DUF1220-coding potential of the human brain, suggesting that such an increase may have conferred strong selective advantages.

The genomic regions that harbor DUF1220 sequences appear to be particularly complex and, as a result, different genome assemblies differ with respect to the predicted number of DUF1220-encoded sequences. However, two recent genome-wide BAC aCGH cross-species studies (*17*, *18*) independently support the findings reported here that DUF1220-encoding genes show human lineage–specific increases in copy number and appeared with remarkable rapidity. If they indeed are the result of strong positive selection, they may play an important role in human lineage–specific traits (*19*) and serve to illustrate how certain regions of the genome can undergo episodes of "punctuated" evolution (*20*).

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21. We thank S. Burgers, J. Chang, A. Blackler, A. Fortna, A. Solidar, J. Smith, and B. Carstens for technical help; D. Manchester, M. Churchill, J. Pollack, Y. Kim, and J. Kent for helpful discussions; L. Jorde for providing genomic DNAs from diverse human populations; the Macaque Genome Sequencing Consortium for generating genome sequence assemblies and making data available before publication; B. K. DeMasters and C.-I. Sze for providing postmortem human brain tissue; R. Levinson for immunocytochemical expertise and for use of light microscopy facilities; and J. Caldwell for assistance with interpretation of immunofluorescence results. Supported by a Butcher Foundation grant and NIH grant AA11853 (J.M.S.) and the University of Missouri Research Board (G.J.W.).

Supporting Online Material
www.sciencemag.org/cgi/content/full/313/5791/1304/DC1
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5 December 2005; accepted 6 July 2006
10.1126/science.1127980

Reducing the Racial Achievement Gap: A Social-Psychological Intervention

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Two randomized field experiments tested a social-psychological intervention designed to improve minority student performance and increase our understanding of how psychological threat mediates performance in chronically evaluative real-world environments. We expected that the risk of confirming a negative stereotype aimed at one's group could undermine academic performance in minority students by elevating their level of psychological threat. We tested whether such psychological threat could be lessened by having students reaffirm their sense of personal adequacy or "self-integrity." The intervention, a brief in-class writing assignment, significantly improved the grades of African American students and reduced the racial achievement gap by 40%. These results suggest that the racial achievement gap, a major social concern in the United States, could be ameliorated by the use of timely and targeted social-psychological interventions.

The drive for self-integrity—seeing oneself as good, virtuous, and efficacious—is a fundamental human motivation (*1*–*3*). Membership in valued social groups is often a major source of individuals' sense of self-integrity (*4*, *5*). Consequently, negative characterizations of one's group can prove threatening, especially in chronically evaluative environments.

Because people subjected to widely known negative stereotypes impugning the intelligence of their group are aware of these negative characterizations, they may worry that performing poorly could confirm the stereotype of their group (*6*–*8*). This situation can create chronic stress at school and work, by burdening people with an extra psychological threat not experienced by those outside their group. If too severe, stress can undermine performance (*6*–*10*). Indeed, simply observing a group member who might confirm a negative stereotype about one's group can induce threat, undermining performance (*5*).

One potentially effective way to buffer people against threat and its consequences, we suggest, is to allow them to reaffirm their self-integrity (*2*, *3*). Self-affirmations, by buttressing self-worth, can alleviate the stress arising in threatening performance situations (*11*). They can take the form of reflections on personally important, overarching values, such as the importance of family or a self-defining skill (*2*, *3*).

The research reported here tested whether a self-affirmation intervention designed to lessen threat would enhance the academic achievement of negatively stereotyped minority students. The intervention rested on three assumptions: First, people are motivated to maintain self-integrity; second, because group memberships are an important source of self-integrity, negative group characterizations can pose a chronic threat to self-integrity; third, such threat, if too severe, can undermine performance.

School settings can be stressful to almost all students regardless of race. However, for African American students, the academic environment involves an extra degree of threat not experienced by nonminority students, due to the negative stereotype about the intelligence of their race. This threat, on average, raises stress to levels that are debilitating to performance (*6*–*9*). Accordingly, we expect that a self-affirmation intervention would be particularly effective at improving their academic performance. We would, in fact, expect this intervention to improve the performance of all groups of individuals subjected to a threat sufficiently pervasive and intense to impede that entire group's average performance.

This prediction was tested in two randomized double-blind field experiments (*12*). The second, a replication study, occurred a year after the first and involved a different cohort of students. Participants were seventh-graders from middle- to lower-middle-class families at a suburban northeastern middle school whose student body was divided almost evenly between African Americans and European Americans. The experiments involved 119 African American students and 124 European American students distributed roughly evenly across the two studies. All the teachers who participated taught the same academic subject (one not typically related to gender stereotypes). This subject was the intervention-targeted course in both studies; it was the one in which the intervention was administered.

In the fall term of each year, students were randomly assigned, at the level of the individual student, to the affirmation condition or the control condition. For each teacher and classroom period, there were approximately equal numbers of participants in each condition. Teachers were blind to students' condition assignment and unaware of the

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specific research hypothesis. The experimental treatment occurred as close to the start of the fall term as possible, when evaluative stress was assumed to be high. Teachers distributed closed envelopes, each containing an exercise packet, to all students in their class. Each envelope was marked with the name of the student who was to receive it. The exercise was presented as a regular class assignment and took approximately 15 min to complete. Students opened their envelopes, removed the packet, and were guided through the procedure via written instructions in the packet. Students completed the exercise independently and in silence, providing written responses to the tasks contained in the packet.

Following standard procedures, the affirmation and control exercises presented a list of values (such as relationships with friends or family or being good at art) (*12*). In experiment 1, treatment students were asked to indicate their most important value, control students their least important value. In the replication study, treatment students were asked to indicate their two or three most important values, control students their two or three least important values.

Treatment students in both studies then wrote a brief paragraph about why their selected value(s) were important to them. Control students wrote about why the chosen value(s) might be important to someone else. To reinforce the manipulation, students indicated their level of agreement with statements concerning their chosen value(s) (such as "I care about these values," in the treatment condition versus "some people care about these values," in the control condition). Upon completion, students placed the exercise packet in its envelope, sealed it, and returned it. Envelopes were collected and forwarded to the researchers. Teachers immediately resumed their lesson plan. One exercise was completed during the academic term in the first study, two in the replication study.

Multiple regression was used to test treatment effects (*12*). Based on their official transcripts, African Americans in the affirmation condition earned higher fall-term grades in the targeted course than did those in the control condition. On a grade metric ("A" = 4.0, "B" = 3.0, etc.), the treatment effect was 0.26 grade points in study 1 [regression coefficient $B = 0.26$, $t(41) = 2.44$, $P < 0.02$] and 0.34 grade points in the replication [$B = 0.34$, $t(60) = 2.69$, $P < 0.01$]. The likelihood of observing two effects of this magnitude by chance is approximately 1 in 5000. No treatment effect occurred for European Americans in either experiment [$|B\text{'s}| < 0.16$, $|t\text{'s}| < 1.1$, NS]. The race × experimental condition interaction was significant in both experiments [$B = 0.29$, $t(98) = 2.00$, $P < 0.05$; $B = 0.52$, $t(119) = 2.80$, $P < 0.01$, respectively]. Tables S1 and S2 present the regression coefficients, standard errors, and *t* values for each term in the full regression model for experiments 1 and 2, respectively (*12*).

This treatment effect was not limited to a small number of students performing poorly or well before the intervention. Figure 1, displaying the treatment effect at varying levels of preintervention performance (averaged over both studies), illustrates the generality of the impact of the treatment. It benefited nearly 70% of African Americans. The treatment benefit was equally strong for previously poorly performing students [$t(31) = 2.74$, $P = 0.01$] and for students in the moderate range [$t(30) = 2.40$, $P = 0.02$]. The highest performing students benefited less from the intervention than did low- or moderate-performing students, but covariate-adjusted results continued to show a marginally significant trend toward a positive effect of the intervention [$t(31) = 1.72$, $P < 0.10$].

The average performance gap between African Americans in the control condition and European Americans overall in the fall term of the targeted course was 0.75 grade points (0.68 in the first experiment, 0.82 in the second). The average treatment effect for African Americans was 0.30 points, roughly a 40% reduction in the racial achievement gap.

Combining the data from both studies provides a sufficiently large sample to permit meaningful analysis of the rate of poor performance (the percentage of students receiving a D or below) (*12*). For African American students, this rate was 20% in the control condition and 9% in the treatment condition, a significant difference in logistic regression [Wald (1) = 8.14, $\Delta\chi^2$ (1) = 11.40, $P < 0.01$]. European Americans did not vary by condition (6% versus 7%, respectively). The race × experimental condition interaction was significant [Wald (1) = 3.96, $\Delta\chi^2$ (1) = 4.39, $P < 0.05$]. Figure S1 shows that the poor performance rate of African Americans in the control condition did not differ from that of African Americans in the fall term of the targeted course in the three previous years ($z < 1$, NS). In contrast, the poor performance rate of African Americans in the affirmation condition was significantly lower ($z = -2.73$, $P < 0.01$) (*12*). That is, the control condition showed no effect on performance, whereas the affirmation condition did.

An exploratory issue concerns whether, if the affirmation reduced feelings of threat, its impact extended to other courses. African American students in the affirmation condition earned a higher grade point average (GPA) in these nontargeted courses than did those in the control condition [experiment 1: $B = 0.31$, $t(40) = 2.63$, $P < 0.02$; experiment 2: $B = 0.21$, $t(58) = 1.70$, $P < 0.10$ two-tailed test, $P < 0.05$ one-tailed test]. Pooling data from both experiments yielded a significant effect [$B = 0.23$, $t(108) = 2.51$, $P < 0.02$]. European Americans again displayed no condition effect in either experiment [$|B\text{'s}| < 0.13$, $|t\text{'s}| < 1$, NS]. The race × experimental condition interaction was significant in experiment 1 [$B = 0.45$, $t(97) = 2.75$, $P < 0.01$], marginal in experiment 2 by a two-tailed test [$B = 0.30$, $t(117) = 1.74$, $P < 0.09$], significant by a one-tailed test ($P < 0.05$), and significant over both studies [$B = 0.30$, $t(228) = 2.42$, $P < 0.02$]. Because of these effects, the treatment effect on overall GPA was virtually as significant as it was on grade in the targeted course.

We obtained data related to how the affirmation process played out in vivo. The replication study provided data on performance over time. Figure 2 displays average in-class performance (proportion of total points earned) for each of 10 chronological performance blocks during the academic term

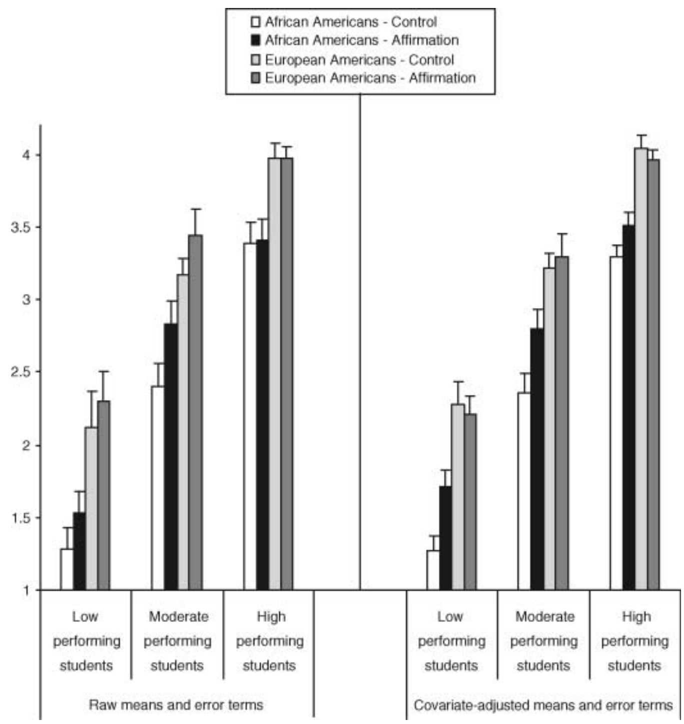

Fig. 1. Mean grade point average in the targeted class as a function of student race, experimental condition, and preintervention level of performance (an average of the prior year's GPA and preintervention in-class performance). Students were categorized into low-, moderate-, and high-performance categories on the basis of tertiary splits done separately within each racial group; the categorization represents students' relative standing within their race. (**Left**) Raw means and error terms. (**Right**) Means and error terms adjusted for baseline covariates. The scale reflects the grade metric, ranging from 0 (= F) to 4.33 (= A+). Error bars represent standard errors.

(*12*). These data suggest that the intervention buffered African American students against the impact of an early decline in performance by interrupting a downward trend. The performance pattern of African Americans in the affirmation condition, unlike that of the remaining groups, was a "sideways S" pattern, well-fitted by a cubic function [$F(1, 29) = 9.53$, $P < 0.01$], not a downward linear trend ($F < 1$, NS). In contrast, African American students in the control condition showed a significant downward linear trend; their performance continued to fall as the term progressed [repeated measures analysis, $F(1, 33) = 10.45$, $P < 0.01$]. European Americans showed a similar, although somewhat less steep, downward trend in both conditions [$F(1, 30) = 4.86$, $F(1, 25) = 7.30$, respectively, P values < 0.05] (*13*).

We also obtained evidence of another psychological process that may play a role in the intervention's efficacy by having students complete a measure of cognitive activation of the racial stereotype presented as a classroom exercise. This validated measure consisted of 34 word fragments (*5*, *6*). Seven (such as _ACE) could be completed with either a stereotype-irrelevant word (such as FACE) or a stereotype-relevant word (such as RACE). Because the experiments yielded similar effects on the primary outcome of course performance and because condition effects on the activation measure did not vary by experiment (F's < 1.7, NS), data were combined to increase statistical power in this ancillary analysis (*12*). African American students generated fewer stereotype-relevant words in the affirmation condition (mean = 2.79, SD = 0.98) than in the control condition (mean = 3.25, SD = 0.91) [$t(105) = -2.56$, $P < 0.02$]. European American students showed no condition effect (means = 3.07 and 2.79; SDs = 1.08 and 1.28, respectively) ($t < 1.3$, NS). The control condition thus replicated the established pattern of African Americans' displaying higher racial-stereotype activation than European Americans in intellectually evaluative situations (*6*) [$t(111) = 2.20$, $P = 0.03$]; the affirmation condition eliminated it ($|t| < 1.5$, NS). The race × condition interaction was significant [$F(1, 218) = 6.61$, $P < 0.02$]. Activation was not generally associated with performance; however, this may have occurred because the measure was assessed several months after the original intervention and the critical performance variable (*12*).

How did our seemingly small intervention produce such large effects? First, in normal school settings, a negative recursive cycle can occur, where psychological threat and poor performance feed off one another, leading to ever-worsening performance. This downward spiral effect is indicated by (i) the relatively steep linear decline in African Americans' performance in the control condition (Fig. 2) and (ii) an ancillary analysis that showed, after controlling for level of preintervention performance, that African Americans in the control condition who saw their performance sinking early in the term (that is, who showed a relatively large preintervention drop from block 1 to block 2) performed worse later in the term (earned lower mean performance across blocks 3 to 10) (partial $r = -0.52$, $P < 0.01$) (*12*). This was not seen with European Americans in either condition (partial $r = +0.24$, $P < 0.08$). Because a recursive process depends on a continual feedback cycle, any interruption of that cycle could have long-term effects (*14*).

Second, a small reduction in psychological threat can set off another recursive cycle by leading to a slight improvement in subsequent performance, which in turn can further lessen performance-inhibiting threat, etc., leading to sustained or improving performance over time. Two of our results support this notion: (i) The intervention interrupted African Americans' downward trend and deflected it upward (Fig. 2), and (ii) an early drop in performance in this group did not predict worse performance later (partial $r = 0.02$, NS). The difference in correlations between the African American conditions was significant ($z = -2.06$, $P < 0.05$).

Third, small interventions can generate large effects if those effects accumulate across multiple trials (such as the multiple performance opportunities observed here) (*15*). Even if the intervention produced only a small improvement on each assignment, the sum of those improvements can translate into a large effect on final grades.

Fourth, as past research suggests, the psychological availability of mental concepts can affect the encoding and interpretation of social experience (*16*). Consistent with this possibility, our intervention reduced the psychological availability of the stereotype. This then could have changed African Americans' perception of the level of bias in the environment, and their interpretations of academic success and defeat, over the long term.

Finally, our apparently disproportionate results rested on an obvious precondition: the existence in the school of adequate material, social, and psychological resources and support to permit and sustain positive academic outcomes. Students must also have had the skills to perform significantly better. What appear to be small or brief events in isolation may in reality be the last element required to set in motion a process whose other necessary conditions already lay, not fully realized, in the situation. The flicking of a switch viewed in isolation may seem a quick and minor physical movement, seemingly out of proportion with the effect of having a room or a city block flooded with light.

Our findings demonstrate that alleviating psychological threat can improve intellectual achievement in a real-world environment (*8*). Our intervention is among the first aimed purely at altering psychological experience to reduce the racial achievement gap, a major problem in the United States. Unlike other interventions, it benefits the targeted students, including those most at risk, reducing group-based inequality while not adversely affecting nontargeted students (*17*). This research highlights the importance of situational threats linked to group identity in understanding intellectual achievement in real-world, chronically evaluative settings. Our results challenge conventional and scientific wisdom by demonstrating that a psychological intervention, although brief, can help reduce what many view as an intractable disparity in real-world academic outcomes.

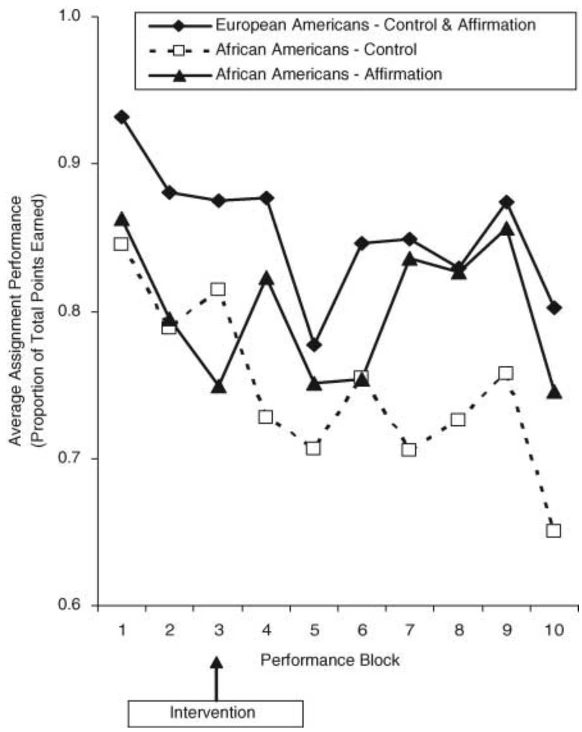

Fig. 2. Mean academic performance as a function of chronological performance block, student race, and experimental condition. Blocks 1 and 2 represent preintervention performance; blocks 3 to 10 represent postintervention performance. The data on European Americans in both conditions were combined, because they did not differ significantly.

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18. We are grateful to the student participants and their parents and to the teachers and administrators of the school district for their involvement in the project. We also thank J. Sherwin, P. Brzustoski, V. Purdie-Vaughns, C. Steele, E. Zigler, D. Green, E. Uhlmann, G. Walton, and S. Cole for their guidance and feedback. This research was supported by grants from the Nellie Mae Education Foundation and from the Institute for Social and Policy Studies (Yale University).

Supporting Online Material
www.sciencemag.org/cgi/content/full/313/5791/1307/DC1
Materials and Methods
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4 April 2006; accepted 6 July 2006
10.1126/science.1128317

A Role for the Macaque Anterior Cingulate Gyrus in Social Valuation

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Complex human social interaction is disrupted when the frontal lobe is damaged in disease, and in extreme cases patients are described as having acquired sociopathy. We compared, in macaques, the effects of lesions in subdivisions of the anterior cingulate and the orbitofrontal cortices believed to be anatomically homologous to those damaged in such patients. We show that the anterior cingulate gyrus in male macaques is critical for normal patterns of social interest in other individual male or female macaques. Conversely, the orbitofrontal cortex lesion had a marked effect only on responses to mildly fear-inducing stimuli. These results suggest that damage to the anterior cingulate gyrus may be the cause of changes in social interaction seen after frontal lobe damage.

Normal patterns of human social interaction are disrupted after ventromedial frontal lobe damage (*1*). The absence of normal social behavior may be so extreme that patients are described as suffering from acquired sociopathy (*2*). The lesions are not restricted to ventromedial frontal cortex but encompass laterally adjacent orbitofrontal cortex and medially adjacent anterior cingulate cortex (ACC). Damage to just one anatomical subdivision may explain the patients' impaired social cognition. We assessed how selective lesions of ACC gyrus (ACC_G), ACC sulcus (ACC_S), or lateral orbital and ventral prefrontal cortex (PFv+o) affect the way macaques value social information.

The possibility that orbitofrontal damage underlies impaired social interaction has received attention not just as a result of patient studies but because, in macaques, circumscribed orbitofrontal lesions lead to altered emotional responsiveness to stimuli that normally induce mild fear (*3*, *4*). The deficit may be due to an inability to predict the reinforcement consequences of a stimulus or of another individual. Orbitofrontal lesions impair visual discrimination reversal learning, which requires the modification of associations between stimuli and primary reinforcers (*5*). It has been argued that the flexible assignment of reinforcement values to stimuli is a prerequisite for emotion and social behavior (*6*). Patients with ventromedial frontal lesions also perform poorly on visual discrimination reversal tasks (*7*). On the other hand, neuroimaging studies have shown that the ACC is active when human participants engage in social interaction, although its contribution has been unclear (*8*–*11*). Despite their proximity, the connections of ACC and orbitofrontal cortex are distinct in both man and monkey, and so their roles in social behavior may be correspondingly distinct (*12*–*14*).

The three lesions are summarized in Fig. 1 (and figs. S1 to S3). The PFv+o lesion was similar to one previously used to remove the principle target region of visual connections within the frontal lobe (*15*). The ventromedial region, which has connections with both PFv+o and ACC_G regions (*13*), was excluded to better assess each area's independent contribution to social behavior and emotion. Three animals received each lesion, and performances were compared with those of four unoperated controls.

Measurements were made of latencies to pick up food items in the presence of fear-inducing stimuli (toy snakes) in experiment 1, social stimuli (short films of other macaques) in experiment 2, or neutral control objects (fig. S4b). The latencies indexed the macaques' assessment of the value of obtaining further information about the stimulus before reaching and reflected their relative valuation of the stimulus in contrast to the incentive value of

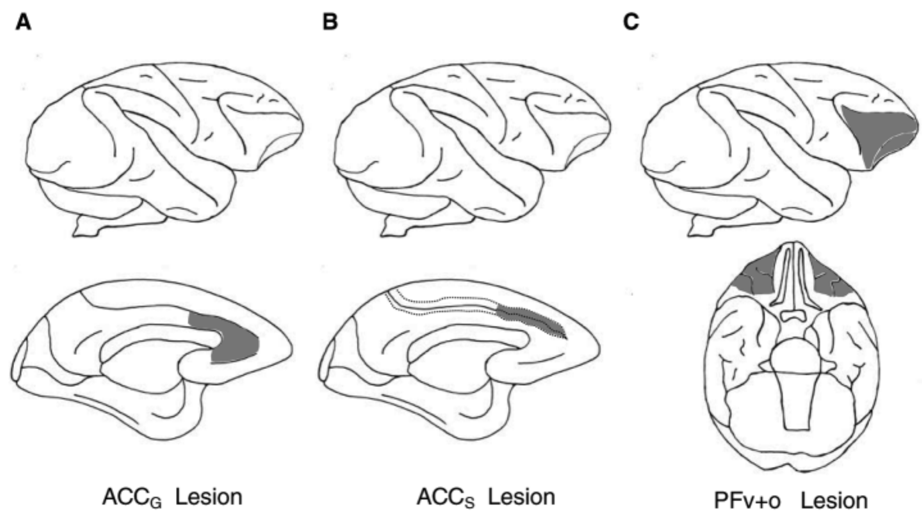

Fig. 1. Summary of (**A**) intended ACC_G lesion, (**B**) intended ACCs lesion (in both cases medial and lateral views of the brain are shown in top and bottom images, respectively), and (**C**) intended PFv+o lesion (ventral and lateral views are shown in top and bottom images, respectively). Lesion locations are shown on views adapted from the atlas of Paxinos *et al*. (*29*).

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