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Reduced attentional blink for gambling-related stimuli in problem gamblers

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ABSTRACT

Although there is considerable information concerning the attentional biases in psychoactive substance use and misuse, much less is known about the contribution of attentional processing in problem gambling. The aim of this study was to examine whether problem gamblers (PrG) exhibit attentional bias at the level of the encoding processing stage.

Forty PrG and 35 controls participated in an attentional blink (AB) paradigm in which they were required to identify both gambling and neutral words that appeared in a rapid serial visual presentation. Explicit motivation (e.g., intrinsic/arousal, extrinsic, amotivation) toward the gambling cues was recorded.

A diminished AB effect for gambling-related words compared to neutral targets was identified in PrG. In contrast, AB was similar when either gambling-related or neutral words were presented to controls. Furthermore, there was a significant positive correlation between the reduced AB for gambling-related words and the sub-score of intrinsic/arousal motivation to gamble in PrG.

Such findings suggest that the PrG group exhibits an enhanced ability to process gambling-related information, which is associated with their desire to gamble for arousal reasons. Theoretical and clinical implications of these results are discussed.

1. Introduction

Pathological gambling, as with other addictions, can be defined as the continuation of maladaptive choices despite the explicit stated desire to make a different choice (APA, 1994). Pathological gambling occurs in about 1.6% of the general population (Inserm, 2008) and can be characterized by the fact that such individuals continue to gamble despite the often adverse consequences (DSM-IV-TR). It is likely that the incidence of gambling dependence will increase over the next decade because of the greater availability of gambling opportunities and will present a serious public health problem (Inserm, 2008).

Numerous studies on substance abusers (i.e., alcohol, drugs and tobacco dependents) have highlighted attentional bias toward addiction-related cues; i.e., addiction-related stimuli are processed more efficiently by addicted individuals, thereby influencing their subsequent cognition and behavior (for a recent review of attentional biases in addicts, see Field & Cox, 2008; Field, Munafo, & Franken, 2009). Such findings are in line with the incentive-sensitization theory (Robinson & Berridge, 1993; 2003) where compulsive gambling (like other addictive conditions) may be due to gambling-induced sensitization in the mesocorticolimbic system of the brain that is characterized by incentive salience to reward-associated stimuli. According to the incentive-sensitization theory (Robinson & Berridge, 1993; 2003), compulsive gambling (as other states of addiction) might be caused primarily by repeated exposure to gambling-related stimuli that would induce gambling sensitization in the brain's meso-limbic and meso-cortical dopamine systems that attribute incentive salience to reward-associated stimuli. In other terms, pathological motivation could arise from sensitization of brain circuits that mediate Pavlovian conditioned incentive motivational processes. Such sensitization might thus occur even in the absence of any drug action, such as in abnormal gambling. Once such hypersensitivity has occurred, these systems will generate pathological incentive of motivation (i.e., *wanting*) for addictive behaviors. By *wanting*, incentive salience is a type of incentive motivation that promotes the consumption of rewards and has distinct psychological and neurobiological features. In this

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context, incentive sensitization could produce a bias of attentional processing toward drug-associated stimuli and pathological motivation for drugs (compulsive *wanting*; Robinson & Berridge, 1993; 2003). Furthermore, it is also considered that this attentional bias is automatic, in that it occurs at early stage of processing that is difficult to control (Robinson & Berridge, 2003). Therefore, attentional biases would appear at early stages of attentional processing, such as the level of encoding.

Recently, several studies have highlighted attentional bias toward addiction-related stimuli at the level of encoding in opiate dependent patients (Liu, Li, Sun, & Ma, 2008), heavy drinkers (Tibboel, De Houwer, & Field, 2010) and smokers (Heinz et al., 2007; Munafó, Johnstone, & Mackintosh, 2005; Waters, Heishman, Lerman, & Pickworth, 2007). Such studies reported reduced attentional blink (AB) for substance-related stimuli in substance-dependent participants during rapid serial visual presentation (RSVP). The AB phenomenon refers to the observation that the second of two-masked target (T1 and T2) in an RSVP stream of distracters is usually poorly identified when it is presented within a short time interval (lag) after T1 (e.g., within a several hundred milliseconds; Raymond, Shapiro, & Arnell, 1992). As the lag time increases, T2 performance will recover (Raymond et al., 1992). Several theories describe these AB results as a limited capacity of our attentional system to deal with all RSVP items. The processing of T1 will leave less resource for T2, such that T2 will be more vulnerable to decay or interference (e.g., Chun & Potter, 1995). A reduced AB is often found when T2 stimuli are highly salient as such stimuli have a lower threshold to gain access into awareness. Hence, they are less affected by interference of other RSVP items (e.g., Anderson, 2005). In this study, we hypothesized that, in a similar fashion to that of other substance abuse and addiction, attentional bias would be present at a level of encoding in an addiction where there is no substance abuse, i.e., pathological gambling.

To our best knowledge, there have been only two previous studies which have investigated attentional bias in excessive gambling in which a modified Stroop paradigm was used (Boyer & Dickerson, 2003; Molde et al., 2010). These studies showed that participants with compulsive gambling took longer to name the color of the words relating to gambling when compared to healthy controls or minor problem gamblers. However, performances evaluated on this modified Stroop paradigm do not allow us to identify which attentional processes are involved in the Stroop effect (e.g., encoding). Indeed, in the Stroop paradigm, the task stimulus and the distracter are spatially and temporally coincident. In this context, it is unclear whether low performance on the Stroop task represents resource competition at the level of attentional encoding, or at a later stage of attentional processing (i.e., initial orienting, attentional capture and attentional shift; e.g., MacLeod, 1991).

In summary, we aimed to investigate whether attentional bias toward gambling-related stimuli occurs at the level of encoding in a group of problem gamblers (PrG). We expected that in an AB task in which T2 is either a gambling-related or a neutral word, AB might be diminished for gambling-related words compared to neutral words in pathological gamblers. A further objective of this study was to examine the relationship between attentional biases toward gambling-related cues in PrG and their motivation to gamble. It was expected that there would be a significant positive correlation between the greater efficiency to process gambling-related information and the intrinsic/arousal reasons to gamble. Indeed, intrinsic motivation to gamble is known to evoke the need for enjoyment and excitement/arousal (Chantal, Vallerand & Vallière, 1995).

2. Methods

2.1. Participants

Two groups participated in the study: (1) the controls (CONT; $n = 35$) and (2) the problem gamblers (PrG; $n = 40$). All subjects were adults (>18 years old) and provided informed consent to participate in the study. The study was approved by the appropriate human subject committee at the Brugmann University Hospital. The demographic data on the two groups are described in Table 1.

2.2. Recruitment and screening methods

PrG were recruited from a number of casinos in Belgium. All PrG scored ≥ 3 on the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), which is indicative of problem gambling. Furthermore, 13 participants (32.5%) met the more stringent criteria of probable pathological gambling (SOGS ≥ 5); we will refer to this combined group henceforth as PrG. The controls, CONT, were recruited from the employees at the psychiatric unit of the Brugmann University Hospital. To avoid biases, psychiatrists, psychologists or any other personnel who had undertaken psychological training were excluded.

2.3. Current clinical status

Current clinical status was rated with the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger, 1983). We excluded any control subject who had (a) an Axis I psychiatric diagnosis assessed by the Structured Clinical Interview for *DSM-IV* (First, Spitzer, Gibbon, & Williams, 2002), or (b) experienced either a drug use disorder during the year before enrollment into the study, or had consumed more than 54 g/day of alcohol for longer than 1 month. The control group was judged to be medically healthy on the basis of the results of their medical history and physical examinations. Participants were asked to avoid the use of narcotics for pain

Table 1
Demographical data and standard deviations for problem gambling (PrG) and normal control (CONT) groups.

	Normal control	Problem gambling	Test statistics	Bonferroni-corrected pairwise comparison
n	35	40		
Age	32.78(9.77)	31.00(10.20)	$t(72) = .74, p = .46$	CONT = PrG
Male/Female	20/15	22/18	$\chi^2(1.75) = .04, p = .85$	CONT = PrG
BDI	2.14(1.81)	4.3(5.41)	$t(73) = 2.11, p < .05$	CONT < PrG
STAI-E	38.62(7.66)	43.25(10.07)	$t(73) = .74, p < .05$	CONT < PrG
STAI-T	30.08(7.31)	34.64(10.23)	$t(73) = .74, p < .05$	CONT < PrG
Cigarettes/Day	3.61(6.67)	8.87(9.33)	$t(73) = 2.81, p < 01$	CONT < PrG
SOGS	/	4.6(2.71)		

Note. Values shown are the mean and standard deviations on each measure. The South Oaks Gambling Screen was administered only in the PrG group. Degrees of freedom differ due to missing data. BDI = Beck Depression Inventory, STAI-E = State version of the State-Trait Anxiety Inventory, STAI-T = Trait version of the State-Trait Anxiety Inventory, SOGS = South Oaks Gambling Screen.

relief, drug use as well as alcohol consumption for the preceding 24 h for the 5 days prior to testing.

2.4. Measure of gambling motivation

The Gambling Motivation Scale (GMS; Chantal et al., 1995) was used to assess intrinsic and extrinsic motivation to gamble in PrG. The GMS is based on the self-determination theory (Deci & Ryan, 1987) and contains 7 sub-scales: intrinsic motivation toward knowledge (e.g., "For the pleasure I get at improving my knowledge of the game."), accomplishment (e.g., "For the feeling of efficacy that I get when I play my favorite game."), and stimulation (e.g., "For the thrill or the strong sensations it gives me."), as well as external motivation introjected (e.g., "To show others that I am a dynamic person."), identified (e.g., "Because it is the best way I know of to eliminate tension."), and external regulation (e.g., "To get rich."). The seventh scale's targeting amotivation (e.g., "I play for money, but sometimes I ask myself if I should continue to play my favorite game."). There are 28 items (4 items for each of the 7 sub-scales) which are assessed on a 7-point scale. For each item, the participant has to circle the number that represents the extent to which the item corresponds to the reasons why the individual plays his favorite gambling game.

2.5. Stimuli and materials

As shown in Appendix A, there were 25 neutral T1 words, that on average had a length of 5.92 letters ($SD = 1.08$), 9 gambling-related T2 words that on average contained 6.22 letters ($SD = 1.56$) and 9 neutral T2 words that on average contained 5.88 letters ($SD = 1.16$). The number of letters and frequency of T1 and neutral T2 words were selected with Wordgen (Duyck, Desmet, Verbeke, & Brysbaert, 2004). We also selected 79 neutral distractors, which were adapted from stimuli used by Anderson (2005), that were long enough to mask the targets ($M = 11.53$ letters, $SD = 2.10$). Stimulus presentation and data output for the AB task were programmed in an E-Prime version 2.0 professional. The AB task appeared on a 17 inch CRT-monitor with a refresh rate of 85 Hz.

2.6. Procedure

The testing of each individual took place in a quiet room, located at the Medical Psychology Laboratory, Brugmann Hospital. Each participant was seated approximately 45 cm from the front of the monitor. After signing the informed consent form and completing the STAI-State questionnaire, participants performed the AB task. Each trial started with the presentation of a red fixation cross, that remained on the screen for 1000 ms. This was followed by the RSVP stream, consisting of 13 distractor words in white, and T1 and T2 in green. All stimuli were presented consecutively for 94 ms (equaling 8 screen refreshes) in 16-point bold Courier New Font, against a black background. Participants were instructed to monitor the stream and to report the green words. At the end of each trial, participants were prompted to type in their responses and were encouraged to guess when appropriate. Participants have to spell the words correctly and have to input the words in the correct order (T1 first, then T2). There was no response deadline.

T1 was always selected from the neutral list of T1 stimuli. T2 was selected from the list of gambling-related words on half of the trials, and from the list of neutral words on the other half of the trails. Selection from the lists was random without replacement and the different types of trials were presented in a random order. T1 could appear at the third or fifth position in the stream, and T2 could appear 2 or 4 lags after T1, reflecting stimulus onset asynchronies (SOA) of 188 and 376 ms respectively. There were 4 presentations of each of these two types of T2, one for each of the two lags and each of the two T1 positions, resulting in 72 experimental trials. At the beginning of the experiment, there was a practice block consisting of 10 trials in which all targets were neutral words. Once the AB task response had been completed, participants were asked to complete the Beck, STAI-Trait. In addition the PrG group also completed the GMS.

2.7. Data analysis

Initially the percentage of accurate T2 responses was calculated for each of the experimental conditions. For the analyses discussed below, only trials with the correct T1 identification were taken into account (T1|T2-correct). When the analyses were assessed in all of the trials, regardless of whether T1 was identified correctly, comparable results were obtained. Furthermore, we observed no difference between PrG and CONT participants on the proportion of T1 correctly spelled ($M = .96$, $SD = .03$ for PrG; $M = .94$, $SD = .04$ for CONT; ts < 1).

Secondly, an item-analyses based on an AB-index was undertaken. This was calculated by dividing the performance at Lag 2 by performance at Lag 4 and then multiplying this value by 100. This yielded a score reflecting the percentage of AB "survival" at the short compared to the long Lag for both T2 types. High scores implied that the "survival" rate was high and that the AB effect was small.

Thirdly, we performed a repeated measures ANOVA on the percentages of accurate T2 responses for each condition, with group as between subjects factor (PrG or CONT) and lag (Lag 2 or 4), and T2 type (gambling-related or neutral) as within-subjects factors.

Finally, in order to determine the relationship between gambling-related AB and intrinsic/arousal motivation to gamble in PrG, correlation analyses ($n = 40$) were conducted between the AB-index related to gambling words and the AB-index related to neutral words with the subscale "intrinsic motivation toward stimulation" of the GMS.

3. Results

3.1. Demographics and current clinical status

A description of demographic variables, scores on the SOGS, the BDI, the STAI and the average number of cigarettes smoked per day is presented in Table 1. Chi square analyses no differences in the distribution of male and female participants. Depression was higher in PrG than in CONT, $t(73) = 2.11$, $p < .05$. State and trait anxiety was higher in the PrG group in comparison with the CONT group, $t(73) = .74$, $p < .05$; $t(73) = .74$, $p <. 05$, respectively. The average number of cigarettes smoked per day was higher in PrG than in CONT, $t(73) = 2.81$, $p < .01$. No other group differences were present. Because our sample of PrG included individuals who met the more stringent criteria for probable pathological gambling, the effect of gambling severity was controlled for the PrG group. When we carried out ANCOVAS using depression, trait-state anxiety, and number of cigarettes smoked per day as covariates, we found no effect for any of these variables on comparisons between the PrG and CONT groups; we thus subsequently carried out ANOVAS.

3.2. Internal consistency analysis

We calculated Cronbach's alpha on the basis of the AB-index separately for the gambling and neutral words, for each participant. Cronbach's alpha of $\alpha = .79$ and .86 for the gambling-related and neutral words, respectively.

3.3. Performance on the AB task

The ANOVA revealed a main effect for lag, $F(1, 73) = 319.11$, $p < .001$, $\eta^2 = .81$, but no main effect for T2 type, $F < 1$. There was an interaction between T2 type and group and between lag and group, $F(1, 73) = 9.36$, $p < .01$, $\eta^2 = .12$; $F(1, 73) = 3.91$, $p = .05$, $\eta^2 = .06$, respectively. The main effect for group failed to reach significance, $F < 1$. More importantly, the repeated measures ANOVA yielded a significant interaction between T2 type, lag, and groups, $F(1, 73) = 6.21$, $p < .05$, $\eta^2 = .08$ (see Fig. 1.). To further explore the three-way interaction, we performed separate analyses for the two groups.

3.3.1. PrG

The main effect for lag was significant, $F(1, 39) = 135.41$, $p < .001$, $\eta^2 = .77$, indicating that the percentage of correct identifications of T2 is higher for Lag 4 ($M = .75$, $SD = .16$) compared with Lag 2 ($M = .46$, $SD = .22$). The main effect for T2 type was also significant, $F(1, 39) = 6.56$, $p < .05$, $\eta^2 = .14$, reflecting a tendency for better performance for gambling-related words ($M = .63$, $SD = .18$) compared with neutral stimuli ($M = .59$, $SD = .19$). The crucial interaction between T2 type and lag was significant, $F(1, 39) = 4.35$, $p < .05$, $\eta^2 = .10$, revealing a smaller AB effect for gambling-related words compared to neutral words: participants were better at identifying gambling-related words ($M = .51$, $SD = .21$) than neutral words ($M = .41$, $SD = .23$, $t(39) = 9.85$, $p < .001$) at Lag 2, but not at Lag 4 ($M = .76$, $SD = .17$ for gambling-related words; $M = .75$, $SD = .16$ for neutral words, $ts < 1$).

3.3.2. CONT

There a main effect for lag, $F(1, 34) = 184.21$, $p < .001$, $\eta^2 = .84$, reflecting a tendency for better performance Lag 4 ($M = .76$, $SD = .19$) compared to Lag 2 ($M = .39$, $SD = .24$). The main effect for T2 type approached significance, $F(1, 34) = 3.17$, $p = .09$, $\eta^2 = .08$, reflecting a tendency for better performance for neutral words ($M = .59$, $SD = .22$) compared with gambling-related words ($M = .56$, $SD = .21$). The crucial interaction between T2 type and lag was however not significant, $F < 1$.

3.4. Relationship between scores on the AB and sub-scales of the GMS

Analyses revealed a correlation between the intrinsic motivation to experience stimulation subscale and the AB-index for gambling words, $r(38) = .39$, $p < .01$, but not for the AB-index for neutral words, $r(38) = 04$; $p > .05$. We also observed significant correlations between SOGS scores and the following sub-scales of the GMS: extrinsic motivation-identified, $r(38) = .48$, $p < .001$; extrinsic motivation-external regulation, $r(38) = .35$, $p < .05$; amotivation, $r(38) = .68$, $p < .001$. Other correlations did not reach significance.

4. Discussion

In these present studies it has been shown that the identification of the second target (T2) was impaired in Lag 2 condition (SOA of 200 ms) compared to Lag 4 condition (SOA of 400 ms) using a dual-target rapid serial visual presentation (RSVP) paradigm with a fast stimulus presentation rates (90 ms) and two stimulus onset asynchronies (SOA). In addition the AB effect obtained on Lag 2 was attenuated for gambling words compared to neutral words in a group of PrG. In addition, the intrinsic motivation to experience stimulation subscale of the GMS and AB survival for gambling-related cues in PrG correlated significantly. To our knowledge, this study is the first to report AB survival for gambling-related cues and its relationship with subjective motivation for gambling in problematic gamblers.

The results which related to the AB effect are consistent with previous studies which used a comparable RSVP tasks involving the detection or identification of letters, words, or nonverbal patterns as stimuli (e.g., Anderson & Phelps, 2001; Raymond et al., 1992). Indeed, in agreement with these previous studies of AB, we also observed that the second of two masked target (T1 and T2) were not correctly identified when it was presented within a short interval (lag 2) after T1 rather than within a less short interval (lag 4) after T1.

The main finding of this study concerned AB survival for gambling-related cues in PrG participants compared with CONT. This result suggests that PrG are more likely to identify gambling-related words than neutral words under conditions of limited attentional resources, which is consistent with an enhanced attentional bias for gambling cues at the encoding level in the PrG group. Taking our present findings into account, it would suggest that gamblers' modified reaction for gambling words observed by studies using a modified Stroop paradigm (Boyer & Dickerson, 2003; Molde et al., 2010) could be induced, in part, by biases of early attentional processes toward gambling-related cues.

Another aim of this present study was to examine the relationship between AB survival for gambling-related cues in PrG and their intrinsic/arousal motivation to gamble. As expected, only one positive correlation was found between the intrinsic/arousal motivation to experience stimulation subscale of the Gambling Motivation Scale (GMS) and AB survival for gambling-related cues in PrG. This result suggests that gambling-related attentional biases are correlated with problem gamblers'

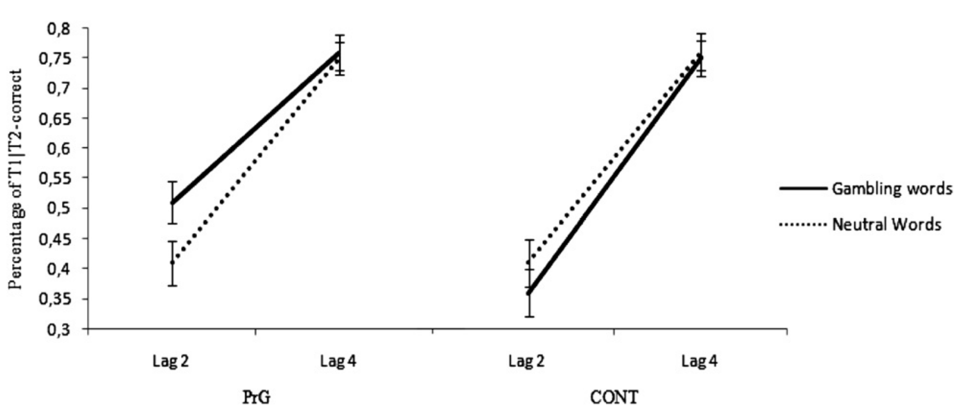

Fig. 1. Percentage of T1|T2-correct for CONT and PrG with gambling-related and neutral stimuli.

perception that gambling is motivationally salient. In this context, this finding is coherent with the incentive-sensitization theory (Robinson & Berridge, 1993, 2003). This model proposes that attentional and approach biases for addiction-related stimuli are indices of incentive processes, and that incentive-sensitization mechanisms play an important role in the development and the maintenance of an addiction state.

Several limitations to our study should be noted. First, the gambling-related stimuli that were used included a number of words for which it was not possible to find matching neutral counterparts. For this reason, in the problem gamblers, AB survival for gambling-related words might be partially explained by the fact that the gamblers were more familiar with the gambling-related words than the controls (for example, Karnadewi and Burt (2010) observed such a word familiarity effect during an RSVP task). However, in our study, it is unlikely that any differences between the groups were due to a familiarity effect. Indeed, if problem gamblers were more familiar with gambling words they might improve with spelling the gambling-related words in both Lag 2 and 4. However, a difference was found only on Lag 2. Secondly, the attenuation of the AB was not associated with gambling dependence severity. This was probably due to the relatively small variation of the South Oaks Gambling Screen (SOGS) between PrG participants. Therefore, it would be helpful to extend this research to a larger sample of gamblers which would include both extreme ends of the spectrum of gambling dependence as well as including both low problem gamblers (e.g., usual lottery players) and pathological gamblers that have attempted to stop gambling. Thirdly, in order to increase the robustness of reduced gambling-related AB effect, it would have been preferable to include gambling-related target in RSVP task that correspond only to the gambler's preferred gambling activity (e.g., blackjack versus slot machine gambles). Finally, the present results suggest that PrG may readily detect gambling-related cues indicative of early AB toward gambling-related cues in gamblers. However, further investigations are needed to examine if AB occur at later attentive processing stages using, for example, extended stimulus exposure time.

In summary, this study showed enhanced attentional bias for gambling cues at the encoding level in individuals with problematic gambling behaviors. Such attentional bias was associated with the gamblers' perception that gambling-related stimuli are motivationally-salient items. The presence of attentional bias in problem gambling as well as in individuals addicted to substance (alcohol, tobacco, & opiate; for a review see, Field, Munafo, & Franken, 2009) suggests that addiction in general may have this common cognitive processing characteristic.

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Appendix A. Stimuli

T1 words

ACCENT (accent), AGENDA (diary), STUDIO (studio), PATRON (boss), DATE (date), PARTAGE (sharing), ENTRE (between), EXACTE (correct), CUISINE (kitchen), GARAGE (garage), LIMITE (limit), LEVIER (lever), BERGER (shepherd), IVOIR (ivory), CALME (quiet), LAMPE (light), MARBRE (marble), NOUVELLE (news), PLAINE (lowland), RADIO (radio), DIAMANT (diamond), VIS (screw), SERVICE (service), SUBTIL (subtle), BRANCHE (branch).

Gambling T2 words

CASINO (casino), ROULETTE (roulette), POKER (poker), JETON (token), CARTE (card), BLACKJACK (blackjack), JACKPOT (jackpot), BINGO (bingo), GAIN (gain).

Neutral T2 words

POMME (apple), PNEU (tire), CHEMISE (shirt), QUARTIER (district), PLUIE (rain), MOUTON (sheep), NEIGE (snow), NUAGE (cloud), SOLEIL (sun).

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