*Journal of Interdisciplinary History,* XLII:2 (Autumn, 2011), 205–233.

*Nicolas Rasmussen*

# Medical Science and the Military: The Allies' Use of Amphetamine during World War II

World War II is regarded as a turning point from multiple historical perspectives. In political history, it represents the last major national conflict, the scale and especially the concluding atom bombs ushering in a new age of multilateralism. Mumford, a historian of technology, saw the war as marking the triumphant rebirth of the "mega-machine" social organization; Adolf Hitler's opponents had to adopt his ways to defeat him. In military history, it marks the dawning not only of nuclear weapons but also of modern air power and high-mobility ground troops, fundamentals for which we have Hitler to thank—along with a new era of psychological warfare. In the history of science, the War is enshrined as the "scientists' war" and the start of a "new partnership" between the government (especially the military) and academic researchers, especially in the United States. The view that "science won the war"—through contributions such as penicillin, radar, and the atom bomb—has been remarkably persistent, and a perrenial focus of historical debate. But whether military linkages are viewed as boon or bane for university science, a shared premise is that during World War II, leading scientists became deeply involved with the war effort, and the miltary was impressed.[1]

Amphetamine was a new product of the pharmaceutical labo-

Nicolas Rasmussen is Professor of History, University of New South Wales. He is the author of *On Speed: The Many Lives of Amphetamine* (New York, 2008); *Picture Control: The Electron Microscope and the Transformation of Biology in America, 1940–1960* (Stanford, 1997).

The author thanks the archivists at the California Institute of Technology, the National Academy of Sciences (U.S.A.), The UK National Archives at Kew, the University of Pennsylvania, and the U.S. National Archives at College Park, Maryland, for their assistance. He also thanks Alan Dericksen, Sydney Halpern, Sanders Marble, Peter Neushul, Hans Pols, Peter Schrivers, Jonathan Simons, Peter Steinkamp, Ian Tyrrell, and anonymous referees for references and helpful comments. The research was supported by the Australian Research Council (grants DP0449467 and DP0984694).



1 Lewis Mumford, *The Myth of the Machine: The Pentagon of Power* (New York, 1970); Vannevar Bush, *Science, the Endless Frontier: A Report to the President* (Washington, D.C., 1945); James Phinney Baxter 3d, *Scientists Against Time* (New York, 1946); A. Hunter Dupree, "The Great Instauration of 1940: The Organization of Scientific Research for War," in Gerald Holton (ed.), *The Twentieth Century Sciences: Studies in the Biography of Ideas* (New York,

ratory that, like the sulfa drugs and penicillin, quickly found its way to the battlefield. Its adoption during the war speaks to the role of science in the war effort, but it also holds a certain inherent interest. The Internet abounds with related apochrypha and misinformation, much of it implying that mind-altering, addictive drugs were dispensed by both Allied and German leaders to make soldiers more aggressive. That the topic of Allied amphetamine use has received little serious historical attention is surprising given that amphetamine abuse has been a significant medical problem ever since the war. This article reconstructs the evaluation of amphetamine for military use by both British and American experts, interpreting how and why (both officially and tacitly) it came be adopted. It argues that, although amphetamine was thoroughly tested by leading scientists for its effects in boosting or maintaining physical and mental performance in fatigued subjects, the results never provided solid grounds for approving the drug's use, and, in any case, came too late to be decisive. The grounds on which amphetamine was actually adopted by both British and American militaries had less to do with the science of fatigue than with the drug's mood-altering effects, as judged by military men—increased confidence and aggression, and elevated "morale." The entire issue has important implications for our understanding of science's role in World War II and American history in general.[2]

---

1972), 443–467; Derek de Solla Price, *Little Science, Big Science . . . and Beyond* (New York, 1986); Alex Roland, "Science and War," *Osiris,* I (1985), 247–272; Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940–1960," *Historical Studies in the Physical and Biological Sciences,* XVIII (1987), 149–229; Daniel Lee Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, 1995); David M. Hart, *Forged Consensus: Science, Technology, and Economic Policy in the United States, 1921–1953* (Princeton, 1998). Revision of the "scientists' war" idea begins with the most seminal wartime documents enshrining the very concept: Bush, "As We May Think," *Atlantic Monthly* (July 1945), 101–108.

2 John P. Swann, "The Search for Synthetic Penicillin During World War II," *British Journal of the History of Science,* LIII (1983), 154–190; Peter Neushul, "Fighting Research: Army Participation in the Clinical Testing and Mass Production of Penicillin during the Second World War," in Roger Cooter, Mark Harrison, and Steven Sturdy (eds.), *War, Medicine and Modernity* (Somerset, 1998), 203–224; Robert Bud, *Penicillin: Triumph and Tragedy* (New York, 2007); John E. Lesch, *The First Miracle Drugs: How the Sulfa Drugs Transformed Medicine* (New York, 2007). For amphetamine apocrypha, see Hugh C. McBride "Amphetamine Abuse: A Brief History," at http://www.drug-addiction.com/amphetamine_addiction.htm (accessed April 7, 2010); Anon. "Amphetamines-History," at http://science.jrank.org/pages/302/Amphetamines-History.html (accessed April 7, 2010).

AMPHETAMINE, ADRENALINE, and FATIGUE C. 1940 Germany's stunningly successful western Blitzkrieg of 1940 spawned a host of rumors, including word of secret "Stuka Tablets" giving pilots of the dreaded dive-bombers a superhuman power to resist g-forces. Newspapers also contained reports of "heavily drugged, fearless, and berserk" German paratroopers. An investigation by the British War Office discovered that the Germans were using methamphetamine. Indeed, April through June 1940, the peak of the Blitz, corresponds to the wartime peak in the German military's consumption of amphetamines. According to Steinkamp, the Wehrmacht used 35 million 3mg methamphetamine tablets for these three months alone, and much less thereafter. In both the United States and Britain, top-level scientific advisory bodies devoted to the military problems of "fatigue" earnestly began studying the effects of the drugs and their military utility. Thus, any understanding of the Allied adoption of amphetamines must begin by addressing two questions: So far as experts in 1940/41 were concerned, what were amphetamines, and what was fatigue?[3]

Invented in 1929 in pursuit of an asthma remedy, and first marketed by the Philadelphia firm Smith, Kline and French (SKF) in a decongestant inhaler, amphetamine was originally thought of as an artificial adrenaline, and its adrenaline-like action on the sinuses and circulation was the basis of its earliest uses. By 1935, medical specialists on both sides of the Atlantic were testing amphetamine for clinical uses ranging from menstrual cramps to bedwetting. Soon, however, the drug's effects on the central nervous system—its psychiatric effects as well as its effect on mental performance—began to draw attention. As recent work in the history of medicine shows, American neuropsychiatry in the 1930s was less dominated by Freudian doctrine than standard historiography once held, and more committed to the type of "psychophysical unity" championed by Cannon, a Harvard physiologist. By 1936/37, many psychiatrists had become enthusiasts for the drug as a remedy for milder "neurotic" depressions, but they also

3 Flying Personnel Research Committee minutes, record code PRO AIR 57/40 and 57/41, June 28, 1940, and November 9, 1940, Flying Personnel Research Committee records, United Kingdom national archives, Kew. Newspaper quoted in William Sargant, *The Unquiet Mind: The Autobiography of a Physician in Psychological Medicine* (Boston, 1967), 45–47; Peter Steinkamp, "Pervitin Testing, Use and Misuse in the German Wehrmacht," in Wolfgang Eckart (ed.), *Man, Medicine, and the State: The Human Body as an Object of Government Sponsored Medical Research in the 20th Century* (Stuttgart, 2006), 61–71.

found that the drug tended to make anxiety conditions worse. Myerson, a Harvard psychiatrist, presciently elaborating Cannon's theories, hypothesized that the drug corrected an adrenaline insufficiency in the brain's circuits controlling activity and rest.[4]

Meanwhile, psychologists quickly established that improvements on intelligence tests were more subjective than real; any gains in performance—typically, in simple testing tasks requiring persistence—stemmed mainly from amphetamine's ability to increase confidence and initiative rather than actual improvement in mental capacity. These findings did nothing to discourage university students, who evidently did not mind whether amphetamine improved their marks or just made exams more bearable. Despite some bad publicity from this misuse, "Benzedrine Sulfate," SKF's brand for amphetamine in tablet form, held great promise in American and British medicine at the war's onset—as the first "antidepressant" (see Figure 1). In Germany, Temmler, emulating SKF, marketed the nearly identical drug methamphetamine (unprotected by patents) under the "Pervitin" brand name, along essentially the same lines.[5]

4 Rasmussen, "Making the First Anti-Depressant: Amphetamine in American Medicine, 1929–1950," *Journal of the History of Medicine and Allied Sciences,* LXI (2006), 288–323; Walter B. Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage* (New York, 1915); *idem, The Wisdom of the Body* (London, 1939). For early work on amphetamines in psychiatry, see Abraham Myerson, "Effect of Benzedrine Sulfate on Mood and Fatigue in Normal and Neurotic Persons," *Archives of Neurology and Psychology,* XXXVI (1936), 816–822; D. L. Wilbur, A. R. Maclean, and E. V. Allen, "Clinical Observations on the Effect of Benzedrine Sulfate," *Proceedings of the Staff Meetings of the Mayo Clinic,* XII (1937), 97–104; Eugene Davidoff and Edward C. Reifenstein, Jr., "The Stimulating Action of Benzedrine Sulfate," *Journal of the American Medical Association,* CVIII (1937), 1770–1776; Erich Guttman and Sargant, "Observations on Benzedrine," *British Medical Journal* (May 15, 1937), 1013–1015; Purcell G. Schube et al., "The Effect of Benzedrine Sulfate on Certain Abnormal Mental States," *American Journal of Psychiatry,* XCIV (1937), 27–32; for historiography of psychiatric medicine generally, Joel Braslow, *Mental Ills and Bodily Cures: Psychiatric Treatment in the First Half of the Twentieth Century* (Berkeley, 1997); Jack D. Pressman, *Last Resort: Psychosurgery and the Limits of Medicine* (New York, 1998); Jonathan Sadowsky, "Beyond the Metaphor of the Pendulum: Electroconvulsive Therapy, Psychoanalysis, and the Styles of American Psychiatry," *Journal of the History of Medicine and Allied Sciences,* LXI (2006), 1–25.

5 Sargant and J. M. Blackburn, "The Effect of Benzedrine on Intelligence Scores," *Lancet* (December 12, 1936), 1385–1387; George Carl and William Turner, "The Effects of Benzedrine Sulfate (Amphetamine Sulfate) on Performance in a Comprehensive Psychometric Examination," *Journal of Psychology,* VIII (1939), 165–216; Turner and Carl, "Temporary Changes in Affect and Attitude Following Ingestion of Various Amounts of Benzedrine Sulfate (Amphetamine Sulfate)," *ibid.*, 415–482; T. Gaylord Andrews, "The Effect of Benzedrine Sulfate on Syllogistic Reasoning," *Journal of Experimental Psychology,* XXVI (1940), 423–431; J. E. Barmack, "The Effect of 10mg Benzedrine Sulfate on the Otis Tests Scores of College

In Allied military medicine of 1940/41, fatigue was freighted with multiple, overlapping meanings based in psychiatry, the science of work physiology, and military thinking about "morale." In 1940, military medical personnel anticipated a crisis from the mental illness known in the previous war as "shell shock." Inserting themselves into the processes used to screen recruits for mental health during the planning stages of the war, American psychiatrists had promised to reduce manpower loss due to "psychoneurotic breakdown," and after hostilities began, secured a place for psychiatry in forward area medical treatment. American psychiatrists and psychologists were also recruited to devise psychological warfare programs, both defensive and offensive (that is, supporting morale on the Allied side and attacking that of the enemy). Their British counterparts were similarly involved in the war effort, even if not as readily embraced by the military.[6]

Although the role of psychiatric experts in controlling mental breakdown during World War II is well documented, the place of physiology and pharmacology in their approaches is not. To psychiatrists of the time, "war neurosis," their own term for shell

---

Students," *American Journal of Psychiatry*, XCVII (1940), 163–166; Clifford Seitz and Joseph Barmack, "The Effects of 10 mg of Benzedrine Sulfate and Low Oxygen Tension on the Span of Attention for Letters, and Other Factors," *Journal of Psychology*, X (1940), 241–247; on student use and abuse, Anon., "Pep-Pill Poisoning," *Time*, May 10, 1937, 45; Editorial, "Students Warned Against Pep Pills at Examinations," *Science News Letter*, 31 (June 12, 1937), 377; Editorial, "Benzedrine Sulfate 'Pep Pills,'" *Journal of the American Medical Association,* CVIII (1937), 1973–1974; Ivor Davies, "Discussion on Benzedrine: Uses and Abuses," Proceedings of the Royal Society of Medicine, XXXII (1939), 385–388; Steinkamp, "Pervitin Testing"; Rasmussen, "Making the First 'Antidepressant.'"

6 Well-known primary sources include Crawford N. Baganz, "The Importance of a Proper Psychiatric Survey in the Enrollment of the Personnel of Military Forces," *Military Surgeon,* LXXXVI (1940), 471–477; William C. Porter, "The Military Psychiatrist at Work," *American Journal of Psychiatry,* XCVIII (1941), 317–323; Karl M. Bowman, "Psychiatric Examination in the Armed Forces," *War Medicine,* I (1941), 213–218; William C. Menninger, "Condensed Neuropsychiatric Examination for Use by Selective Service Boards," *ibid.,* 843–853; Albert J. Glass, Robert J. Bernucci, and Robert S. Anderson, *Neuropsychiatry in World War II* (Washington, D.C., 1966), 153–191. Secondary sources include Nathan G. Hale, *Freud and the Americans, 1917–1985: The Rise and Crisis of Psychoanalysis in the United States* (New York, 1995), 187–210; Ellen Herman, *The Romance of American Psychology: Political Culture in the Age of Experts* (Berkeley, 1995), 48–123; Ben Shephard, *A War of Nerves: Soldiers and Psychiatrists in the Twentieth Century* (Cambridge, Mass., 2001), 187–204; Hans Pols and Stephanie Oak, "War & Military Mental Health: The US Psychiatric Response in the 20th Century," *American Journal of Public Health,* XCVII (2007), 2132–2142. On Britain, see Mark Harrison, *Medicine and Victory: British Military Medicine in the Second World War* (New York, 2007), 58–62, 170–183; for a comparative perspective, Hans Binneveld, *From Shellshock to Combat Stress: A Comparative History of Military Psychiatry* (Amsterdam, 1997).

shock, was closely akin to ordinary neurasthenia or neurotic depression. According to the authoritative 1941 work on the topic by Kardiner, a psychoanalyst, war neurosis was damage to a soldier's "ego organization" caused by the inability to escape or alter a threatening situation. Straying from mainstream Freudian views, Kardiner believed that the condition could be caused not just by acute traumatic experience but also by a combination of chronic anxiety and physical exhaustion. The link between emotional and physical condition lay in the autonomic nervous system. Man, like any organism, handled perceived threats with heightened psychic and physical preparedness, based in Cannon's "fight-or-flight" response. Adrenaline-fired arousal aided survival in the short term, but in the long run, it depleted the nervous system and eroded the resilience of the psyche, which eventually broke down to a state "by intention vaguely called 'operational fatigue,'" a term Grinker adopted in 1942 to smooth his work with patients at the front. Grinker's British counterparts in field psychiatry favored "battle exhaustion" as a euphemism, but their logic was similar.[7]

Thus, psychiatrists understood war neurosis as a condition related to depression, physical fatigue, and the neurophysiology of adrenaline, whereas amphetamine, the synthetic adrenaline derivative, was a medicine of great promise especially for depression. Aside from its increasing support in psychiatric circles, by 1940, amphetamine was already known to have abuse potential, gaining popularity among nonmedical users as the "pep pill" in the United States and "the confidence drug" in Britain. The drug had reportedly found a place in sports (replacing cocaine among bicyclists) as well, and was popularly believed to improve performance in challenging physical and intellectual tasks. Less fully appreciated by the

7 Abram Kardiner, *The Traumatic Neuroses of War* (Washington, D.C., 1941), 27–28, 69–85, 95–101, 116–17, 157–72, 193–205; *idem,* "Forensic Issues in the Neuroses of War," *American Journal of Psychiatry,* XCIX (1943), 654–661; *idem* and Herbert Spiegel, *War Stress and Neurotic Illness* (New York, 1947; orig. pub. 1941), 49–50, 281–296. For more on Kardiner's insistence, despite his Freudian perspective, on the neuro-endocrine basis of war neurosis, see John E. Talbott, "Soldiers, Psychiatrists, and Combat Trauma," *Journal of Interdisciplinary History,* XXVII (1997), 437–544; Allan Young, "Our Traumatic Neurosis and Its Brain," *Science in Context,* XIV (2001), 661–683. Roy Grinker and John Spiegel, "Brief Psychotherapy in War Neuroses," *Psychosomatic Medicine,* VI (1944), 123–131; Grinker et al., "A Study of Psychological Predisposition to the Development of Operational Fatigue. I. In Officer Flying Personnel," *American Journal of Orthopsychiatry,* XVI (1946), 191–206 (quotation, 191); David G. Wright, *Notes on Men and Groups under Stress of Combat* (New York, 1945), 9–10; Harrison, *Medicine and Victory,* 121–126, 170–183.

public, however, was that the available scientific evidence on amphetamines suggested that perceived performance gains reflected only boosted confidence and distorted judgement.[8]

## BRITISH RESEARCH ON AND ADOPTION OF AMPHETAMINE, 1939–1942

In Britain, the Blitz of mid-1940 brought urgency to a research program on fatigue established a year earlier. The Flying Personnel Research Committee (FPRC), organized shortly before the war by the Air Ministry and chaired by Edward Mellanby—the head of the Medical Research Council—included military men alongside academic scientists as active participants. The British studies (like the American) can be roughly grouped into two categories, field studies by the military and lab studies conducted by civilian experts. From the outset, the British hoped for true performance enhancement from the amphetamines, and not just a new "wakey-wakey" pill to replace the venerable caffeine.[9]

The early FPRC studies on amphetamine, many conducted by Bartlett, were mostly careful affairs in University laboratories. Volunteers took a battery of psychological and hand–eye coordination tests. In the vast majority of them, amphetamine did not consistently improve performance, though in a few cases—such as the "pursuit meter," a device with a joystick and crosshairs to track a moving target—amphetamine slowed decline in performance. The FPRC researchers concluded that the exceptional drug-induced higher scores reflected a subject's attitude toward testing. Because amphetamine users felt more confident and lost interest in tedious tasks less quickly, they maintained effort and did better—just as American psychologists had recently concluded about amphetamine's effect in exams and standardized tests. Yet, in general, amphetamine's boost to perfomance appeared to be illusory. What

8 Anon., "Pep-Pill Poisoning"; Iago Galdston, "Pep-Teasers," *Hygeia,* XVIII (1940), 878–880, 918–919; Editorial, "The Confidence Drug," *Pharmaceutical Journal,* CXXXVIII (1937), 539; Ove Bøje, "Doping: A Study of the Means Employed to Raise the Level of Performance in Sport," *Bulletin of the World Health Organisation,* VIII (1939), 439–469.

9 A. Lansborough Thomson, *Half a Century of Medical Research. II. The Programme of the Medical Research Council (UK)* (London, 1975), 317–321. FPRC Minutes, Flying Personnel Research Committee Records, PRO AIR 57/40 and 57/41, June 28, 1940, and November 9, 1940; "Note by Charles Wilson: Use of Benzedrine," PRO PREM 3/103/2, Prime Minister's correspondence files, undated; Anon. ["RAMC Intelligence Officer"], "Drugging and Doping of War Fliers," PRO FD1/6380, Military Personnel Research Committee files, Medical Research Council records. [1942], all in United Kingdom National Archives, Kew.

Bartlett reported to the FPRC about amphetamines' effect on work capacity applied to most performance measures: "Individuals were disposed to try to make greater efforts; they thought they were working harder, whereas they were doing exactly the same amount of work."[10]

Another set of FPRC studies were conducted with pilots in extended flight-simulator sessions, breathing oxygen diluted to levels found at various altitudes. The results yielded no dramatic, quantifiable differences between the effects of caffeine and ampetamine upon performance. Subjectively, most of the test subjects preferred their low-oxygen experience with amphetamines, though amphetamines sometimes distorted their sense of time, and one man complained that it made him "lustful." The drug certainly had psychiatric effects beyond mere alertness, perhaps sufficient to explain the pilots' preference for Benzedrine while flying in low oxygen. Another roughly simultaneous FPRC finding, that rats on amphetamines actually died more quickly in rarefied atmospheres than undrugged ones, made the alternative theory that amphetamine physiologically benefited pilots unlikely. Nor did amphetamine increase resistance to blackout among pilots subjected to high g-forces in a centrifuge, as the Stuka rumors had suggested.[11]

The FPRC also oversaw a set of RAF "operational" studies on men in combat, apparently more convincing to those in command, despite their informality, than the growing body of rigorous experimental work showing little or no benefit. The most influ-

10 D. Russell Davis, "The Use of Benzedrine in Normal Subjects," FPRC Report 234, [1941]; idem, "Investigation into the Psychological Effects of Benzedrine on Normal Adults," FPRC Report 237, January 1941, both in PRO AIR 57/3, Flying Personnel Research Committee records. "Minutes of 18th FPRC Meeting," PRO AIR 57/42, Flying Personnel Research Committee records, April 6, 1941, 6 (Bartlett quotation).

11 R. C. Browne, "The Influence of Oxygen Deficiency and Drugs on Flying the Link Trainer," FPRC Report 285, [1941], PRO AIR 57/4, Flying Personnel Research Committee records; Davis, "The Use of Benzedrine in Normal Subjects," and *idem*, "Investigation of the Psychological Effects of Benzedrine on Normal Adults" are presumably those mentioned as planned for January 1941 at Farnsborough in the minutes of 14th Flying Personnel Research Committee meeting, PRO AIR 57/41, Flying Personnel Research Committee records, November 12, 1940, 6. Browne's study was probably completed in March 1941. Flight Lieutenant W. K. Stewart, "Influence of Drugs on the Ability to Withstand Centrifugal Force," FPRC Report 338, PRO AIR 57/6, Flying Personnel Research Committee records, August 11, 1941. On rats, see J. A. Campbell, "Effect of Drugs in Increasing Resistance to Oxygen Want," FPRC Report 141, PRO AIR 57/1–2, Flying Personnel Research Committee records, May 1941.

ential were a series conducted in 1941/42 by Winfield, a former general practitioner and ship's surgeon working at RAF physiological laboratories. Noting that unofficial Benzedrine use was increasing among pilots and thus that the RAF needed to take an official position on the drug, Winfield flew fourteen long-range submarine patrol missions with Coastal Command to compare the effects of methamphetamine (from the British firm Burroughs-Wellcome), amphetamine (which was well-protected by patents and had to be bought from SKF), and sugar placebos. No comparison was made to caffeine, and no efforts were made to quantify performance; all of Winfield's conclusions were based on his own impressions of pilot behavior during the flights and on interviews with the airmen. Winfield concluded that, although amphetamine and methamphetamine seemed equally effective for alertness, amphetamine was superior due to the more "marked feeling of well-being" it produced. Winfield, and thus the military, was always explicitly concerned with the subjective, mood-altering, "morale" effects of the drugs.[12]

Winfield expanded his field studies to long-range Bomber Command missions just when the RAF leadership first showed active interest in the mounting problem of emotional breakdown among bomber crews. Judging from his observation of participants during twenty harrowing raids, Winfield found that Benzedrine, compared to the placebo, improved the attention of many airmen on the way home, but he was even more impressed with its effects on mood: "In some people the drug may increase determination in circumstances of acute anxiety." For example, on one mission over Cologne, a pilot on Benzedrine decided not to bomb from high altitude through cloud cover like most of the planes, but to "press home the attack" in heavy anti-aircraft fire below the cloud, making a direct hit despite being struck with flak. Similarly, Winfield reported, during an air raid against the Renault factory

12 Roland H. Winfield, "Report on the Factors Influencing the Onset and Production of Fatigue in Catalina Flying Boat Crews," FPRC Report 355, PRO AIR 57/6, Flying Personnel Research Committee records, August 18, 1941; *idem,* "The Use of Benzedrine to Overcome Fatigue in Operational Flights in Coastal Command," FPRC Report 361, PRO AIR 57/6, Flying Personnel Research Committee records, October 1941; Flying Personnel Research Committee minutes, PRO AIR 57/42, Flying Personnel Research Committee records, April 6, 1941, 6, and August 20, 1941, 9–10. On Winfield, see T. M. Gibson and M. H. Harrison, *Into Thin Air: A History of Aviation Medicine in the RAF* (London, 1984), 69–73; Winfield, *The Sky Belongs to Them* (London, 1976).

outside Paris, another of his Benzedrine-charged bomber crews strafed and killed an enemy anti-aircraft team at a tree-triming 200 feet. Winfield concluded that because about half of the men taking amphetamine seemed to behave with the desirable "determination" and aggression, the drug should be offered to all bomber crewmen before each flight. As noted, he made no effort to evaluate caffeine in these studies, perhaps because the well-known and widely available drug was seen by British fliers as somehow insufficient (obviously so by those buying their own Benzedrine). The RAF began procuring Benzedrine from SKF in large quantities by early 1942, and Winfield's recommendations to issue two 5 mg tablets per man for each mission were formally adopted late that year.[13]

The Royal Navy seems to have done its own informal testing with both methampethamine and amphetamine in mid-1942, but it never instituted a systematic evaluation. However, the British Army drew upon extensive, rigorous studies by top scientists, as well as less formal field studies by its own people, to assess the potential of amphetamine's use by ground forces. By October 1941, the Subcommittee on Analeptic Substances of the Military Personnel Research Committee (MPRC, the Army's counterpart of the RAF's FPRC) had begun studies of Army units on maneuvers, many employing placebos, statistics, and the latest in quantitative clinical research methods. For instance, a Canadian infantry brigade performed a set of marches, drills, obstacle courses, and exercises lasting about thirty-six hours. The experimenters found no difference in the performance of soldiers with or without Benzedrine but concluded that the Canadians were not sufficiently exhausted. Similar studies conducted on British soil through 1942 found that

13 Winfield,"Use of Benzedrine to Overcome Fatigue on Operational Flights in Bomber Command," FPRC Report 493," record code PRO AIR 57/9, Flying Personnel Research Committee records, [1942]. In the FPRC minutes, Winfield is first noted as investigating the use of Methedrine in Bomber crews in August 1941—record code PRO AIR 57/42, August 20, 1941, 9–10. He may not yet have begun sorties on that date. On RAF interest in psychological breakdown in Bomber Command, see Mark Wells, *Courage and Air Warfare: The Allied Aircrew Experience in the Second World War* (London, 1995), 60–88; on the unofficial and official adoption of ampehtemine by the RAF, Paul K. Smith, "Trip to Philadelphia," memo, folder "Benzedrine: AML Reports," box 123, Records of Headquarters U.S. Air Force, Entry 44, RG 341, November 21, 1941, U.S. National Archives, Washington, D.C.; Alfred Newton Richards to Col. James Simmons, March 16, 1942, folder 6, box 12, Richards papers, University of Pennsylvania archives; FPRC minutes, PRO AIR 57/42, Flying Personnel Research Committee records, November 26, 1942.

the drug produced no clear advantage, and sometimes caused erratic behavior. One late 1942 study found a gain of marginal statistical significance in physical performance with Benzedrine. A carefully controlled, double-blind follow-up found no difference in efficiency between drugged and undrugged officers doing calculations and paperwork. Thus by the end of 1942, leading British scientists had few grounds to recommend amphetamine, despite a year and a half of intensive and sophisticated testing, and what evidence they had was not getting stronger.[14]

The British Army's own field trials in the combat theater, like those of the RAF, apparently carried more weight than the careful but equivocal studies of the professors. Bernard Montgomery, the North African commander from August 1942, showed special interest in Benzedrine; the pill's reputation as a "confidence drug" might have appealed to him as an antidote for his troops' wariness of Erwin Rommel, the formidable German commander. Two simple experiments in the field seem to have convinced him. One compared drugged and undrugged marching speeds of an ambulance unit. The other compared two infantry squads during fifty-six straight hours of rifle shooting, trench digging, and specialty testing (such as code signaling and machine-gun re-assembly), followed by a competitive seven-mile march. Not only did the "Benzedrine squad" win by eleven minutes in the latter study, and report feeling more energy and clearer thinking; they also displayed a "snap and zest" "conspicuously absent" in the placebo squad. No effort to ascertain equal undrugged performance was

14 Subcommittee on Analeptic Substances minutes, August 18, 1941, October 21, 1941, February 28, 1942, and June 12, 1942; A. Carmichael to A. Landsborough Thomson, September 23, 1941; D. P. Cuthbertson, "Summary of Tentative Conclusions based on 42 Ergometer Studies on Six Army Subjects," report, May 12, 1942; W. C. Wilson, "Trials of Analeptics," report, October 12, 1942; E. L. Davies (with W. Somerville), "The Effect of Benzedrine (Amphetamine) Sulphate on Marked Fatigue in Trained Troops," report, December 16, 1942; E. Lloyd Davis (with Somerville), "The Effect of Benzedrine (Amphetamine) Sulphate in Preventing Mental Fatigue in Officers Engaged in Staff Work," PRO FD1/6380, Military Personnel Resarch Committee records, February 4, 1943. On the Royal Navy, see PRO AIR 57/42, Flying Personnel Research Committee records, August 20, 1941, 9–10, November 26, 1942; on the development of clinical trial methodology, Abraham Lilienfeld, "Ceteris Paribus: The Evolution of the Clinical Trial," *Bulletin of the History of Medicine*, LVI (1982), 1–18; Harry Marks, *The Progress of Experiment: Science and Therapeutic Reform in the U.S., 1900–1990* (New York, 1997); Ted J. Kaptchuk, "Intentional Ignorance: A History of Blind Assessment and Placebo Controls in Medicine," *Bulletin of the History of Medicine*, LXXII (1998), 389–433; Rasmussen, "The Commercial Drug Trial in Interwar America: Three Types of Clinical Collaborator," *ibid.*, LXXV (2005), 50–80; Iain Chalmers, "Joseph Asbury Bell and the Birth of Randomized Trials," *Journal of the Royal Society of Medicine*, C (2007), 287–293.

described, raising obvious questions about the marching result. Nonetheless, Montgomery ordered large quantities of amphetamine for his massive offensive against the entrenched Germans at el Alamein.[15]

Montgomery's opinion of the drug's value at Alamein must have been favorable, since in November 1942, Middle East command issued standard orders authorizing amphetamine use at higher doses than those approved by the Air Council—as much as 20 mg of amphetamine per day for as many as five days straight, or half that dose for officers not physically taxed. Thus, by late 1942, the British Army, like the RAF, had adopted amphetamine use mainly on the basis of the drug's effects on "morale" as assessed by military men. Quantifiable, objective advantages for physical and psychomotor performance (perception and hand–eye coordination) remained unproven despite thorough testing by experts in England.[16]

AMERICAN RESEARCH ON, AND ADOPTION OF, AMPHETAMINE, 1940–1942 Fatigue was among the most pressing problems of military medicine under discussion by the elite scientists who convened at the hastily organized committees of the National Research Council (NRC, an arm of the Academy of Sciences), to help the U.S. government to prepare for war in mid-1940. A year later, Vannevar Bush's now-famous Office of Scientific Research and Development (OSRD)—the Federal agency created to allow him to fund university scientists for war projects—took over most of such matters. The NRC medical authorities chose physiologist Andrew C. Ivy of Chicago as their coordinator of fatigue research. He, like

15 A. M. Lester, "A Comparative Test of the Action and Relative Merits of Benzedrine and Pervitin," October 1942, and A. L. Chute, "The Action of Benzedrine on Fatigue," PRO FD1/6380, Military Personnel Resarch Committee records, October 11, 1942. [Anon], "The Use of Benzedrine in War Operations," report, July 20, 1943, folder "The Tactical Importance of Benzedrine Sulfate," box 12, Gordon Alles Papers, California Institute of Technology archives. For official aknowledgement of use at Alamein, see Q. V. B. Wallace, "The Battle of Alamein and the Campaign in Libya," in Henry Letheby Tidy and J. M. Browne Kutschbach (eds.), *Inter-Allied Conferences on War Medicine: Active Operations, June 1943* (London, 1947), 312–319. On Montgomery's worries about morale, especially with respect to Rommel, see Jon Latimer, *Alamein* (Cambridge, Mass., 2002), 98; Rick Atkinson, *An Army at Dawn: The War in Africa, 1942–1943* (New York, 2002), 419.

16 [Anon], "Notes on the Use of Benzedrine in War Operations," attached to H. J. Bensted, "Notes on Use of Benzedrine," memo, PRO WO 222/9, War Office records, December 23, 1942, United Kingdom National Archives, Kew; Body Protection Committee minutes, PRO FD1/5292, Military Personnel Research Committee records, November 27, 1942.

David Dill of the Army's Aeromedical Lab, belonged to a circle associated with the Fatigue Lab of Harvard's Business School, which emphasized the link between the psychology and biology of work. One of its basic principles was that "fatigue," in the sense of a single physical reaction to the strains that impair efficiency, did not exist. Elton Mayo, the lab's co-founder, is still famous for showing that improved morale boosted the productivity of factory workers more than better work conditions did. Ivy approached the problem of military fatigue broadly and pragmatically, taking into account psychology, physiology, and engineering factors.[17]

Ivy's initial opinions of Benzedrine's effects are evident in a review article of early 1941 in which he evaluated a large body of international experimental work on the psychological, psychiatric, and physiological effects of amphetamine, methamphetamine, and caffeine. Ivy regarded amphetamine's ability to increase wakefulness—based partly on personal experience—as unquestionable, and its psychiatric mood-elevating action as well-established. He viewed evidence that the drug improved performance in mental and psychomotor tasks as inconsistent—flawed by poor controls and by confusion between objective changes in capacity and the drug's mood effects—and as irrelevant for predicting its effects on sleep-deprived or physically exhausted individuals, because most of the studies had been conducted with rested subjects. Ivy concluded that science could not yet justify the military use of amphetamines instead of caffeine, especially in view of the amphetamine's risks, such as habit formation and unknown effects under high-anxiety combat conditions. For the next two years, he supervised intensive research about amphetamine's effects on exhausted subjects for the military.[18]

In 1941, Ivy began experiments in his own laboratory at

17 "Military Medicine" records, Series 5, Bulletin of the Subcommitee on Clinical Investigation, August 14, 1940, 10–11, National Academy of Sciences Archives (hereinafter, NAS), Washington D.C. On the OSRD and medical research, see G. Pascal Zachary, *Vannevar Bush, Engineer of the American Century* (New York, 1997), 118–145; Baxter, *Scientists Against Time*; Edwin Cowles Andrus (ed.), *Advances in Military Medicine* (Boston, 1948). Dill, "The Harvard Fatigue Laboratory: Its Development, Contributions, and Demise," *Circulation Research*, XX, Supp. I (1967), 161–170; Carleton B. Chapman, "The Long Reach of Harvard's Fatigue Laboratory, 1926–1947," *Perspectives in Biology and Medicine*, XXXIV (1990), 17–33.

18 Ivy and L. R. Krasno, "Amphetamine (Benzedrine) Sulfate: A Review of its Pharmacology," *War Medicine,* I (1941), 15–42.

Northwestern University Medical School, at first under the auspices of the NRC and later the OSRD's Committee on Medical Research's (CMR) Subcommitee on Clinical Investigation. In one early study of physical exhaustion, medical students took amphetamine, caffeine, or a placebo before doing stepping exercises while carrying a heavy burden. Despite the fact that many of those on Benzedrine reported unusual energy, Ivy found no difference in either total work output or recovery time. In a second, related study, Ivy compared the effects of caffeine, amphetamine, and methamphetamine, which the Illinois pharmaceutical company Abbott wanted to sell to the military, on another group of medical students whose baseline performance had been determined through a fixed diet and a regime on an exercise bicycle. Like Bartlett in England, Ivy again found that amphetamine neither increased total work output nor speeded recovery after exhaustion. Caffeine, however, seemed to increase total work output.[19]

Ivy also organized drug testing on men in rarefied atmospheres to advise the Army Air Force, under the banner of the NRC–OSRD Committee on Aviation Medicine. In Ivy's experiments, subjects on caffeine, amphetamine, methamphetamine, ephedrine (a close relative of the amphetamines), and, in some cases, adrenal steroids performed visual, psychological, physiological, and coordination tests at progressively altered, simulated altitudes of 5,000, 10,000, and 18,000 in a decompression chamber during a period of two hours. Ivy concluded that at pressures simulating 5,000 feet, caffeine and both amphetamines helped to reverse impaired visual discrimination. Under low air pressure, men felt better and appeared to work harder with amphetamines, even if measurable exercise capacity did not differ significantly. Strangely, even though his data were still preliminary and by no means compelling, Ivy already was prepared to endorse Benze-

19 Ivy and Dill, "Report No. 2, A Comparison of the Effect of Benzedrine (10–15 mg.), Caffeine (250 mg. Sod. Benz.) and a Placebo on Psychomotor Performance, Steadiness, Blood Pressure, Heart Rate and Mood," undated [November 1941?], Abstracts and Reports, Subcommitee on Clinical Investigation (200–201) December 15, 1941; Eliot Foltz, C. J. Barborka, and Ivy, "The Influence of Benzedrine and Pervitin upon Work Output and Recovery when Rapidly Exhausting Work is Done by Trained Subjects," "Report No. 3" ("Not an O.S.R.D. Project"), undated [1942]; Foltz, M. J. Schiffrin, and Ivy, "The Influence of Benzedrine and Caffeine on the Performance of Rapidly Exhausting Work Is by Untrained Subjects," "Report No. 4" ("Not an O.S.R.D. Project"), undated [1942], folder "Reports, Subcommitee on Clinical Investigation"; E. H. Volwiler to A. B. Hastings, March 6, 1942, Bulletin of the Committee on Aviation Medicine 490, NAS.

drine as a performance enhancer for aviators by January 1942, unfazed by the drug's habit-forming tendencies. In any case, the other scientists on the Aviation Medicine fatigue subcommittee remained unimpressed, asking Ivy to continue experiments and rejecting his endorsement pending solid evidence that showed amphetamine to be superior to caffeine at high altitudes.[20]

Ivy continued his decompression-chamber experiments through 1942, accumulating quantitative data on the effects of caffeine, amphetamine, methamphetamine, a caffeine-amphetamine combination, an amphetamine-methamphetamine blend, and dextroamphetamine (SKF's new "Dexedrine" product) from sea level to 18,000 feet. All of the drugs proved better than placebo in every test (except for hand tremor, where caffeine was actually worse than nothing). Statistical analysis indicated that differences between the drugs were largely insignificant. However, even though the quantitative evidence now showed that caffeine was about as good as amphetamines (worse for tremor and flicker discrimination, better for work output, but otherwise not different), the burden of proof had shifted by July 1942, and for reasons not specified. Now, Ivy argued, since his data showed that amphetamine was no worse than caffeine, Benzedrine could be taken by aviators for its waking effect without fear of impairing performance or judgment—regardless of the fact that no tests of the drug's effects on judgment were reported. For Ivy, amphetamine had become the "drug of choice" until proven otherwise. His reasoning remained the same in his final report on psychomotor performance at high altitudes, around the end of 1942. Here he did not even bother presenting a statistical analysis, reasoning that

20 John Fulton, "Memorandum On a Study of Drugs Useful in Aviation Medicine," Bulletin of the Committee on Aviation Medicine, [August 1941?], 277–281; Anon., "Second Survey of the CAM," Committee on Aviation Medicine Special Reports no. 38, January 1942,; Schiffrin, Ivy, and L. Paskind, "The Effects of Benzedrine, Pervitin, and Caffeine on the Response of Human Subjects under Conditions of "Anoxia" Produced by the Nitrogen Dilution Technique," Committee on Aviation Medicine Special Reports no. 10, undated [1942]; H. F. Adler, W. L. Burkhardt, and Ivy, "Detailed Report on the Effect of Benzedrine, Pervitin, and Caffeine in Maintenance of Efficiency under Ordinary Conditions and Conditions of Anoxia (Decompression Tank): A Comparison between Nitrogen Dilution and Decompression Tank Techniques," Committee on Aviation Medicine Special Reports no. 9, undated [1942], NAS. On the City College research, see "Extracts from the Diary of the Committee on Aviation Medicine of the National Research Council of U.S.A," "FPRC report no. 330," folder "Reports, Flying Personnel Research Committee," PRO AIR 57/5, Flying Personnel Research Committee records, May 28, 1941. Rasmussen, "Steroids in Arms: Hormones of the Adrenal Cortex and US Military Research, 1940–1945," *Medical History*, XLVI (2002), 299–324.

there would be no point in doing so: Since the average scores in most of the performance tests were higher with amphetamine than with caffeine, Benzedrine could hardly be worse.[21]

What shifted the burden of proof and thus allowed amphetamine to become the preferred drug for fatigue, given the absence of decisive quantitative evidence? Ivy's interim findings about psychomotor performance did not become more solid with further research. Nor were amphetamine's mood effects ever discounted as a cause of differences in certain test outcomes. Ivy had certainly not forgotten the psychiatric component: His influential mid-1942 document summarizing his research and issuing recommendations affirmed that the drug "increases confidence" and "raises morale which has suffered from fatigue and sleepiness," permitting issues like "sore feet . . . to be disregarded due to general elevation of mood." Indeed, in his recommendations that the Army use amphetamine for ground troops, based on several driving and marching trials that he conducted at domestic military bases, Ivy acknowledged the drug's subjective, "morale" effects as decisive, even favorably citing his subjects' requests about "obtaining capsules for use on other occasions, such as weekend leaves." Ivy evidently did not care whether the drug enhanced performance through its psychiatric or its physiological effects, or even whether it objectively enhanced performance at all. By the time his endorsement of amphetamine received the approval of his oversight committees in early 1943, the U.S. military was already buying it from SKF in bulk. Hence, CMR's scientific advice was unlikely to have driven that outcome. Other elements had been urging a decision favorable to Benzedrine.[22]

21 Ivy et al., "The Effect of Various Drugs on Psychomotor Performance at Ground Level and at Simulated Altitudes of 18,000 ft. "Decompression Chamber," Committee on Aviation Medicine Special Reports no. 58, July 14, 1942; Ivy et al., "OEMcmr-72 Abstract of Final Report," May 3, 1943, both in folder "reports," Committee on Aviation Medicine files, NAS. Ivy et al., "The Effect of Various Drugs on Psychomotor Performance at Ground Level and at Simulated Altitudes of 18,000 ft. in a Decompression Chamber," Report No. 14 (OEMcmr-72, final report), folder "Reports," Abstracts and Reports, Subcommitee on Clinical Investigation files, February 5, 1943, NAS.

22 Ivy, OEMcmr-72, final report. Ivy et al., "Pertaining to the Effect of B2B (dextroamphetamine) and of Preoxygenation plus B2B on the Incidence of 'Bends' and 'Incapacitating Bends and Chokes' at 40,000 ft for One Hour," Committee on Aviation Medicine Special Reports no. 113, December 23, 1942; H. W. Ryder et al.,"An Assay of Dextro-Amphetamine for Its Protective Value in Decompression Sickness," Committee on Aviation Medicine Special Reports no. 112, January 28, 1943, both in Committee on Aviation Medicine files, NAS. Ivy, "What Benzedrine Is or Does" ("Report No. 2"), folder "Reports," Ab-

The U.S. military decided to adopt amphetamine based on relatively informal research conducted by the services themselves, together with some decidedly unscientific political interventions. In December 1941, after a planning conference involving Ivy, Army officials, and several scientists on the NRC-OSRD Aviation Medicine Committee, the Army Air Force conducted a number of its own experiments at East Coast airfields and at the Aeromedical Laboratory in Ohio, where Dill worked. The Army researchers on the East Coast found that amphetamine improved the visual discrimination (as tested by the flicker-fusion technique) of airmen who were tired from four-hour flights, compared with placebo. By October 1942, they had concluded that pursuit-meter scores after several hours showed a statistically significant, slower decline with amphetamine than with placebo. The reports recommended the drug for the return leg of long flights, echoing Winfield's recommendations for the RAF Bomber Command, which were known to the Air Force. None of the Air Force studies made any effort to distinguish genuine gains in capacity from changes due to altered mood, attitude, and effort under the contrived test conditions. Nor did they include any systematic comparison with caffeine. Even so, by mid-1942, these military scientists were, like Ivy, endorsing amphetamine as the best way to alleviate a range of "fatigue" effects on performance in combat.[23]

Perhaps, as in the British military, some demand for the drug

---

stracts and Reports, Subcommitee on Clinical Investigation files, undated [1942], nas. *Idem* and R. H. Seashore, "The Effects of Analeptic Drugs in Relieving Fatigue from Prolonged Military Operations: An Advance Summary," folder "OEMcmr-46," box 15, Entry 29, Office of Scientific Research and Development records, RG 227, undated [1943?], 5 ("week-end leave" quotation), United States National Archives (Washington D.C.). Office of the Surgeon General, War Department, Circular Letter No. 58, February 23, 1943, cited in Robert Bigelow, "Benzedrine, Possible Operational Uses of in Navy and Marine Corps," July 7, 1943, Committee on Aviation Medicine Special Reports no. 183, NAS. SKF sales of Benzedrine Sulfate to the government began in Q4 1942, at $14,000, a paltry amount when compared with the more than $800,000 spent on it by the U.S. military during the war. Gordon Alles to George Piness, handwritten accounting sheet attachment, folder "Correspondence and Other Documents Relating to Accountings 1945–1947," box 6, February 15, 1946, Gordon Alles Papers.

23 Unsigned [Paul K. Smith] memo, "Field Trials of Drugs to Determine Their Effect on Tactical Efficiency and the Occurrence of Fatigue," August 15, 1941; *idem*, "Studies of the Use of Drugs in Fatigue," memo, December 15, 1941; Dill, "Conference on Pilot Fatigue and Related Problems," memo, December 24, 1941; Unsigned [Smith] memo, "Service Tests of the Use of Drugs in Fatigue," February 25, 1942; George Mason and Dill, report and attached

was emanating from the lower military echelons. Be that as it may, traditional political influence is difficult to ignore in this case. In the summer of 1942, with both the U.S. military's and Ivy's studies in mid-stream, SKF Vice President Francis Boyer informed Assistant Secretary of War John McCloy—an internationalist Republican adopted by President Franklin D. Roosevelt's adminstration to harness the interests of American industry to the war effort through his strong banking and big-business connections—that the British military were already buying Benzedrine, and urged him to follow suit. Several days later, McCloy asked the office of the Army Surgeon General to provide the War Department with information about the military use of amphetamines. A dense eight-page report, much of it sourced from the British War Office, quickly followed.[24]

Defensive in tone, this report maintained that, contrary to SKF's suggestions, the U.S. scientific elite, under the Army Surgeon General's watchful eye, had already done considerable research on amphetamine, not only for its waking effect but also for its "actual prevention of fatigue"—that is, its effects on performance. It described most of the British studies as useless because not "scientifically controlled," except for three of them deemed reliable and "useful" enough to consider, albeit inconclusive. The first was the MPRC study of Canadian infantry in January 1942 (see above), which found no significant advantage; the second, a simple sixty-seven-mile forced march said to offer strong evidence that the drug reduced the number of men unable to complete the gruelling task (25 percent in the Benzedrine group vs. 70 percent in the undrugged group), despite inadequate controls; and the third, Winfield's Coastal Command study, which endorsed amphetamine for wakefulness on long flights but did not actually measure performance. An OSRD liaison officer just returned from

memo, "Fatigue Relieving Properties of Amphetamine Derivatives," October 31, 1942, all in folder "Fatigue: AML Reports," box 123, Records of Headquarters U.S. Air Force.

24 Boyer to McCloy, July 1, 1942; C. C. Hillman to McCloy (two letters), July 3, 1942; Hillman to McCloy, "Benzedrine Sulfate" memo, July 4, 1942, all in folder 441, box 45, entry 180, records of the Assistant Secetary of War, RG 107, U.S. National Archives (Washington D.C.). For McCloy's wartime role and context, see Donald Marr Nelson, *Arsenal of Democracy: The Story of American War Production* (New York, 1946); Bruce Catton, *The Warlords of Washington* (New York, 1948); Kai Bird, *The Chairman: John J. McCloy—The Making of the American Establishment* (New York, 1992).

London was quoted as saying that the British had still not obtained conclusive results.[25]

The report also described three categories of American amphetamine studies conducted by the military and the NRC: (1) "numerous small scale studies by individual medical officers" in the services, inconclusive due to unrigorous methodology, which raised warning flags by noting frequent "idiosyncratic" subjective reactions to the drug; (2) a November 1941 study by Harvard physiologist John Talbott, finding that the drug kept Army truck drivers continuously alert for longer; and (3) Ivy's studies on students in the decompression chamber, together with some of his Army field studies. The report concluded by characterizing amphetamine as "a drug which produces both desirable and objectionable effects, the one closely balancing the other" and by calling for the results of carefully controlled studies already underway. In short, more scientific work was necessary before Benzedrine could be recommended.[26]

Ivy's studies with regular Army units at domestic bases, for which he had just requested additional funding to complete testing on vehicle drivers, moved ahead quickly at this point. The intervention by McCloy coincides, as well, with the July 1942 shift in the burden of proof in Ivy's reasoning, as noted above. Continuing his pressure, Boyer, in late July 1942, delivered to McCloy samples of the Benzedrine packets supplied to individual soldiers in Britain, and likely a report drawn up by SKF (dated only a few days prior), detailing the trial in which the "Benzedrine squad" proved its mettle with snappy marching (see above). The next week, McCloy's department twice sent memos to Bush at OSRD describing the use of amphetamines by the Germans. Bush's office replied that his agency was already studying the problem thoroughly at the Army Surgeon General's request, through the CMR.[27]

Apparently in response to McCloy's intervention, the Army

25 Hillman to McCloy, "Benzedrine Sulfate" memo.

26 *Ibid*.

27 Ivy to Andrus, folder "OEMcmr-46," box 31, entry 163, June 30, 1942, Office of Scientific Research and Development records. Boyer to McCloy, July 23, 1942; D. C. McDonald, "Memorandum for Dr. Vannevar Bush," July 31, 1942; McDonald, "Memorandum for Dr. Vannevar Bush," August 1, 1942; Bush to McDonald, August 3, 1942; Andrus to McDonald, August 5, 1942, all in folder 441, box 45, entry 180, Records of the Assistant Secretary of War. [Anon], "The Use of Benzedrine in War Operations."

Surgeon General's office drafted another synopsis of amphetamine research, based on Ivy's views—gleaned from an interview with him by scientists on CMR's Subcommitee on Clinical Investigation—and those expressed in a new British (MPRC) report (presumably the one requested upon McCloy's first query). The general tone remained cautious, even deflationary, presenting the British as favoring occasional amphetamine use under extreme conditions and Ivy as generally equating amphetamines (both Benzedrine and Pervitin) with caffeine, except for caffeine's negative effect on hand tremor and its advantage in overall work capacity at altitude (as noted above). Remarkably, the report cited caffeine and the two amphetamines as improving morale similarly by elevating mood, downplaying Benzedrine's distinctive advantage as perceived by Ivy, Winfield, and many other sources, including mainstream medical literature. It further depicted amphetamine as habit-forming, even if not outright addictive, and not appropriate for recreational use. Ivy's preliminary view was said to be that amphetamine was suitable for occasional use by exhausted troops and aviators on long bombing missions in the British manner, as well as in emergency kits, although much the same benefits were obtainable from frequent doses of caffeine. Finally, a conclusive judgment would not be forthcoming until Ivy completed his studies, presumably in late September. The scientific elite had filtered and diluted Ivy's enthusiasm for the drug, rendering a much more conservative collective judgement.[28]

While research on amphetamine continued into 1943, neither Ivy's nor any other work by American scientists quantitatively demonstrated the drug's performance superiority over caffeine (although the shift in the burden of proof had obviated the necessity). Science notwithstanding, however, the decision was already made. In September 1942, Boyer thanked McCloy for his help in securing the large order for Benzedrine that the military had just placed. He also requested all of the classified studies on Benzedrine for SKF to consult in preparing a guide to the drug's use for military medical personnel. Despite McCloy's enthusiasm, the Army Sur-

28 Roger Prentiss (Medical Corps), "Status of Information of Benzedrine and Associated Drugs" (Report No. 11), Reports, Subcommitee on Clinical Investigation, August 1942, NAS. Prentiss appears to paraphrase Ivy, "What Benzedrine Is or Does," extensively in this document.

geon General successfully resisted at least this intrusion of commercial interests into the sphere of the government's designated medical experts, indignantly denying the request. In February 1943, the Army's Supply Service announced the availability of 5mg Benzedrine sulfate "pep pills" in packets of six for individual soldiers, for issue whenever commanders saw fit, to fifteen theater commands throughout the world. A special communique went to Generals Dwight D. Eisenhower and Douglas MacArthur, commanders in the most active North African and the Southwest Pacific theaters, recommending that 100,000 packets per month be supplied immediately to them until sufficient stocks were built up. Eisenhower quickly replied, requesting 500,000.[29]

By the first half of 1943, Benzedrine tablets were supplied to the Army's ground forces and aviators. Flight crews also received the Benzedrine Inhaler, which both cleared the sinuses and, with concerted sniffing, produced significant stimulation, at a rate of two per airman on combat flying duty per year (and one per airman on non-combat flying duty). Official sources, like the U.S. Army Air Force's chief medical officer, cautioned servicemen to use Benzedrine only in special circumstances. Policy notwithstanding, special circumstances evidently prevailed; journalistic accounts, as well as one Air Force survey, indicate that Benzedrine consumption was routine both in the air and on the ground, and did not follow official usage guidelines. The Navy also adopted Benzedrine for use by the Marines, in time to use the drug during their bloody November 1943 battle for Tarawa atoll. The Navy's decision to adopt amphetamine had followed a careful placebo-controlled, statistically assessed, double-blind study, meeting the highest standards for medical research of the day. Navy scientists found no significant superiority in marksmanship (the study's main measure of performance) among amphetamine-drugged Marines after three continous days of maneuvers and exercises without sleep. The subjective effects on mood or "morale," as evidenced

29 Boyer to McCloy, September 11, 1942; McCloy to James C. Magee, September 13, 1942; Magee to McCloy, September 17, 1942, all in folder 441, box 45, entry 180, Records of the Assistant Secretary of War. [Anon], cables of February 27, 1943, from Headquarters, Services of Supply to Theater Commands; [Anon], cable "Algiers" to "War," March 2, 1943, both in folder "Benzedrine," box 85, entry 30, Records of the Surgeon General's Office, RG 112, U.S. National Archives (Washington, D.C.).

by the "devil-take-the-hindmost" attitude of Benzedrine-charged Marines reported in this study, must have recommended the drug to Navy leadership (despite evidence of hallucination and impaired judgment).[30]

Although the American and British military were each able to draw on expertise of the highest caliber to evaluate whether amphetamine improved physical and mental performance in fatigued subjects, science never offered unequivocal grounds for preferring the new drug over caffeine. Amphetamine's effects were too variable, and the differences too marginal. Indeed, available evidence indicated that caffeine was about as good in flight and marching tests, and as effective in preventing sleep if taken often enough. However, around mid-1942, when the British military adopted the drug based on its own assessments, the American scientists took the view that so long as Benzedrine did not make performance objectively worse, the military should use it. The rationale for this twist in logic was never committed to paper. Clearly, however, the military on both sides of the Atlantic (whose own testing seldom compared the new drug to caffeine) was always interested in amphetamine's effects on "morale" as much as on its quantifiable, objective effects on psychomotor performance as carefully assessed by scientists. These subjective effects were consistently noted in reports—the aggressive bombing into the teeth of blazing

30 G. Ledfors to Surgeon General's Office Requirements Division, folder 441, September 23, 1943, and A. T. Beisner to Commanding General, Air Surgeon's Office, folder 440-440.-1, box 83, entry 30, November 27, 1944; R. Carpenter to Commanding General, Army Air Forces, folder "Drugs," box 116, entry 44, December 2, 1944, both in Records of the Surgeon General's Office; Sydney Waud, "The Effects of Toxic Doses of Benzyl Methyl Carbinamine (Benzedrine) in Man," *Journal of the American Medical Association,* CX (1938), 206–207; Office of the Air Surgeon, "Benzedrine Alert," *Air Surgeon's Bulletin,* February 1944 (no pagination); Don Hart, memo "Fatigue and Morale Problem of Fighter Pilots," folder "Fatigue: AML Reports," box 123, entry 44, May 28, 1945, Records of Headquarters U.S. Air Force. For the Marines, see E. L. Corey and A. P. Webster, "Field Study of the Effects of Benzedrine on Small Arms Firing Under Conditions of Acute Fatigue," folder X120, box 8, Aviat[ion] F6–2, RG 52, June 2, 1943, Records of the Naval Bureau of Medicine and Surgery, Records of the Research Division, Terminated Medical Research Project Reports File, 1940–66, U.S National Archives (Washington, D.C.). This report gives quantitative grounds for preferring amphetamine to a placebo, based not on marksmanship but "fire power," or rate of hits "near the target center," an obviously post-hoc measure of questionable miltary value for amphibious operations, in which ammunition supply is often limited. Thanks to Alan Dericksen for relocating this report in the National Archives.

flak described by Winfield, the "snap and zest" described in the British North Africa studies, the neglect of "sore feet" due to elevated mood noted by Ivy, and the "devil take-the-hindmost" attitude of drugged Marines.

On the American side, no experts or military officials ever questioned or restricted use of amphetamine after intial approval and distribution of the drug. Military purchases of amphetamine tablets from SKF remained strong through the second quarter of 1945, and resumed as soon as the Korean conflict flared. This continuing American enthusiasm for amphetamines stands in strong contrast to the case of the German military, who by the end of 1940 sharply cut their military consumption of Pervitin, and in 1942 officially restricted both methamphetamine and amphetamine as dangerously addictive narcotics. It also contrasts with developments in Britain, where opinion about the drug in military (at least RAF) circles increasingly cooled as the dark days of the Blitz receded. As a 1943 Air Ministry advisory to medical officers put it, "Benzedrine has the effect of causing the individual to feel on top of things and able to carry on with his duties without rest: he feels that he is doing well, when in fact he is making all sorts of mistakes." By the end of the war, RAF researchers had concluded that enough Benzedrine reliably to affect performance on tests like the pursuit meter was enough to impair judgment. Furthermore, mistakes in combat flying were caused (as Davis, an RAF scientist, put it in a publication summarizing war research) by "anxiety, rather than prolongation of work and fatigue," so that attributing them to fatigue was sheer confusion; and in any case "the benefits claimed for the drug are obtained by training and by other measures that lead to good morale." By implication, some military men were so "confused" as to use the drug to raise "morale," and to counteract behavioral deficiencies related to fear in combat.[31]

31 Alles, handwritten accounting sheet attached to Piness, folder "Correspondence and Other Documents Relating to Accountings 1945–1947," box 6, February 15, 1946, Alles Papers. The military began purchasing Dexedrine for the Korean conflict in 1950: [Anon], "Summary of Royalties Payable and Amounts Paid," folder "SKF v Alles: Documents Received from Alles Office," box 2, 1955, Alles Papers. Steinkamp, "Pervitin Testing"; Wolf Kemper, "Pervitin—Die Endsieg-Droge," in Werner Pieper (ed.), *Nazis on Speed: Drogen im Drittten Reich* (Lohrbach, 2003), 122–133; Hartmut Noeldeke, "Einsatz von Leistungssteigernden Medikamenten," *ibid.,* 134–142; Anonymous Air Ministry pamphlet, "Notes on the Prevention of Fatigue in Flying Personnel," PRO AIR 57/10, June 1943 (reprint of September 1943), Flying Personnel Research Committee records; F. H. K. Green and Gordon Clovell, *History of the Second World War: Medical Research* (London, 1953), 21–22, 38. D. Rus-

This critique seems to fit the Americans. It might not be too extreme to describe the "fatigue" rationale for the U.S. military's use of amphetamine as a cynical charade. Science merely cloaked the use of amphetamine for morale purposes—to induce aggression and raise confidence—with elaborate but inconclusive studies on psychomotor performance, except to the extent that the "confusion" to which Davis referred was sincere (as in Ivy's case, it surely was not). Here we enter uncertain territory, as available sources do not allow a survey of the circumstances and thinking that drove Benzedrine usage in action. As noted, American psychiatrists like Grinker adopted euphemisms such as "operational fatigue" and "combat fatigue" for the official terms "psychoneurotic breakdown" and "war neurosis," to reduce friction with the military hierarchy and to avoid stigmatizing their patients at the front. But even for them, this euphemism was actually half true; "battle fatigue" was "about 50% fatigue and 50% emotional illness," according to wartime authorities Hastings, Wright, and Glueck. This was a "confusion" that the psychiatrists cultivated and to some extent shared.[32]

Commonsense medical thinking during the war assumed a basic glandular connection between physical fatigue and emotional breakdown. As Kardiner explained, if Cannon's adrenaline-fired fight-or-flight state became chronic—as it generally did on the front—the constant arousal would exhaust both nervous system and psyche to produce war neurosis. Respite away from the front could prevent or reverse the anxiety and irritability that marked the early stages of war neurosis, but if such early warnings in the mildly "flak-happy" man were ignored, psychomotor retardation and apathy could ensue. These were all also the key signs of depression.

American medical experts like Kardiner, field psychiatrists like Grinker and Hastings, and Army corpsmen like Andersen—who saw countless men grow disoriented, weepy, and dangerously

---

sell Davis, "Psychomotor Effects of Analeptics and Their Relation to 'Fatigue' Phenomena in Air-Crew," *British Medical Bulletin,* V (1947), 43–45 (quotation on 44).

32 David W. Hastings, Donald G. Wright, and Bernard C. Glueck, *Psychiatric Experiences of the Eighth Air Force* (New York, 1944), 5–6; Frederick R. Hanson, "The Factor of Fatigue in the Neuroses of Combat," in *idem* (ed.), *Combat Psychiatry: Experiences in the North African and Mediterranean Theatres of Operation, American Ground Forces, World War II* (Washington, D.C., 1949), 147–150; Grinker et al., "A Study of Psychological Predisposition."

apathetic during his four years in the Pacific—all viewed "combat fatigue" as a depressive condition. Thus, one sensible remedy for it was Benzedrine—the synthetic adrenaline, the first and only antidepressant, and the only drug recommended for depression in U.S. military medical manuals—to bolster adrenaline pathways and to keep soldiers fighting until rest was possible. Presumably, for this very reason, psychiatrist Moses Kauffman, having just read Grinker's report on "operational fatigue," packed his luggage with Benzedrine when he shipped off to the combat zone. Moreover, it was hardly an accident that in a 1944 medical journal advertisement for Benzedrine featuring combat troops, SKF chose the title, "When the Going Gets Tough," exactly echoing U.S. Army medical training materials describing situations likely to produce high levels of neuropsychiatric casualties in forward areas (see Figure 2). The clear implication is that Benzedrine use in such situations was appropriate and helpful.[33]

Perhaps research in wartime diaries, especially those of medical personnel at the front, will reveal how eager soldiers were to take amphetamine not just to relieve drowsiness but also to allieviate "jitters" or anxiety in combat, and how medical thinking about adrenaline's role in "combat fatigue" figured in the distribution and usage of the drug. Conceivably, these primary sources could also shed some light on the speculation that amphetamine usage may have contributed to the savagery that historians of World War II have only lately begun to discover. For example, the sudden feeling of invincibility and the cool but overwhelming urge to kill that Overton, a Marine medic, first felt one night in

33 Kardiner, *Traumatic Neuroses,* 27; Grinker and Spiegel, "Brief Psychotherapy"; Roy Laver Swank, "Combat Exhaustion," *Journal of Nervous and Mental Diseases,* CIX (1949), 475–508; Dean Andersen, *Praise the Lord and Pass the Penicillin: Memoir of a Combat Medic in the Pacific in World War II* (Jefferson, N.C., 2003), 143, 169. Edward G. Billings and The Subcommittee on Clinical Psychiatry, "A Brochure for Medical Officers on the Recognition, Prevention, and Treatment of Personality Disorders in Soldiers," Reports, Subcommitee on Psychiatry, NRC Committee on Neuropsychiatry files, March 14, 1941, Committee on Medical Research Records; Shephard, War Of Nerves, 224. See also Army training film, *Combat Exhaustion,* Department of the Army, Office of the Chief Signal Officer, Department of Defense, ARC Identifier 35906/Local Identifier 111-M-1197, National Archives and Records Administration (http://www.archive.org/details/gov.archives.arc.35906, viewed August 10, 2010). In Reel 1, a psychiatry specialist says to medical officers in training, "In prolonged engagements where the going is really tough, we find that 30 to 50 percent of all men coming under your care . . . are suffering from combat exhaustion."

Iwo Jima, must have had something to do with his heavy Benzedrine consumption at the time. In this connection, Andersen provides an intriguing clue as to how excessively violent behavior figured in the wartime medical imagination. One day in Leyte, after the medic's unit decimated a small Japanese detachment, a particularly enthusiatic eighteen-year-old gleefully shot his final staggering, unarmed opponent point blank in the face. "Kill happy," judged an aghast Andersen, a condition that he viewed as the polar opposite of depressive "battle fatigue"—that is, a mania related to excess adrenaline action.[34]

Speculations on battlefield drug experience aside, there are solid reasons to regard the adoption of amphetamine for relatively unrestricted military use as a foreseeable (indeed, foreseen) mistake. The U.S. military was well aware during the war that servicemen were not taking Benzedrine strictly as directed in combat and that they were also taking it recreationally. A study by Army psychiatrists at the end of the war found strong evidence that officially sanctioned amphetamine use had caused serious abuse of the drug among soldiers during the war (and presumably among veterans afterward), confirming fears expressed by Ivy himself in 1941. But whatever the impact of Benzedrine use, the Allied—and especially American—embrace of the drug casts the wartime participation of scientific elites in an unaccustomed light. The prevailing idea has been that independent scientific expertise has provided the American government a mere rubber stamp for decisions made on other grounds only since the 1970s. Yet, the amphetamine story underscores the limits of science's influence even at its storied wartime peak: Mainstream scientific opinion was always that amphetamine was not warranted for military use in the absence of objective evidence for its superiority over caf-

34 John Dower, *War without Mercy: Race and Power in the Pacific War* (New York, 1986); Peter Schrijvers, *The GI War Against Japan: American Soldiers in Asia and the Pacific during World War II* (New York, 2002); J. Robert Lilly, *Taken by Force: Rape and American GIs in Europe During World War II* (London, 2007); Andersen, *Praise the Lord and Pass the Penicillin*. 143; Richard Overton, *God Isn't Here: A Young American's Entry Into World War II, and His Participation in the Battle for Iwo Jima* (Clearfield, Utah, 2004), 251; for Overton's understanding of combat fatigue and its relationship to physical exhaustion and adrenaline, 202, 215, 271. Even Albert Cowdry, *Fighting for Life: American Military Medicine in World War II* (New York, 1994), 136, unconsciously and uncritically adopts the "fight or flight" concept of the medical men that he studied.

feine, because of its potential for abuse and its behavioral side effects. But science eventually had to capitulate to a decision evidently made on the usual grounds of military expedience and economic interest (as mediated, the evidence strongly suggests, by direct political intervention). Like all others, this war ultimately belonged not to the scientists but to the generals, the politicians, and—in America perhaps more than elsewhere—the businessmen.[35]

35 Don Hart, memo "Fatigue and Morale Problem of Fighter Pilots," folder "Fatigue: AML Reports," box 123, entry 44, May 28, 1945, Records of Headquarters U.S. Air Force, United States Naval Academy; Theodore Wallace to Alles, folder "SKF v Alles: Documents Requested by SKF on Disclosure," box 7, June 22, 1943, Alles papers; Russell Monroe and Hyman Drell, "Oral Use of Stimulants Obtained from Inhalers," *Journal of the American Medical Association,* CXXXV (1947), 909–915. On postwar abuse of amphetamine in the United States, see Charles O. Jackson, "The Amphetamine Inhaler: A Case Study of Medical Abuse," *Journal of the History of Medicine and Allied Sciences,* XXVI (1971), 187–196; Rasmussen, "America's First Amphetamine Epidemic 1929–1971: A Quantitative and Qualitative Retrospective with Implications for the Present," *American Journal of Public Health,* XCVIII (2008), 974–985; *idem, On Speed: The Many Lives of Amphetamine* (New York, 2008), 87–112. Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge, Mass., 1990). Bush's OSRD contravened its own explicit pro-science policy in favor of business interests on other occasions. See Rasmussen, "Of 'Small Men' Big Science and Bigger Business: The Second World War and Biomedical Research in the United States," *Minerva,* XL (2002), 115–146. The evidence suggests that the OSRD was far friendlier to business interests than the War Production Board was when their authority overlapped. See Peter Neushul, "Science, Technology, and the Arsenal of Democracy: Production Research and Development during World War II," unpub. Ph.D. diss. (University of California, Santa Barbara, 1993).