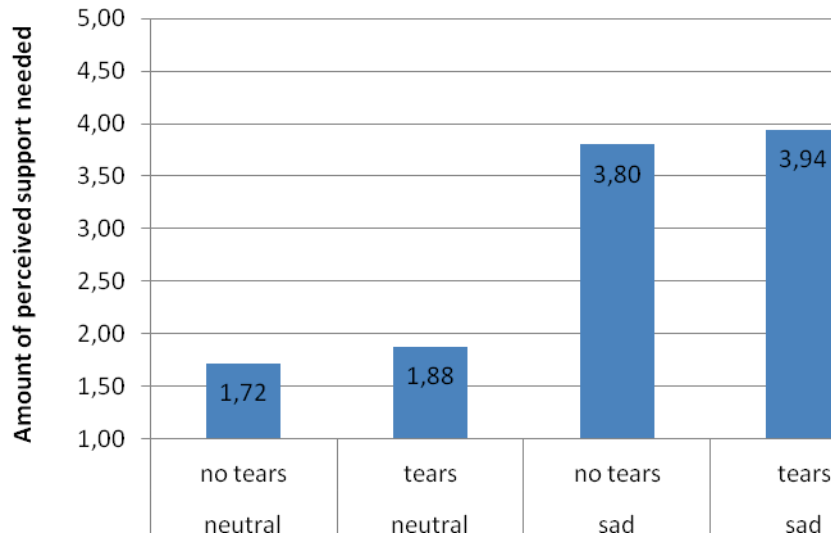
Figure 3. Average amount of perceived support needed, by pressing buttons 1 to 5 (1 = no support, 5 = lots of support) in Experiment 2a ($n = 39$).

Experiment 2b

The results are summarized in Figure 4. Mean responses were analyzed using a 2 x 2 repeated measures ANOVA, with factors Tears (levels: present, absent) and Face (levels: sad, neutral). The analyses revealed, as expected, that participants considered sad faces to be more in need of support ($M = 3.87$) than neutral ones ($M = 1.8$), $F(1, 25) = 62.89$, $p < .001$, $\eta2 = .716$. Crucially, however, we also found a main effect of Tears: participants considered faces with tears to be more in need of support ($M = 2.91$) than those without ($M = 2.76$), $F(1,25) = 15.02$, $p = .001$, $\eta2 = .375$. No significant interaction between the two factors was found. Three participants (out of 26) reported awareness of the presence of tears on some faces during the experiment, but were again not excluded from analysis.

Figure 4: Amount of perceived support needed, by pressing buttons 1 to 5 (1 = no support, 5 = lots of support) in Experiment 2b (*n* = 26).

Results thus demonstrated that people reported a stronger perceived need for social support to both sad and neutral faces with tears than to the same faces without tears.

General Discussion

The aim of the present studies was to investigate the impact of brief exposure to sad and neutral faces with and without tears on emotion perception and perceived need for support. In line with our expectations, the addition of tears to sad faces significantly speeded up the recognition of sadness. Moreover, the presence of tears was shown to increase the perceived need for support in individuals with both a sad and, more remarkably, with a neutral facial expression. In other words, tears as a visual signal seem to enhance both emotion recognition and social bonding behavior.

Experiment 1 corroborates the earlier findings by Provine et al. (2009) and Zeifman and Brown (2011), showing that emotional tears serve as important visual cues, improving perception and processing of human facial expressions; the so-called *tear effect*. However, the present study differed in two major aspects from Provine's work. First, whereas Provine and colleagues removed tears from crying faces, we digitally added them to tear-free sad faces instead. Second, and more important, is the difference between the two studies in terms of the perceptual level being measured. Provine and coworkers used long presentation times of 5 seconds, whereas our facial stimuli were presented for only 50 milliseconds. This very short presentation time (slightly more than one movie frame) enabled us to investigate whether early processing mechanisms are affected by emotion perception. Indeed, our results seem to confirm this. Our accuracy data additionally show that all participants performed very well with judging whether a person's face, only shown for 50 milliseconds, was sad or not. The mere addition of tears to a sad face thus facilitates the recognition of sadness. Although participants were instructed to judge whether the person shown was sad or not, the main dependent variable in our experiment was reaction

time, allowing us to measure the influence of tear perception independently of personal awareness.

These results seem to suggest that even at an early pre-attentive level, tears already can be detected and serve as an important visual cue which speeds up subsequent recognition processes. Since all but three participants reported to be unaware of the presence of tears on the faces, it can be argued that automatic processing mechanisms are involved. In line with this, earlier research (Blair, Morris, Frith, Perrett, and Dolan, 1999) showed that certain brain areas, previously associated with the perception of fearful faces (e.g., amygdala and right temporal lobe), display similar enhanced neurological activity in case of exposure to sad faces. Based on these findings, a faster recognition of sadness in general (compared with neutral expressions) was to be expected. The even faster recognition of sadness when tears were added to sad faces seems to confirm that tears serve as an additional major visual cue to facial displays of emotions. Whether this applies to other emotions occasionally associated with tears, such as happiness, remains to be investigated in the future.

As expected, experiment 2 showed that participants identified a higher need for support in sad faces than in neutral ones. More importantly, in both emotional conditions, this perceived need for support significantly increased when tears were added to the same faces. Again, these results suggest that tears serve as an important additional cue, supporting our hypothesis that weeping (or more specifically visible tears) conveys a need for succor. Apparently (and similar to experiment 1), this already happens at an early perceptual level, given the short 50 millisecond presentation time.

The present study is the first, to our knowledge, to demonstrate that tears seem to be (at least partly) predominantly driven by extremities. Not only does a tearful sad face seem to express the perceived need for social support more clearly than the same tearless sad face, perhaps even more importantly, a similar effect was found for neutral facial expressions as well; tearful neutral faces also evoke more feelings of perceived need for support than their tearless counterparts.

Moreover, in earlier investigations of crying behavior and social reactions (Hendriks et al., 2008; Hendriks and Vingerhoets, 2006) only self-reports to a target stimulus (a person who was crying or not), were assessed, possibly biased in terms of social desirability. In the current experiment, we measured the signaling value of tears decoupled from emotional facial expression. In conclusion, the present findings suggest that exposure to tears is not merely limited to sad emotional expressions in terms of signaling a general need for attention and support, but serving similar function in neutral faces.

Although these results are intriguing, some limitations of the current experiments need to be emphasized. First, in experiment 1, participants were instructed to indicate whether the person presented on the computer screen was sad or not. Given these specific instructions, a focus on sadness was likely to be made prior to the actual experiment. One could argue that this could have influenced the amount of accurate responses overall. Nevertheless, effects on our covert variable "response time with regard to the presence of tears" regarding this matter can probably be neglected. Second, as shown by Zeifman and Brown (2011), the signal value of tears seems to vary with the age of the crier. The effectiveness of tears in terms of communicating sadness and eliciting social responses from others is greatest in adult criers, less in children, and least in infants. In both of our experiments, we used adult faces. Exposure to, for instance, children's faces might have

yielded less strong effects in terms of identification and/or social supportiveness. A third limitation could be the possible lack of ecological validity in our studies. It is not unlikely that tears evoke different responses from the observer dependent, among others, on the context. There are many examples that crying individuals (infants, children and adults) are at greater risk to be reacted at with negative social reactions, varying from physical abuse, bullying, to being ridiculed (Vingerhoets, 2013). Fourth, in both experiments the presence of tears was the independent variable. A possible limitation could have been the lack of an additional control condition, with the tears at different locations (e.g., the same "tears" running from the nose or mouth, instead of from the eyes) or another salient visual cue (e.g., geometric shapes from the eye). Would such kinds of manipulation also have resulted in similar findings? A fifth limitation could be the fixed stimulus presentation time of 50 milliseconds in all trials. Further manipulation of viewing times could have given more insight into the size and direction of the effects. For instance, an increased viewing time might also augment the effect sizes. Finally, we only used sad and neutral faces in both experiments. The fact that neutral faces with tears more strongly stimulated the willingness to provide support than neutral faces without tears suggests that the signaling value of tears is independent of facial emotional display. Adding more emotional categories (for instance, happiness and fear) to the experiment, would have allowed us to explore this phenomenon in more detail.

In conclusion, our research provided further evidence for the facilitating effect of tears on processing emotion recognition and social judgments. Their function seems to surpass the connection with merely enhancing sadness recognition. Rather, tears seem to play a significant role as a visual signal in terms of promoting (pro)social behavior.

Recent research by Gelstein and coworkers (2011), suggests that tears have a chemosignaling function as well. That would imply that crying implies three-modal stimulation: acoustic, visual and olfactory. Taken together, it seems that crying is a behavior that still leaves much to discover, before we will have an adequate understanding of and insight into the power of this behavior. Given the promising results from our studies, many specific challenges (e.g., adding control conditions, various presentation times, context information or more emotional categories) are still open for further exploration in this new area of research.

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