

## **RAGE Control: Regulate And Gain Emotional Control**

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### *Abstract:*

*Advances in neurobiology and computer science make possible interventions designed to strengthen basic processes behind emotional control. We present one such computer-based intervention, RAGE Control (Regulate And Gain Emotional Control). This extends the usual paradigm of biofeedback by requiring relaxation in the midst of engaging executive processes in a quick reaction task. RAGE Control teaches children to simultaneously focus, react, inhibit impulses, and keep their heart rate down in the context of a traditional space battle game. The program is grounded in the theory of Cognitive Behavioral Therapy and is currently in clinical use by psychotherapists at Children's Hospital in Boston. It aims to reduce the need for psychotropic medication to help children gain emotional control. Clinical trials to test the promise of this technology are warranted.*

### **1. The case examples of John and Emily**

RAGE Control (Regulate and Gain Emotional Control) is an approach to treating a wide variety of challenges faced by people every day. One of the major disorders that we are looking at initially is explosive disorders, a psychiatric condition where emotional control deteriorates rapidly. The easiest way to describe how explosive disorders affect people is through the exploration of the case studies of John and Emily. To this end, we outline two case studies, and intertwine the need for RAGE Control within the difficulties faced by Emily, John, and many like them.

John, a 13 year old enrolled at an inner city middle school, seems at first blush to be much like his peers. During a silent reading exercise, he was talking with his peers. His teacher gave him a gentle reminder in an exchange that would typically be completely unremarkable. But for John, these were the first steps toward a psychiatric explosive episode, where John, and others like him, are unable to hold their emotions in check. These situations rapidly deteriorate, creating an emotionally tense and potentially physically dangerous scenario. *We want to examine whether there are certain steps that can be taken to help children like John regain control before the situation gets out of hand, while avoiding the path of medication. Further, we seek a therapy that will engage these children in a manner that he is comfortable with, making him more receptive and engaged with his therapy.*

Explosive episodes unfold rapidly. When the teacher reminded John that he was supposed to be silently reading, John, he denied that he was talking. As a result, the teacher stood between John's desk and the other student's in an effort to decrease John's distractions. Moments later another student approached the teacher with a question and John began drawing on the desk. This exasperated the teacher and caused her to tell John to get rid of his pen because he didn't need it. In reaction, John then threw the pen across the classroom towards the trash. The teacher gave John a disappointed and exhausted

look, but did not comment on his actions. John replayed by saying: "You told me to get rid of it. I don't know why you're so mad."

John then proceeded to get up from his desk and walk around the classroom. Another student, frustrated with his actions, said to him "Just sit down and read already." John began swearing at her and then told her to "mind her own business." John's teacher told him to leave, but redirecting his anger towards the teacher, John refused. The teacher had to call the office and request help from the administration to get John out of the classroom. As the teacher waited, John continued to swear at her and the other students. He also began ripping pages out of his notebook and throwing them on the floor.

John's explosive episode rippled outward. The teacher's control of the classroom was tried as John's outburst aroused the interest of the other students. John's verbal accosting of his teacher and peers put a level of stress in the environment that was neither conducive to his peers' education nor fair to his teacher. While his destruction was ultimately harmless, in the heat of the moment, there is no way for his fellow students to know that the student throwing pens and ripping apart his notebooks, all while exploring the base elements of the English language is not an immediate impediment to their safety.

Emily, a 10 year old girl who attends an affluent elementary school in the suburbs, began crying in science class and refused to continue working on the class assignment. The class had been working in small groups of four students and their initial task was to develop a timeline for a class project. Emily, who is a bright girl that excels academically, quickly came up with a possible outline for the project. However, one of the girls in her group didn't like her proposal and suggested an alternative plan. Emily, now standing and speaking rapidly, insisted that her timeline was the best way to do the project. The other girls in her group continued to disagree and asked her to consider their plan, but Emily would not. She continued to plead her case and grew more and more upset as her other group members continued to disagree with her.

After going back and forth for approximately ten minutes, one of the group members said: "We have wasted all this time arguing, just give it up." Emily replied by calling her other group members stupid and told them they were bound to fail the project. She then proceeded to walk away from the group, sit at her desk, and began to cry. When her teacher asked Emily what was wrong she would not respond and avoided looking at her. Concerned about this incident and Emily's past difficulty working with peers, the teacher called Emily's mother after school to talk about her behavior.

Compare John's explosion to Emily's sullen withdrawal. At first glance these stories may not seem similar. However, upon closer examination, both cases reveal children ill-equipped to manage the everyday stresses of their lives. Although the presentation of their external behavior in the face of adversity differed slightly, the internal states of these two children were remarkably similar. For instance, as was evident by their nervous and impulsive dispositions, both John and Emily were faced by situations that called for them to focus their efforts and inhibit impulses, trying to engage the brain systems required to accomplish this was impeded by the negative physiological arousal they each felt. For each of them the battle between negative arousal and attempts to control it failed and led to their loss of behavioral as well as emotional control.

For nervous and impulsive children such as John and Emily, levels of anxiety that accompany focusing attention to accomplish challenging tasks can trigger negative emotional and physiological responses which inhibit attention causing failure at the task.

The reciprocal feedback where negative emotion inhibits brain attentional systems which then causes more negative emotions quickly spirals out of the child's control and is converted into uncontrollable nervousness or aggression towards others.

## **2. Challenges facing children with externalizing disorders**

Behavioral difficulties among children and adolescents similar to John and Emily are a major mental health concern and a common issue faced by clinicians at hospitals and outpatient clinics. In early childhood, small amounts of aggression can be seen as a normative part of child development. However, as children age, advancement in their development involves mastering certain tasks, one of which is the capacity to better self-regulate when encountering stress. Children who are unable to master this task face numerous challenges in adolescence and later adulthood. The Diagnostic and Statistical Manual, 4<sup>th</sup> addition (DSM IV) [i] describes several disorders that can lead to disruptive and aggressive behavior, including Anxiety disorders, Attention Deficit Hyperactive Disorder (ADHD), Disruptive Behavior Disorder (DBD), Oppositional Defiant Disorder (ODD), Bipolar Disorder, and Conduct Disorder (CD). Disruptive, impulsive, and aggressive children are at high risk for rejection by their peers, poor school adjustment and academic underachievement. They show marked deficits in self-esteem and problem solving abilities. These children are more likely to drop out of school, develop delinquency, and fail in adult work and social relationships [ii, iii, iv, v, vi]. Psychotropic medication is often prescribed so as to reduce emotional dyscontrol to a level that these children can engage in psychotherapy. In recent years the rate at which psychotropic medication is prescribed to children has increased dramatically and become a major source of societal concern [vii]. Development of alternative therapies that can reduce the need to use psychotropic medication in children deserves a high priority.

## **3. Cognitive behavioral therapy**

There are a number of different approaches to treating disorders characterized with impulsive aggression and emotional dyscontrol. However one of the most empirically validated treatments in the literature is for Cognitive Behavioral Therapy (CBT) [viii, ix, x]. In CBT, the therapist interacts with patients in a problem solving manner, providing the child with skills that he or she can use to help overcome maladaptive behaviors. The therapeutic skills taught by CBT therapists to children and adolescents presenting with impulsive aggression and emotional dyscontrol can vary to some degree. However, one of the primary goals for these patients is to obtain a better ability to self-regulate their behavior and emotions. In CBT, this skill is often obtained through the use of relaxation techniques. Relaxation techniques include Deep Breathing and Progressive Muscle Relaxation (PMR) [xi, xii]. CBT often makes use of biofeedback or providing patients with information on indices of their state of arousal such as heart rate, electrodermal conductance, or skin temperature. Biofeedback is particularly useful in relaxation training [xiii]. Showing patients their level of physiological arousal helps them learn to control their emotional state.

The limitations of CBT and CBT-based techniques can be traced back to acronym. Cognitive behavioral therapy presumes a certain amount of cognitive operations on behalf of the patient. Starting with the work of Piaget [xiv], developmental psychologists have learned that the type of cognitive processes required by techniques

like CBT, sometimes called concrete operations, are typically only available to children only reaching adolescence. They also require that the children be willing to engage in learning the relaxation techniques and seeing the value of applying them when they are most emotionally aroused. The techniques themselves often require that the child disengage from the task with which they are wrestling to then apply the relaxation technique and when calmer return to the task. The most behaviorally impaired children are the ones that are hardest to motivate to learn these techniques and who have the most trouble seeing the value of inhibiting their anger long enough to apply them.

The theory behind RAGE Control is that a child's desire to do well in a video game can be harnessed to give him or her an opportunity to see the value of maintaining emotional control and practice maintaining it in the midst of a challenging and frustrating task. To succeed at the game of RAGE Control the child must apply the relaxation techniques while stimulating their brain attentional and rapid response systems. This is a more ecologically valid application of relaxation than practicing relaxation in the calm of a therapist's office. It is hoped that RAGE Control will provide a bridge from the use of relaxation in the office to its use in difficult situation in real life.

#### **4. Challenges facing therapist**

Relaxation and biofeedback training is effective in reducing anxiety and other externalizing behaviors among children. However, the challenge therapists often face in treating patients with these types of behaviors, like John and Emily, is their level of interest to actively participate therapy. Some patients dislike this training. Some patients are too hyperactive to sit calmly in a therapist's office and focus on a PMR script being read by a therapist. For other patients, they may feel uncomfortable doing relaxation because it doesn't feel natural to them and they feel uncomfortable trying to do it. Patients may struggle because they can't see how relaxation is effective or how it is going to be useful for them. Some are oppositional and do not see the value in engaging with their therapist at all [xv].

#### **5. RAGE Control**

In response to the above challenges it is important to develop innovative and effective strategies to teach these relaxation skills to patients who otherwise are not motivated to learn them, and to give all patients the opportunity to apply what they learned in a situation that more closely approaches the clinical situations where they need to gain emotional control.

Therefore we have developed a new method to teach emotional control which is to teach patients relaxation and how to apply it during a challenging task. An instantiation of this method is a video game we are calling RAGE Control (Regulate and Gain Emotional Control). It is our first implementation of biofeedback and relaxation during a challenging task. We start with a traditional video game, inspired by the classic Space Invaders. The plot of Space Invaders, to use a generous word, runs about as deep as any of the pioneering arcade games. A hero's world is under attack by an alien armada. The hero gets into his spaceship, and forms the last line of defense between everything he holds dear and alien annihilation. The gameplay is equally simple, but compelling. The aliens traverse the screen vertically, starting at the top, making way to the player who sits at the bottom of the screen. The hero moves horizontally across the screen, firing

bullets. Points are awarded for shooting aliens, and the game ends when an alien succeeds in crashing into the hero, or the aliens cross in sufficient numbers to destroy the home world.

From our point of view, Space Invaders offers an attractive starting point, blending solid game play with exceedingly simple controls. In fact, in the traditional implementation of Space Invaders, there are three controls: drive left, drive right, and fire. The task is equally simple to understand. Get under an approaching alien, and fire. Avoid the descending aliens, and don't let them by. The interface and task are elegant in their simplicity. This is not to say that they are boring. Clones of Space Invaders are still available on web-based gaming sites and still enjoy interest in an age of highly sophisticated three-dimensional games with elaborate tasks and goals.

RAGE Control, while building on the template of Space Invaders, makes several key departures not only from Space Invaders, but the traditional approach to gaming. The most prominent of these changes is the input device. The user still makes use of a traditional input, in our case a keyboard. But unlike any game found in an arcade or on a living room console, the user also tethers him/herself to the computer using a heart rate monitor. The user's own physiology becomes part of the gaming experience, and the physical link immediately reinforces the idea that the game's narrative now depends on control of heart rate, a physiological variable. RAGE Control currently uses a pulse oximeter for heart rate input, which clips onto the user's finger. The other inputs of the game are unchanged. A keyboard controls left and right movement and firing.

The activity of firing a bullet is moderated by heart rate. At the onset of the game, a threshold heart rate is calculated as sitting heart rate plus seven beats per minute. So long as the user is under their heart rate threshold, they can fire their weapon as expected. Should the heart rate go above the threshold, they begin to fire 'blanks:' visually smaller, slower bullets that will not damage the attacking aliens.

Other tasks are modified from the space invader game. We require that the child intermittently inhibit a potent impulse to fire. For this we introduce a number of friendly craft that enter the game board at random moments. Along with aliens entering from the top of the screen, 'friends' of the hero do as well, and the player now needs to avoid shooting their friends. These must not be shot. In the game narrative, we describe this as the player's friends fleeing from the alien onslaught. From a design perspective, this completes a tidy task matrix presented to the user.

**Table 1: Task matrix for RAGE Control**

	Hit	Passed
Alien	Correct hit (+100)	Incorrect rejection ( $\beta$ -error; -100)
Friend	Incorrect hit ( $\alpha$ -error; -500)	Correct rejection (+100)

After several iterations, we decided that, as an introduction to RAGE Control, users only play for a high score. Thus, aliens striking or passing the player have no effect on game play, other than detracting from the score, while shooting aliens and allowing friends to pass increase the score. Shooting friends carries the highest penalty. This design decision was made to ensure that users would have a chance to become familiar with the game and train themselves to regulate their heart rate.

What does the design of an active biofeedback game like RAGE Control accomplish? Patients increase their ability to regulate emotion and behavior under stressful conditions. Players of RAGE Control experience a number of challenges to their autonomic nervous systems (ANS). The sympathetic and parasympathetic nervous systems of the ANS acts as the fight or flight mechanism within the body. The sympathetic nervous system responds to excitement and fear whereas the parasympathetic works to control relaxation restoring a person's body to a normal physiological state.

RAGE Control begins by having players attend to one active task, shooting aliens. As the game progresses, players face increased ANS challenges corresponding with increased levels of the game. The next challenge player's encounter is their friends flying on the screen. This is an inhibitory task asking players to avoid hitting certain spaceships. As the levels increase the numbers of aliens and friends multiply and begin flying at a greater velocity. Adding more challenges to players ANS's we believe the game provides players with motor, emotional and performance challenges, which replicates the stressful challenges they will encounter in day to day situations. Mastering the ability to utilize relaxation with the game will generalize to other stressful encounters players face in their lives. The reason why children and adolescents are more likely to acquire relaxation skills using RAGE Control is because it grounds them in a computer game which is often already an interest of this population. Therefore, therapists will be able to reach patients who may not respond to the therapists walking them through traditional relaxation training.

The figure below is a design brief for Psychiatry Invaders. It is meant to capture the game from the user's perspective, describing the games goals, inputs and outputs

**Table 2: RAGE Control Game Description**

Goals	Active tasks	Destroy incoming enemies		
	Inhibitory tasks	Don't destroy friends		
Inputs	Traditional	Left arrow - drive left		
		Right arrow - drive right		
		Space bar - fire bullets		
	Physiological	Oximeter - heart rate		
Outputs	Under threshold	Shot fired - large, effective bullet		
			Hit	Pass
		Alien	+100	-100
		Friend	-500	+100
	Over threshold	Shot fired: slow, ineffective bullet		
			Hit	Pass

Alien	0	-100
Friend	0	+100

## 6. RAGE Control Utility

The promise of RAGE Control are that we will increase the ability of children to regulate their emotions even while under stress and this will reduce the need to administer psychotropic medication. These medications come with two-fold cost to the patient and the health care system. First, the system is responsible for the direct costs associated with the medication. However, many psychotropic medications come with severe side effects, which are a burden on the patient, their family, and the system. The use of powerful psychotropic medication to treat common childhood disorders leading to explosive episodes is a matter of deep societal concern. Our hope is that RAGE Control can augment a treatment plan in a way that can teach the patient valuable coping skills while mitigating and maybe even eliminating the use of psychotropic medication for many of these children. However, this is just the beginning of the benefits we hypothesize for RAGE Control.

Clinically, we expect that RAGE will have particular utility with adolescent boys. In addition to providing an in vitro environment for the child to learn how to self-regulate emotion, we believe RAGE Control will also help to strengthen the therapist-child therapeutic alliance. Research has suggested that early therapeutic alliance is associated with later treatment outcomes, but for children and adolescents the therapeutic alliance becomes more complicated with the therapist needing to form and maintain an alliance not only with the patient, but with the patient's parents/caregivers as well. Many families report that the reason they terminate therapy was quite straightforward: the child did not like it. RAGE Control is a fun activity for patients to use while in therapy, that challenges them to take the skills they acquire with their therapist and put them to use in an environment in which they are familiar. We believe this will make coming to therapy more appealing for patients who previously may have been reluctant to come engage in therapy. We think this will help to build a stronger therapeutic alliance between the patient and the therapist. By forming a stronger alliance, patients will remain in treatment longer, be able to tackle more emotionally charged issues, and have better outcomes.

The challenges addressed in an intervention that includes RAGE Control are faced by enormous numbers of people. Because of this it is easy to image RAGE Control expanding to help a variety of people beyond our initial target population of adolescents in clinical settings. Stress can be a good thing. An autonomic response can heighten the senses and increase performance. But this same autonomic response can elevate and impair judgment and degrade performance. When one finds oneself in this situation, it would be valuable to have rehearsed skills that help them overcome these challenges.

RAGE Control does not need to be used in one-on-one settings. We envision building a multi-user cooperative game version of RAGE Control. This version could be used in group and family therapy settings. One example is a social skills group, a group-based therapy where a small group of patients acquire and practice social skills in a controlled setting. Using this cooperative multi-user RAGE Control would require group members to support each other in maintaining concentration and calm so that every player can contribute to the group succeeding at the game. This means that other people

in the room would need to refrain from distracting others and also from upsetting others even as they share information in order to succeed. These skills are often a goal of social skills groups because children require these skills when in school and adults in their work and family lives. Another aspect of the game involving social skills happens at the conclusion of the group's turn playing the game. This is an opportunity for each player to give other players positive feedback on his or her performance. RAGE Control offers a number of features group members are able to comment on including how well each player was able to keep their heart rate low, how well they were able to shoot the aliens, how well they were able to avoid shooting their friends, and how well they worked together. This helps teach group members how to search for positive attributes of each player that helps to increase members' social skills. Taking these skills into the home and school settings will help members develop better peer relations which is an important protective factor against other mental health problems in the future.

In this light, it is easy to picture RAGE Control, ported to a hand-held device, providing skills on an everyday level. Possible applications range from the student who has difficulties self-regulating during a test, or an executive trying to navigate particularly demanding circumstances. However, there are other uses that are particularly valuable in the domain of public health. For example, populations of at-risk expecting fathers could use the self-control training of RAGE Control and then use RAGE Control to teach self control to their children. It is even possible that RAGE Control could help with the impulse control in addiction recovery.

RAGE Control offers a tremendous amount of versatility, both in its current instantiation and in potential future instantiations. The current prototype application is being used at Children's Hospital, Boston in the outpatient psychiatry clinic, the inpatient psychiatry unit and the Emergency Psychiatric Department. RAGE Control can be used as a one time intervention but is more likely to be effective as part of ongoing psychotherapy. RAGE Control has the best chance at making an impact when the psychotherapist provides the tools (relaxation techniques) the child requires to succeed at RAGE Control and then helps the child see the link between using relaxation techniques to gain emotional control to succeed at the computer game and using them to succeed in difficult situations or conflicts in their lives. Future instantiations of the idea behind RAGE Control will likely include more realistic virtual reality games which could increasingly mimic the actual situations where the child often loses emotional control.



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