



CATS NEWSLETTER

The Biannual Publication of the
College Athletic Trainers' Society

IN THE SPOTLIGHT: SCOTT ANDERSON

By: Richard Campbell, MS, ATC, LAT, Rutgers University



SCOTT ANDERSON

Current Position: CATS President

Education History:

University of Oklahoma 1979

A person that needs little introduction to collegiate athletic training is the current president of the College Athletic Trainers' Society, Scott Anderson. Scott epitomizes the standard of care that college athletic trainers should strive for during their careers. In addition to his 2022 NATA hall-of-fame induction, he was inducted into the 2015 Oklahoma Athletic Trainers' Association Hall of Fame, received the National Athletic Trainers Association's College and University Committee Athletic Trainer of the Year Award in 2006, and was named the Outstanding Athletic Trainer from the All-American Football Foundation in 2005. Although he has garnered numerous accolades, Scott says his most rewarding achievement as an athletic trainer has been working with all the great people that make up his sports medicine team. "I have been, and am, blessed to work with some of the all-time great physicians, athletic trainers, and physical therapists."

Like many athletic trainers in the setting, Scott attributes his career to his mentors while an undergraduate student at the University of Oklahoma; Dr. Don O'Donoghue - the father of sports medicine,

and Ken Rawlinson. Those two paved the way for his interest in college athletic training and provided him with his first opportunity as an assistant athletic trainer at Oklahoma when he graduated in 1979. Scott also credits and thanks Dr. Randy Eichner, an internist for OU athletics', and Dr. Brock Schnebel, the Sooners' orthopedic physician, for their guidance and support in helping shape his career. He was a part of the Oklahoma athletic training staff for his first seven years in the profession. Scott then departed OU in 1986 to become the head athletic trainer at Tulane University in New Orleans. During his nine-year tenure at Tulane, he helped develop a comprehensive sports medicine program in conjunction with the Tulane Medical School. He then returned to his alma mater as the head athletic trainer in 1996 and has overseen the health and well-being of the Sooner athletes for the past 26 years.

As the current president of CATS, Scott continues to be active in serving and improving health and safety in sports on a national level. He also helped establish the Oklahoma Athletic Training Practice Act in 1981, was

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the co-chair of NATA's Task Force for Sickle Cell Trait in Athletes and continues to be a contributing member to other NATA task forces. With his commitment and contributions to the athletic training industry, Scott has always tried to provide the best medical care to the student-athletes that he oversaw, which he says was his biggest challenge entering the profession. In doing that Scott has impacted athletic training at numerous levels, but especially in collegiate athletics and that's how he became involved with CATS.

Scott stated, it started simply by attending CATS meetings for him; because, it was the most relevant membership to our setting. "I figured why not be in the room with athletic trainers that have the same issues, and then we can problem solve them together." Scott helped create policies for managing sickle cell trait, concussions, and many more throughout the NCAA, but he said he could not have done it without the knowledge and assistance from other members. Scott attributes his success in CATS to Don Lowe, CATS founder and Board Chair, as a visionary and providing the leadership to put him in a position to be a contributor/president to the society. To Josephine Lee, CATS Executive Director, through her commitment and unquestionable leadership in making CATS the paramount college athletic training organization it is today. Along with the support and hard tireless work of the other board members. "If we help each other, we can solve any problem that will occur in our setting because there will always be challenges that we face," says Scott.

Scott believes the two biggest challenges that we face other than always trying to provide the best health care are adding/retaining athletic trainers in college athletics and tackling time management. He believes that both challenges are intertwined and can be solved with more mentorship/leadership within each institution. "As leaders at our institutions, we need to pressure the administration to create positions of value. We must stop devaluing our credentials and training with some of these new positions that we have created and show our young professionals; especially our athletic training students going into the profession, that they have much more value at our level than we are currently offering. If we are successful in doing this, then we can add/retain more positions and in turn help with the work/life balance for our staffs and lessen the hours and team responsibilities that they endure each week." We have work to do in order to advance collegiate athletic

training, and always will, and we are fortunate enough to have had Scott Anderson lead our membership. Although he is retired as the head athletic trainer at OU, Scott is still looking forward to helping advocate and solve challenges within college athletics.

Being inducted into the 2022 NATA Hall of Fame is an incredible and humbling honor for Scott. An exciting moment that he has shared with colleagues and friends, but none more than his family. "It is a time that their sacrifices for allowing me to be an athletic trainer have paid off and without them, I would not have been able to receive this honor. I am excited and looking forward to being on my family's schedule rather than an athletics schedule."

Thank you Scott, for your dedication to athletic training, CATS, and the pursuit of the best health care possible for athletes.

Quotes from the membership on Scott's value to the profession and society.

"Scott is a superlative athletic trainer and person. He embodies a rare blend of knowledge, skill, humanity, and humility. I saw him use that blend to help hundreds of athletes thrive and reach for their dreams. He's one of a kind. He's liked and admired by all of them. He leads a team that everyone wants to join, and no one wants to leave." - Dr. Randy Eichner

"Scott Anderson has been a champion of student-athlete health and safety for 3 decades. His contributions at the state, conference, and national levels led to legislative and policy changes that have made sports safer for all who participate. In retirement, he leaves behind a legacy of advocacy that sets the standard for all those who follow. Scott's sage advice and wise counsel - and his dry sense of humor - will be missed." - Allen Hardin ATC, PT, MS, SCS, LAT, CSCS Chief Medical Officer at the University of Texas

"First and foremost, I consider Scott a great friend. His role as President of CATS enhanced our society through his efforts on several Task Force/Summit projects on preventing injury & death in college athletics and improving safety in college football. Scott has great vision and the ability to carry on through difficult projects and issues. CATS has been blessed to have him lead our society. It has been a pleasure working with him on behalf of our society in our attempts to serve our members and their student-athletes. I am pleased that Scott Anderson was

inducted into the 2022 NATA Hall of Fame class, an honor overdue and richly deserved.” - Donald Lowe, CATS Founder and Chairman of the Board

“Scott Anderson has always pursued the best path to protect the health and safety of student-athletes. He has done this through collaboration and discussion with others in leadership positions to attempt to truly put the health of students above all else. It has not always been popular or easy, but he has always stayed true to the task.” - Scott Oliaro, CATS Board Member

“Scott Anderson has been relentless in his pursuit of changes that improve and help protect the student-athletes overall health and wellbeing. He has accomplished this by leading CATS, consulting with the NATA and advising the NCAA. Scott has helped our profession by improving the standard of care that our Institutions demand, Student-Athletes deserve and the public supports.” - Tim Garl, CATS Board Member

“Another quality of Scott’s that I admire is his strong leadership of CATS in not only bringing us to the table but as CATS president leading the discussions and driving the safety outcomes. He has guided CATS to the roles in which we proudly serve our members and athletes today -- quality education, athlete safety focus, collaboration and networking, and mentoring.” - Jenny Moshak, CATS Board Member and Treasurer

“The thing I admire the most about Scott is his unwavering commitment to what is best for the student-athlete. The second thing I admire is his perseverance in achieving a task and his ability to collaborate with outside organizations (especially the NCAA) when they have been often bureaucratic and not always focused on the student athletes’ welfare.”

- Dr. James Tucker, CATS Board Member

“Not only did Scott Anderson lead by example, but he was also motivated by example. In addition to all his tireless efforts to promote student-athlete health and safety, he was the head athletic trainer for a major college football team and supervised a large Power 5 sports medicine department. In an era when those two responsibilities are often split into two positions, Scott demonstrated the success a thoughtful, driven, and selfless college athletic trainer can achieve.” - Bob Murphy, CATS Board Member

“Over the years, it has been my great pleasure to witness Scott’s leadership of our society and profession. While he remains very passionate about athlete safety, behind the scenes he has been a huge advocate for athletic trainers, especially in the collegiate setting. He is fearless when it comes to telling administrators, the NCAA, and others that athletic trainers must have a seat at the table and have a voice. He remains vocal that an athletic trainer should be at the level of senior administration as well as advocate the true intent of unchallengeable authority. He always made a point to remind these groups that athletic trainers were the ones who provided the data that helped them develop health and safety rules for athletes. It’s leadership like this that helps us advance our profession. His representation of our profession brings true growth and positive change.” - Josephine Lee, CATS Executive Director

NEWS AND NOTES

Fueling Greatness Education Grant

The Fueling Greatness Education Grant sponsored by Gatorade is now open to all college athletic trainers. The purpose of this grant is to recognize college athletic trainers who have helped advance their institution’s sports medicine programs and improved their student-athlete services. Presented each spring, this grant will help support the continuing education of three (3) deserving college athletic trainers in the

amount of \$1,000 to assist with their expenses in attending the upcoming CATS Spring Symposium. This grant is open to all CATS members. Members can also encourage their college athletic trainer colleagues who would be excellent candidates to apply. To find more information about this continuing education grant visit:

<https://www.collegeathletictrainer.org/Grant>

Congratulations to our 2022 Recipient:

Tom Lechtenberg,
University of Texas Permian Basin

cases where there is a charge **2022 CATS Family Scholarship Recipients**

CATS would like to congratulate the 2022-23 CATS Family Scholarship recipients.

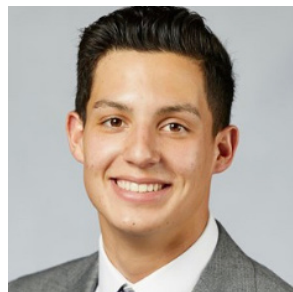
CATS Family Scholarship recipients show success academically, demonstrate the qualities of a leader and are actively involved within their communities. Many even assist their parents with the financial responsibilities of a college education. We wish our new recipients great success and hope they continue to work hard in their respective studies, achieve their goals, and make their parents proud.



Moose Detty Scholarship sponsored by PRO Orthopedics

Zachary Jones is a sophomore at the University of Toledo and is majoring in Business with a possible minor in Entrepreneurship. He is the son of Brian Jones at

the University of Toledo.



Otho Davis Scholarship sponsored by CDM Sport

Castro Cameron is a senior attending the University of Nevada, Las Vegas and is majoring in Hospitality. He is the son of Maria Castro at Cerritos College.



Gatorade CATS Family Scholarship

Connor Wood is a freshman attending Purdue University and plans to major in Kinesiology. He is the son of Ian Wood at Bucknell University.



HydroWorx CATS Family Scholarship

Dara Rozen is a junior at the University of Rochester and is majoring in Digital Media Studies and Studio Art. She is the daughter of Eric Rozen, University of Rochester.



LiteCure CATS Family Scholarship

Hayden Thomason is a freshman attending Hastings College and plans to major in Secondary Education. He is the son of Matt Thomason at Kansas State University.

Is your child college bound? Does he or she qualify for our scholarship? To find out if your child qualifies for the CATS Family Scholarship and to find out how to apply visit <https://www.collegeathletictrainer.org/Scholarships>

INVESTING IN YOURSELF TO ADVANCE YOUR CAREER

Jenny Moshak, MS, ATC/L, CSCS
CATS Treasurer/Board Member

Collegiate athletic trainers are exceptional at providing medical care to their athletes, but they don't always nurture their careers with the same dedication. Sometimes good work is enough to advance within an institution. Often, if it does result in a promotion, there is no additional training to help with the issues that arise with supervision and leadership. Other times, supervisors see professional development as just "doing your job." So how do you get noticed for that desired promotion?

What can young professionals and aspiring leaders do to enhance their career development - prepare, be recognized, land and succeed in a supervisory role? The answer is to grow personally and professionally.



Jenny Moshak

Maximize your full potential by improving self-knowledge. By refining leadership and supervisory skills and learning new ones, you can build (or renew) your self-esteem to increase your confidence, develop your strengths and talents, and, ultimately, build your professional identity to thrive in your role.

Ample opportunities exist for personal and professional development at little to no cost.

Access campus resources

Your institution is a great place to start. The Human Resource department likely offers free in-person, online, or self-paced course opportunities to develop skills in categories as varied as

- Leadership/supervision
- communication
- organizational change
- computer programs
- workplace diversity
- customer service
- business ethics
- coaching/counseling techniques
- strategic planning
- conflict resolution

Certificate programs with a curriculum-focused series on particular topics relevant to success and effectiveness in the workplace may also be available. Certificate programs can enhance your resume and demonstrate to your supervisor and institution your desire to advance.

As a supervisor, you will eventually have to deal with conflict; in actuality, you are dealing with it now in situations involving coaches, athletes, parents, or administration. Big or little, these issues are never pleasant and they do not miraculously go away by simply ignoring them. Successful conflict resolution depends on your ability to manage stress while remaining calm in order to accurately read and

interpret verbal and nonverbal communication. You probably already read those cues from your athletes, so translate those skills to read your professional setting. Control your emotions and behavior.

When you are in control of your emotions, you can communicate your needs in a productive manner. Avoid writing and sending an email when you are emotionally charged. Be aware of and respectful of differences. Avoid disrespectful words and actions. Learn to manage and resolve conflict in a positive way. If you want to improve your skills in this arena, mediation training courses are a structured method to examine conflict resolution involving the legal, ethical, and emotional issues that are common in disputes and to acquire the skills necessary for successful resolution.

I can't tell you the number of times I attended a career development course and the next day a situation arose where information, a skill, or the confidence I gained was relevant in handling the situation. The reality is, the issues were always there, but I was now able to recognize the situation and utilize my new knowledge and tools to skillfully and professionally address the scenario, thus becoming a successful administrator.

Connect with your college/university

Be the person who connects the athletic department with the larger campus. Look for opportunities to serve on committees, councils, advisory groups, or task forces – diversity/inclusion, campus beautification, disaster policies, sustainability, strategic planning, retention, or others. Representing your athletic department on campus committees is a way to meet people from other departments while working toward a common goal. Focus on an area of interest and get involved. This experience will educate you on how campus entities function, provide you with a network of campus employees, and lead to recognition via campus awards.

Connect with your community

Research to see if your community has programs or workshops that connect leaders in order to build relationships, explore local issues, help develop leadership skills, become educated in community affairs and structure, and engage with the community. These opportunities can open doors to resources, network development, recognition and an

understanding of how you can positively impact your community.

Share and be recognized

Make an impact through public speaking. Presenting can be frightening, but you don't have to begin your public speaking career at a major conference. Get comfortable by speaking to the booster club, as a guest lecturer in a college/university class, at community events, or an area high school career day. Speak to your passion. Write articles for journals, newsletters, campus and community newspapers, sharing your expertise for a lasting impact. You have knowledge, experiences, and a story to tell. Be heard and be recognized.

Connect with peers through organizations such as CATS. Your peers share your experiences. Through exploring different perspectives, and building comradery, finding solutions will be easier.

Find a mentor

You do not have to do this alone. Many have succeeded before you. Seek out a mentor – people are willing to help, so tap into their wisdom to guide you and be in your corner. Then, pay it forward by one day assuming the mentor role.

Set and share your goals

Build your personal and professional growth into your performance review goals so that your supervisor knows your aspirations and can support you with the time necessary to achieve your goals. A knowledgeable, skilled, trained employee enhances a department and reduces a supervisor's stress. If asked to write your job description or go through a position review, include career development aspects. Build your resume with your newly learned skills, development and well-deserved awards. Make your case and show your value.

Many young professionals might think "I don't have time," but my response is "You can't afford not to." Enhancing your personal and professional development and building your network will give you skills and resources to efficiently and effectively lead.

Invest in yourself! The dividends are priceless.

QPR SUICIDE PREVENTION TRAINING AND ITS PLACE IN ATHLETIC TRAINING

Eric Pitkanen, MS, ATC, Pacific University

It may not have happened to some, and to others, it may have happened more than they want to admit. A text. A late-night phone call. A panicked coach on the line; "I have an athlete with me that is having suicidal thoughts. What do I do?"

As athletic trainers, we are supposed to know how to handle every situation that happens with our athletes. If that same phone call comes in the middle of the night from someone suffering full body cramps, we have been trained for that. An athlete dislocates an

ankle, we are trained for that. But how many of us were trained in suicide prevention or early recognition of suicide warning signs? I can speak for myself that I was not...until we did an athletic department-wide QPR training during the COVID-19 pandemic.

So, what is QPR? QPR stands for Question, Persuade, Refer. It was created in 1995 by Paul Quinnett as an emergency mental health intervention for suicidal persons with the intent to identify and interrupt a mental health crisis and direct that person to the proper care¹. Its mission is simple: *"to save lives and reduce suicidal behaviors by providing innovative, practical, and proven suicide prevention training."*¹.

1. QPR Institute | Practical and Proven Suicide Prevention Training. (n.d.). QPR Institute. Retrieved July 20, 2022, from <https://1.qprinstitute.com/about-qpr>

In the busy world of college athletics, where we see a chronic understaffing of sports medicine staff across the country, while also seeing a simultaneous rise in responsibility due to the navigation of a global pandemic, QPR training can seem time-consuming, daunting, and even burdensome. But if we look at the effect of the last few years specifically, not only on our student-athletes but ourselves, there is a marked increase in mental health stress that is affecting college athletics.

That's where QPR gatekeeper training comes in. What is a gatekeeper? According to the Surgeon General's National Strategy for Suicide Prevention (2001), a gatekeeper is someone in a position to recognize a crisis and the warning signs that someone may be contemplating suicide¹. In essence, it helps tackle the naturally weighty subject of suicide and suicide prevention and breaks it down into a tangible, learnable skill set for anybody: coaches, staff, and administrators alike. The training can be done in as little as one hour, or longer if chosen, and can be done in a group setting. A group setting is what worked for our department and allowed for increased conversation, accommodation for the nature of the subject, and departmental bonding over the care we want to be able to provide to our student-athletes. QPR isn't intended to solve or fix the thoughts a student-athlete is having, rather it teaches how to navigate a crisis and hopefully lead someone to a place of care and aid from someone qualified to handle the situation.

As athletic trainers and coaches, we deal with a population of young men, women and non-binary individuals that often look to us first and foremost in situations of crisis, not knowing what to do, where to go, or why they are having these thoughts. In the world of sports medicine, we can equate QPR similarly to the premise of CPR. The short comparison is that both systems were designed to increase the chance of survival during a crisis¹. Looking at it from a CPR lens, we know that early recognition and early access can lead to sooner advanced life support response. Stripping away the premise of cardiac arrest and

applying the warning signs of suicidal thoughts and ideations, early detection of those signs can directly lead to better outcomes of a suicidal crisis.

None of us wants to be the one to have to ask the questions: "Are you having thoughts of suicide?" "Do you have a plan?" "Are you going to go through with that plan?". But early QPR opens up a conversation that may eventually lead to someone getting the help they need. QPR dives heavily into the details of how to provide these intervention strategies through its gatekeeper training, but the question becomes "Why should we do this within athletics, and athletic training specifically?" and "Why haven't we done it already?" QPR has been around for almost 30 years and it took me 15 years as a certified athletic trainer to even hear about it. With the continued increase in mental health stressors and the push from the NCAA to implement mental health best practices, it seems only natural to bring this to the table of our administrators as something that needs to be added. There is most likely one, if not multiple people on every campus that are already trained in QPR that can be utilized. QPR is cost-effective, time conducive, and abjectly pertinent to today's world and should be considered as departments keep innovating and improving their mental health support for student-athletes.

Our job as sports medicine professionals is to identify and treat almost any malady that comes our way. We are trained to be non-discriminate and unbiased in nature and to offer up varying degrees of reality, optimism and hope to those that come to us broken and in need. "Oftentimes, the simple offering of hope and social and spiritual support can avert a suicide attempt entirely¹."

Hope. Four letters that can change a life.

1. QPR Institute | Practical and Proven Suicide Prevention Training. (n.d.). QPR Institute. Retrieved July 20, 2022, from <https://1.qprinstitute.com/about-qpr>

BEYOND CAFFEINE FOR MENTAL PERFORMANCE

David O. Kennedy, PhD

Brain, Performance and Nutrition Research Centre, Northumbria University, UK

KEY POINTS

- Caffeine, when taken alone in a research context, is associated with consistent ergogenic and psychological benefits, although within differing optimal dose ranges. The effects of caffeine on mental performance are limited and do not typically encompass benefits to several sport-relevant cognitive domains.
- Caffeine has a number of mechanisms of action and enzyme substrate properties that predispose it to interact with other co-consumed bioactive compounds, including multifarious medicinal and psychoactive drugs.
- In a real-world sport/exercise context, caffeine is often consumed alongside other bioactive compounds in the form of manufactured energy drinks or naturally occurring, plant-derived, caffeinated products.
- Where relevant research has been conducted, the evidence suggests that caffeine-containing, multi-component, plant-derived products and energy drinks/shots can engender mental performance benefits that are broader than those expected from caffeine alone.
- Given the paucity of research designed to disentangle the comparative contributions of caffeine and other co-consumed bioactive ingredients to their combined effects, further research is required in this area.

INTRODUCTION

Three-quarters of athletes consume caffeine before or during competition (Del Coso et al., 2011). Whilst caffeine has well-established ergogenic properties, it also exerts purely psychological effects. However, caffeine's beneficial effects here are largely restricted to improved alertness/fatigue and enhanced attention/

concentration. Caffeine's effects do not generally extend to the other cognitive domains that can be conceived as being intrinsic to peak sporting performance, such as spatial and verbal working memory, executive function, and declarative memory (Scharfen & Memmert, 2019).

Caffeine's multifarious mechanisms of action predispose it to have interactive relationships with a wide range of bioactive medicinal and dietary compounds, potentially broadening, increasing, decreasing, or modulating the time course of their functional effects, or vice versa. This Sports Science Exchange article describes the mechanisms of action and functional effects of caffeine, and the psychological effects of commonly consumed multi-component caffeinated products. It also assesses whether the non-caffeine components of these products either have relevant independent effects on mental performance beyond those of caffeine, or whether they enjoy an interactive relationship with caffeine that potentiates their own functional effects, or indeed those of caffeine.

WHAT IS CAFFEINE?

Caffeine and related methylxanthines are alkaloid defence chemicals synthesized by a small group of unrelated plants, including those that give us tea, coffee, cocoa, and guaraná. Caffeine's primary role is to act as a toxic, neurological behaviour-modifier, dissuading insect and mollusc herbivores from eating the plant's most vulnerable tissue by increasing locomotor activity at low doses, with incapacitation and death following at higher doses. The mechanisms here are largely the same as those that drive caffeine's effects on human behaviour (Kennedy, 2014a).

In plants, methylxanthines are synthesized from ubiquitous purines, including adenine, guanine, and adenosine. Caffeine's biological effects are then directly related to its structural similarity to adenosine (Kennedy, 2014). Adenosine itself is an inhibitory neuromodulator that builds up in the cortex and basal forebrain as a direct consequence of neural activity throughout the waking hours, increasing fatigue and decreasing alertness. It then dissipates during sleep. However, adenosine is also the building block for a host of other functional cellular molecules, including anabolic and catabolic metabolism factors (e.g., adenosine di/triphosphate [ADP/ATP], S-adenosyl methionine [SAM-e]), second messenger molecules

(e.g., cyclic adenosine monophosphate [cAMP]), and multiple enzymes (e.g., poly [ADP ribose] polymerase [PARP]).

CAFFEINE'S MECHANISMS OF ACTION

Orally consumed caffeine is rapidly absorbed and distributed with a circulating half-life of ~3–5 hours (McLellan et al., 2016). Caffeine's central nervous system effects are generally attributed to antagonism of A1 and A2A adenosine receptors and the resultant blockade of adenosine's inhibitory action.

Downstream, this increases the neural activity associated with a variety of neurotransmitters, including dopamine, acetylcholine, noradrenaline, serotonin, glutamate, and gamma-aminobutyric acid. However, caffeine also inhibits the activity of several key enzymes, including those involved in the catalysis of neurotransmitters and amino acids, gluco-regulation, and cellular signalling and repair throughout the body (including phosphodiesterase and PARP). Caffeine at very high concentrations also mimics the role of ATP at ryanodine receptors, increasing muscle contractions.

In terms of ergogenic effects, these mechanisms translate into increased motor unit firing, suppression of exercise-related pain, reduced sensation of force, and decreased ratings of perceived physical effort, alongside related psychological benefits (Guest et al., 2021; Meeusen et al., 2013).

Based on the above mechanisms, caffeine also has potentially wide-ranging modulatory properties with regards to the effects of other bioactive molecules. However, caffeine also affects the absorption, distribution, metabolism, and excretion of many other bioactive molecules via complexation with other compounds, multiple gastrointestinal effects, and modulation of the distribution of molecules, by increasing the tightness of the blood-brain barrier. Caffeine and its metabolites are also metabolized by several members of the cytochrome P450 (CYP450) family of enzymes (CYP1A1, 1A2, 2A6, and 2E1) that manage the metabolism and clearance of endogenous and exogenous bioactive compounds. Caffeine can therefore interact with the many other compounds that also interact with these enzymes, increasing or decreasing their bioavailability, clearance,

effectiveness, or toxicity of the compound/drug/nutrient, or vice versa. Unsurprisingly, caffeine has well-established interactive relationships with a wide range of medicinal and psychoactive drugs.

CAFFEINE'S FUNCTIONAL EFFECTS

In terms of ergogenic benefits, caffeine has been shown to enhance endurance exercise, muscular endurance and power, high-intensity and intermittent exercise, and sport-specific aspects of physical performance (for review, see Guest et al., 2021). The optimal dose range is 3–6 mg/kg body mass (bm), with some evidence from the limited literature that caffeine's effects extend down to 2 mg/kg bm (Pickering & Kiely, 2021; Spriet, 2014).

Caffeine's psychological effects are evident at much lower doses, with benefits evident from as low as 32 mg¹ (i.e., <0.5 mg/kg bm), and consistent benefits apparent at 75 mg² (~1 mg/kg bm). Enhancement plateaus above 100 mg (~1.5 mg/kg bm), begin to decrease beyond 300 mg (~4 mg/kg bm) and can become negative in terms of anxiety and performance beyond 400 mg (~5.5 mg/kg) (McLellan et al., 2016). The psychological effects of caffeine within the optimal range are consistent but are restricted to increased subjective alertness/arousal or decreased fatigue and relatively modest improvements in the performance of tasks assessing attention or focussed attention/vigilance (Haskell et al., 2013). Caffeine's effects do not generally extend to other cognitive domains potentially relevant to sport, such as spatial or verbal working memory, executive function or long-term memory. There is little research addressing the cognitive effects of caffeine during sport/exercise, with most studies in a sport/exercise context measuring psychological function before and/or after rather than during exercise. These benefits are similar to the general psychological literature (Lorenzo-Calvo et al., 2021).

In general, the literature addressing caffeine's functional effects is complicated by a number of unresolved issues, such as the role that genetic polymorphisms (e.g., in CYP1A2), habituation, and withdrawal and tolerance may play with respect to caffeine's effects.

1. Research outside of a sport context tends to administer a set dose for all participants. Where mg/kg bm is given, this is based on an average 70 kg body mass.

2. The dose currently required for an EFSA (European Food Safety Authority) caffeine claim.

MULTI-COMPONENT CAFFEINATED PRODUCTS

In research, caffeine is most often administered in a pure, anhydrous form (Guest et al., 2021), whereas in the real world caffeine is usually consumed alongside other bioactive compounds, which may have independent effects or enjoy an interactive relationship with caffeine. The following summarizes the available information on the most common sources of caffeine.

Polyphenols and Caffeine

Natural sources of caffeine always contain significant concentrations of polyphenols. This group of phytochemicals engender global benefits to health and physiological functioning via interactions with, and modulation of diverse components of a wide range of mammalian cellular signal transduction pathways throughout the body, leading to multifarious metabolic, cardiovascular, and inflammatory status benefits. Within the brain these include modulation of neuro-inflammation, direct and indirect effects on neurotransmission and local blood flow, modulation of neurotrophin synthesis/function, and increased angiogenesis/neurogenesis (Kennedy, 2014a).

Meta-analyses of controlled-trial data suggest that polyphenols from diverse sources improve cardiovascular function, aid physiological recovery from exercise, and improve some aspects of physical performance (Ammar et al., 2020; Hepsomali et al., 2021). They also benefit cognitive function, including tasks assessing attention, executive function, and mental fatigue (Blake et al., 2021; Carey et al., 2021; Fraga et al., 2019). Caffeine and polyphenols also enjoy wide-ranging interactive relationships, increasing both the bioavailability and functional effects of the polyphenols (e.g., Sansone et al., 2017).

Cocoa (seeds of *Theobroma cacao*). Cocoa contains caffeine (and theobromine) and high levels of polyphenolic flavanols and their oligomers, with the polyphenol levels dictated by the fermenting, roasting, and manufacturing process (Andres-Lacueva et al., 2008). Research generally employs high-flavanol extracts or dark chocolate with low levels of caffeine (<40 mg). Meta-analyses of a substantive body of controlled trials show that both single doses and longer-term administration of high-flavanol extracts and chocolate engender a wide range of cardiovascular benefits. Cocoa-flavanols also reduce oxidative stress and modulate metabolism during or

after exercise and enhance cerebral blood flow and the synthesis of neurotrophic factors such as brain-derived neurotrophic factor (BDNF) (Kennedy, 2019).

In terms of psychological benefits, a single study in a sport context showed that cocoa-flavanols improved executive function task performance before and after exercise (Tsukamoto et al., 2018). This corresponds well with multiple studies showing that single doses of high-flavanol, low-caffeine extracts have potentially broader cognitive effects than caffeine alone (Kennedy, 2019). Two particularly thorough studies also reported that 4 weeks of supplementation with high-cocoa-flavanol extracts increased both attention and executive function task performance, alongside beneficial effects on multiple health related biomarkers, in 90 healthy elderly (Mastroiacovo et al., 2015) and 90 sufferers from age-related cognitive impairment (Desideri et al., 2012). In confirmation, a meta-analysis of chronic supplementation (2 weeks to 3 months) studies reported improvements in executive function task performance (Zhu et al., 2021), whilst a complementary meta-analysis also reported improved depression, anxiety, and positive affect (Fusar-Poli et al., 2021).

It is important to note that much of the human research has compared cocoa-flavanol extracts with caffeine matched control interventions. This approach differentiates the added value of cocoa-flavanols but clearly runs the risk of underestimating the effects of the cocoa-flavanol/caffeine combinations.

Guaraná (seeds of *Paullinia cupana*). Guaraná seed extracts have a similar polyphenol makeup as cocoa, with high levels of flavanols and their oligomers. Extracts also typically contain 2.5-5% caffeine and several triterpene compounds.

There is little research investigating the effects of guaraná on physical performance. However, a number of studies have demonstrated cognitive benefits following guaraná that are much broader than would be expected from caffeine. These include benefits to long-term memory, working memory, and executive function, alongside typical caffeine-like effects on mental fatigue and attention. Given that these effects are seen even when very low, sub-psychoactive doses of caffeine are involved (from ~0.05 mg/kg bm), it can be concluded that caffeine has not contributed directly to these effects (Haskell et al., 2013). In support of this, one study compared a guaraná extract with multivitamins to its comparatively high caffeine

content (100 mg) and demonstrated significantly greater improvements in cognitive function for the guaraná condition compared both with placebo and caffeine alone (Pomportes et al., 2014). Of particular relevance here, a single study in a sport/exercise context also showed that single doses of a product combining guaraná extract (40 mg caffeine or ~0.6 mg/kg bm) and multivitamins improved working memory and episodic memory task performance both before and after 30 minutes of treadmill running in 40 young males (Veasey et al., 2015).

Coffee (*Coffea* genus). The coffee roasting process leads to depleted levels of polyphenols (mainly chlorogenic acids [CGA], alongside several simple phenolic acids and their derivatives). Unroasted or lightly roasted green coffee and coffee berry extracts made from the pulp surrounding the seed retain much higher levels of the same polyphenols.

Roasted Coffee. In ergogenic terms the small body of research that has directly compared coffee and caffeine has generated equivocal evidence as to their comparative efficacy. In terms of psychological functioning, there is a lack of research employing the requisite comparator arms to disentangle the effects of caffeine from those of the other bioactive components. One recent study did compare the cognitive and mood effects of caffeinated and decaffeinated coffee to an inert coffee flavoured placebo (Haskell-Ramsey et al., 2018). The results showed that both the caffeinated and decaffeinated coffee drinks led to increased alertness, but that the caffeine-containing drink alone revealed significant cognitive effects. However, the overall pattern of results showed that the decaffeinated drink fell between the placebo and caffeinated drink on most measures, leading the authors to surmise a modulatory effect of the non-caffeine components of coffee.

Green Coffee. There is some evidence that chronic consumption of high-CGA green coffee has beneficial effects on multifarious cardiovascular parameters, and that single doses of green coffee engender greater cardiovascular benefits than their caffeine content. However, a single physical exercise study found that whilst a high-CGA/caffeine coffee did improve overall mood, it was no more effective in ergogenic terms (Nieman et al., 2018). With regards to brain function, two single-dose studies have demonstrated that high-CGA decaffeinated green coffee improved the performance of attention tasks, subjective alertness, and other aspects of psychological state compared

with placebo (see Haskell et al., 2013). Two recent studies also demonstrated some cognitive improvements, including in executive function tasks, following administration of caffeine-free green coffee to older adults over several months (Ochiai et al., 2019; Saitou et al., 2018).

Coffee Berry. Single doses of coffee berry extracts with very low caffeine levels have been shown to enhance cerebral blood flow and increase the synthesis of neurotrophic factors such as BDNF and attenuate the effects of extended performance of demanding cognitive tasks on alertness and mental fatigue. One study also investigated chronic effects. In this case, when coffee berry extract was taken in the morning or twice per day for 7 and 28 days by sufferers of mild, age-related cognitive impairment, the performance of a demanding working memory/executive function task was improved (Robinson et al., 2019). However, this effect was not seen when the extract was only taken in the evening.

Green tea (*Camellia sinensis*). Green tea contains significant levels of flavanols, including catechin, epicatechin, and the tea-specific polyphenol epigallocatechin gallate (EGCG), plus the tea-specific amino-acid L-theanine and caffeine. Meta-analysis of controlled-trial data showed that the consumption of green tea extracts was associated with a number of cardiovascular and anthropometric benefits, although the effects on exercise performance are unclear to date (see Golzarand et al., 2018; Rasaei et al., 2021).

There is little research assessing the mental performance effects of green tea extracts or tea catechins, and no studies in a sport/exercise context. However, a number of studies have investigated interactions between the green tea components caffeine and L-theanine. The general finding across a number of studies was that the combination of caffeine with L-theanine can potentiate the mental performance effects of caffeine alone, attenuate the reduction in cerebral blood-flow associated with caffeine, and elicit a synergistic, interactive effect on activation in brain regions associated with task performance. As an example of functional effects, one study found that whereas caffeine (150 mg) and caffeine combined with L-theanine (250 mg) elicited common improvements in the performance of a Rapid Visual Information Processing (RVIP) task and decreased subjective mental fatigue, the caffeine/L-theanine combination also led to a number of significant benefits over those seen following caffeine

alone, including improved alertness and tiredness and enhanced working memory performance (Haskell et al., 2008). Whilst the balance here is in favour of beneficial caffeine/L-theanine interactions, it should be noted that two studies demonstrated that the addition of L-theanine simply attenuated caffeine's effects on cognitive function (Dodd et al., 2015; Giles et al., 2017).

Conclusion: Polyphenols and Caffeine. Caffeine enjoys a number of interactive relationships with polyphenols. Evidence suggests that the benefits to mental performance following plant-based sources of caffeine are broader than those following caffeine alone, and potentially include enhancement within cognitive domains relevant to sporting performance that are unaffected by caffeine. These benefits are also evident following products with lower doses of caffeine than would normally be considered psychoactive. The strongest evidence here, but also the most consistent research, relates to high cocoa-flavanol products and guaraná, with emerging evidence for high CGA coffee products. Whether these effects are entirely independent of caffeine or represent an interaction with the low dose of caffeine present remains to be explored by studies equipped with the appropriate comparator arms. The question of whether higher doses of caffeine will further potentiate the effects of low caffeine products also requires elucidation.

CAFFEINATED DRINKS

Caffeine/Carbohydrate Drinks. In general, carbohydrates consumed alone have very short-term effects on cognitive function, with improvements most often seen in long-term memory. However, whilst drinks containing caffeine and carbohydrate also have consistent effects on mental performance, there is little research disentangling their contributions. Just under half of the small number of studies published to date with the requisite arms for the comparison found evidence of a greater effect for the carbohydrate/caffeine combination than for the component parts, leaving the question unresolved (Boyle et al., 2018).

Energy Drinks/Shots. Energy drinks and shots typically contain caffeine and taurine, often in combination with carbohydrates, amino acids, vitamins, or herbal extracts. All of these components may have independent effects on brain function. In terms of ergogenic effects, a recent meta-analysis of the data from 34 studies found that energy drinks

containing caffeine and taurine resulted in significantly improved endurance exercise test performance, jumping, muscle strength and endurance, and cycling and running performance (Souza et al., 2017). Importantly, these effects were evident from doses of caffeine (~1 mg/kg bm) that were lower than those typically considered to be ergogenic (Guest et al., 2021) and were correlated with the amount of taurine in the drinks rather than caffeine. The few studies on psychological functioning in a sport/exercise context are consistent with the findings from the general literature that energy drinks have reliable beneficial effects on attention task performance, although it is notable that these studies have not interrogated other cognitive domains.

Interestingly, in studies controlling for the effect of carbohydrates, the mental performance effects of multi-component energy drinks have extended to cognitive domains typically unaffected by caffeine. For example, a particularly thorough cross-over study, involving a large sample of healthy adults, compared a carbohydrate-free energy shot to placebo over 6 hours post-dose (Wesnes et al., 2013). The results demonstrated broad cognitive benefits that included improved attention task performance and improved alertness. More importantly, improvements were also seen in measures that would not be sensitive to caffeine, including across working memory and episodic memory tasks and in ratings of depression and anxiety. All of these improvements were also seen during the later assessments, when the effects of caffeine might be expected to be waning (Wesnes et al., 2013). With regards to specific interactions within ingredients, two studies suggest that taurine serves to attenuate caffeine's psychological effects, although again these studies did not interrogate the cognitive domains unaffected by caffeine (Giles et al., 2012; Peacock et al., 2013). Notably, irrespective of the direction of the functional relationship seen here, these results also confirm that both taurine and caffeine contribute to the effects of products that combine them.

NON-CAFFEINATED PHYTOCHEMICALS

A number of plant extracts and phytochemicals, several of which commonly appear in energy drinks,³ have been shown to have broader mental performance effects than caffeine. Recent evidence shows that single doses of mango leaf extracts containing high levels of the polyphenol mangiferin (> 60%) have physical performance-enhancing properties when combined with other polyphenols, and can engender broad improvements in cognitive function, including during mentally demanding tasks (Wightman et al., 2020). Several studies have also extended the psychological benefits of chronic supplementation with curcumin, the principal polyphenol in turmeric, typically seen as effective in depression, to include improved attention and working memory. Phytochemicals from other classes have also been shown to be effective in terms of improving attention and aspects of memory (working memory/long-term memory). These include single oral doses of volatile monoterpenes from sage (*Salvia officinalis*/*lavandulaefolia*) and peppermint (*Mentha piperita*); acute and chronic consumption of diterpene/polyphenol rich Ginkgo biloba extracts; and single doses of triterpene rich ginseng (*Panax ginseng*/*quinquefolius*) extracts. For a more detailed review, see Kennedy, 2019.

Potential interactions with caffeine have not yet been investigated in humans for any of these plant extracts. However, given that many of their bioactive compounds share the same CYP enzymes as caffeine, and are potentially prone to caffeine's other modulatory effects on pharmacokinetics, there is real potential for boosted mental performance following combination products.

PRACTICAL APPLICATIONS

SUMMARY

In the real world, outside of a caffeine research context, athletes and participants in sport typically consume caffeine alongside a complex mixture of other bioactive compounds, potentially taking advantage of the many interactions that caffeine enjoys with phytochemicals and other bioactives. There is direct evidence of functional interactions between caffeine and polyphenols, L-theanine, and taurine. Additionally, multi-component caffeine-containing products or extracts can engender broader benefits to mental performance than expected from caffeine, even at higher doses. To what extent this is due to the independent effects of the non-caffeine bioactives or interactions with caffeine is not yet clear. Indeed, this area is typified by a lack of adequate research, and future research could usefully investigate the contributions of caffeine and the non-caffeine bioactive compounds in caffeinated products, the optimal level of caffeine in caffeinated products, the potential for additional caffeine to further enhance the functional benefits of low caffeine extracts, and the potential for caffeine to potentiate the functionality of multifarious other psychoactive phytochemicals. In general, this research effort should also include exercise or sporting contexts.

- Taking pure caffeine is likely to be the most impoverished method of consuming this phytochemical.
- Doses of caffeine at the higher end of the optimal ergogenic range (3 to 6 mg/kg bm) also coincide with doses that are liable to be detrimental in terms of anxiety and mental performance.
- The results from “pure caffeine” research cannot necessarily be extrapolated to everyday caffeine consumption.
- Plant caffeine sources will also provide significant levels of polyphenols, and energy drinks may contain significant levels of beneficial bioactives. These additional compounds may engender independent physiological or psychological benefits, and the additional compounds may enjoy functional interactive relationships with caffeine.
- Evidence suggests specific benefits for high-flavanol cocoa products (extracts or dark chocolate) and guaraná extracts, and high CGA coffee products. Regular tea and coffee would benefit from more research.
- Multi-component caffeinated products may deliver broader benefits to mental performance than caffeine alone, and at much lower doses of caffeine.

The views expressed are those of the authors and do not necessarily reflect the position or policy of PepsiCo, Inc.

3. The content of the bioactive components of plant extracts included in energy drinks is rarely stated.

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