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# Effects of Behavioral Intervention Content on HIV Prevention Outcomes: A Meta-Review of Meta-Analyses

Blair T. Johnson, PhD,\* Susan Michie, DPhil,† and Leslie B. Snyder, PhD‡

**Objective:** Numerous meta-analyses have examined the success of trials of interventions to reduce the behavioral risk of acquiring or transmitting HIV. Yet, to date, meta-reviews have not systematically examined which type of intervention content is more likely to lead to successful HIV outcomes. The current study addresses this gap.

**Methods:** Published meta-analyses on HIV prevention ( $k = 56$ ) were retrieved, then coded, and analyzed in terms of the intervention content.

**Results:** Past meta-analyses have examined relatively few dimensions of intervention content. Larger meta-analyses were more likely to find that information content dimensions, especially skill provision and motivational enhancement, relate to risk reduction.

**Conclusions:** Fully incorporating behavior change technique (BCT) taxonomies into both intervention research and systematic reviews of this research offers considerable potential. It can improve the precision of conclusions about which specific types of content best promote HIV prevention behaviors and help to lower the cost of interventions. International efforts to improve reporting standards and generate the scholarly expertise necessary to discern BCTs reliably and validly help to address some of the challenges to including BCTs in study reports. Contextualizing research on effective strategies for HIV prevention by reporting and including in analyses community, social, and sample factors is also recommended. Together, such efforts can help refocus the field of HIV prevention on improved research strategies to further improve future interventions by discerning the content design factors related to success for particular populations, rather than merely to assess whether interventions have been successful.

**Key Words:** communication strategies, intervention content, HIV risk reduction, HIV care and AIDS care, meta-review, meta-analyses

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From the \*Department of Psychology, University of Connecticut, Storrs, CT; †Department of Clinical, Educational and Health Psychology, University College London; and ‡Department of Communication, University of Connecticut.

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Correspondence to: Blair T. Johnson, PhD, Department of Psychology and Center for Health, Intervention, and Prevention, 2006 Hillside Road, Unit 1248, University of Connecticut, Storrs, CT 06269-1248 (e-mail: blair.t.johnson@uconn.edu).

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## INTRODUCTION

Successful communication efforts hinge on many factors, not the least of which is message content. Knowing the specific content responsible for behavior change should help design optimal interventions to achieve behavior change goals, such as reducing sexual risk, averting HIV infections, and improving adherence to antiretroviral drugs for those living with HIV. Knowing the particular elements of communications that are used in a study facilitates replication in scientific studies, promotes high-quality syntheses of evidence, and aids the implementation of successful interventions in communities.

Many problems have impeded clear knowledge to explain why some communication-based interventions succeed and others fail. As several scholars have concluded, the main problems are that, in scientific reports, methodological statements describing the content of the intervention have often omitted critical details,<sup>1</sup> interventions commonly confound different communication elements,<sup>2</sup> descriptions of control condition communication content have been even more cursory than those of interventions,<sup>3</sup> sample biases may be inadequately described, and, because of the foregoing problems, subsequent studies can only partially replicate the methods of a prior trial.<sup>4</sup> It is little wonder that the results of health promotion trials vary widely, with unknown sources of heterogeneity.<sup>5</sup> These concerns typify fields related to behavior change, including HIV risk reduction and improving adherence to drug therapy.

From the earliest meta-analyses related to HIV risk, scholars have taken an interest in which dimensions are actively responsible for the behavior change that resulted from interventions. This interest notwithstanding, meta-reviews have focused more on whether HIV prevention interventions significantly decrease risk behavior and for whom<sup>5,6</sup> rather than on intervention content dimensions that might be related to success. Increased attention to the content of interventions and mechanisms of behavior change can be seen as a sign of progress in the field: Greater understanding logically translates into improved future interventions and more cost-effective translation of research. Enough meta-analyses focused on behavioral strategies to reduce HIV risk exist to conduct a systematic meta-review—a meta-analysis of meta-analyses—on this subject. Our meta-review offers an assessment of the state of the science on how intervention content relates to HIV risk reduction. In our Discussion, we address limitations of the meta-review, make recommendations for future intervention trials and for meta-analyses of these trials, comment on meta-analyses focused on adherence to antiretroviral therapy (ART), and

propose the use of formal, comprehensive taxonomies in future HIV intervention trials and relevant meta-analyses.

## METHODS

We relied on the sample of 56 psychological, social, or behavioral HIV prevention meta-analyses from Johnson et al,<sup>7</sup> August, 2013, which was 1 of 3 domains sampled in a meta-review focused on how meta-analyses of health promotion literature have incorporated dimensions of methodological quality in drawing conclusions about efforts to promote health. (See that report for a description of the search procedures.) Meta-analyses qualified for this HIV prevention sample if they focused primarily on a psychological or social strategy to reduce the behavioral risk of transmitting or acquiring HIV in human samples. We coded each meta-analysis for its (1) publication type (journal vs. dissertation); (2) report date; (3) date of search for studies (estimated for the 5 meta-analyses that did not report it as 2 years before the report date); (4) number of included studies (*k*), defined as independent databases; (5) number of intervention content dimensions used in results, which is underestimated in the case of 4 reports<sup>8–11</sup> that implied having coded other dimensions but did not report them; (6) results relating intervention content dimensions to intervention efficacy, which is typically tested in meta-analyses by treating intervention content dimension in subgroup analyses, as a moderator of intervention exposure on intervention outcomes; and (7) impact factor, defined as number of Google Scholar citations (as of August 2013) per year since the report date. An intervention content dimension was operationalized as a type of message or activity or a stated strategy about messages or activities undertaken in the intervention, such as providing information or facts, assessing personal risk, or teaching behavioral skills. Analyses used Stata statistical software, version 13.1; a *t* test assumed unequal variances.

## RESULTS

Table 1 summarizes the date of each meta-analysis, the topic, the end dates for its literature search (which approximates when the databases were completed), how many studies each included, how many intervention content dimensions were evaluated in subgroup analyses (also called moderation patterns), and what these patterns were, if any. The meta-analyses appeared between 1993 and 2013 and have been appearing at an accelerated pace with the passing of time ( $r = 0.55$ ,  $P = 0.03$ ). All were published in journals except for 1 dissertation. The meta-analyses have had widely varying rates of citations (median = 7.55 citations per year; range: 0–91 citations per year). The meta-analyses reviewed diverse topics related to risk reduction, although nearly all meta-analyses focused on sexual risk for HIV; 4 focused either on injection needle risk or on drug users. Most ( $k = 37$ , 66%) restricted samples to a geographical area and/or to a particular target population. End dates for searches were as early as 1991 and as recent as 2012. The meta-analyses summarized between 2 and 354 studies (median = 27.5, mean = 44.41), which were typically controlled interventions. The meta-analyses reported examining between 0 and 18 intervention

content dimensions (median = 4); 19 (34%) examined no such dimensions at all. Qualitatively, meta-analyses most often labeled intervention content or persuasive arguments; 1 meta-analysis used the term behavior change technique (BCT) but only in its introduction.<sup>13</sup> No meta-analysis used a formal BCT taxonomy. A few meta-analyses focused on a particular intervention content dimension, such as motivational interviewing<sup>15</sup> or eroticization of safer sex.<sup>59</sup>

Neither more recent meta-analyses nor more impactful meta-analyses examined significantly more intervention content dimensions ( $r$  values =  $-0.04$  and  $-0.07$ ,  $P$  values = 0.78 and 0.61, respectively). Meta-analyses sampling more studies examined significantly more intervention dimensions ( $r = 0.33$ ,  $P < 0.05$ ). Figure 1 plots the number of intervention content dimensions reported as a function of date of database construction. Regardless of date, intervention content was unlikely to be considered in meta-analyses with small samples of studies. Of those including fewer than 36 studies, 51% evaluated no intervention content dimensions; of those with more than 35 studies, all but one evaluated at least one aspect of intervention content. Figure 1 represents the 12 (20%) most highly cited meta-analyses with solid circles; of these, only 2 (8%) examined more than 10 content dimensions and 4 (33%) examined none. Of the 37 meta-analyses that considered at least one dimension of intervention content, 23 (62%) found that at least one related significantly to risk reduction. Meta-analyses that examined more information content dimensions and that included larger samples of studies were more likely to find significant moderation patterns ( $r$  values = 0.47 and 0.45, respectively,  $P$  values  $< 0.001$ ). In 1 larger meta-analysis, the authors reported lack of detail in source reports as an impediment to examining intervention content.<sup>62</sup> Meta-analyses that found at least one information content dimension relating significantly to risk reduction had much larger samples of studies than did those that examined content but found no such patterns (mean values = 77.13 and 21.61, respectively,  $t = 2.75$ ,  $P < 0.01$ ), a pattern that remained intact when the meta-analysis with the largest sample was omitted. As for specific intervention content dimensions, there was insufficient overlap in coding across meta-analyses to conduct a quantitative assessment of the relationship between intervention content dimension and intervention effectiveness. (When reports do not code for a particular type of intervention content, it is unknown whether that type of intervention content was not present in the original studies or present but not coded.) Qualitatively, there were multiple meta-analyses that found that teaching skills (including behavioral, communication, and psychological skills) and motivational enhancement (eg, attitudinal arguments, motivational interviewing) often were associated with greater risk reduction behaviors (Table 1).

## DISCUSSION

### Role of Information Content in HIV Risk Reduction

Numerous meta-analyses have evaluated the efficacy of psychological, social, and behavioral interventions to reduce

**TABLE 1.** Meta-Analyses of HIV Prevention Trials and the Extent to Which They Have Coded and Examined IC, Including Relevant Results, if Any

Meta-Analysis	Topic and End Date for Search*	k†	No. ICs in Results‡	Significant Moderator Results for IC§
D. Albarracín et al <sup>12</sup>	Interventions promoting condom use using verbal, written, or visual communication strategies without other components, 1998	72	9	Messages that presented attitudinal information and modeled behavioral skills led to increased condom use
D. Albarracín et al <sup>13</sup>	Behavioral interventions focused on increasing condom use, 2003	354	10	Interventions were more successful with attitudinal arguments, educational information, behavioral skill arguments, and behavioral skill training; least successful was inducing fear of HIV
J. Albarracín et al <sup>14</sup>	HIV prevention interventions for samples with varying percentages of Latinos and Latin Americans, 2005	142	10	Only threat-inducing strategies were associated with increased condom use in samples with more Latinos/Latin Americans
Berg et al <sup>15</sup>	Behavioral interventions adapting motivational interviewing for HIV risk behaviors in samples of MSM, 2009*	10	0	None, but selection criteria used IC
Burke et al <sup>16</sup>	Trials investigating adaptations of motivational interviewing, 2001	2	0	None, but selection criteria used IC
Carvalho et al <sup>17</sup>	Behavioral interventions to promote condom use among women living with HIV, 2010*	5	0	None
Chin et al <sup>18</sup>	Group-based comprehensive risk reduction and abstinence education interventions to prevent or reduce the risk of adolescent pregnancy, HIV, and STIs, 2007	62	4	NS
Copenhaver et al <sup>19</sup>	Behavioral HIV risk reduction among people who inject drugs, 2004	37	3	Equal emphasis on injection and sexual risk behaviors was more successful at decreasing injection risk (no IC reported significant for sexual risk); ICs not predicting risk were not reported
Crepaz et al <sup>20</sup>	Behavioral interventions for HIV risk behavior for PLWHA, 2004	12	2	NS
Crepaz et al <sup>21</sup>	Behavioral interventions to reduce HIV risk sex behaviors and incident STIs in Black and Hispanic STI clinic patients in the United States, 2005	18	9	Ethnically matching improved sex risk behavior but others did not; ICs were included in “intervention features”
Crepaz et al <sup>22</sup>	HIV/STI behavioral interventions for African-American females, 2007	37	6	Greater efficacy with gender- or culture-specific materials, addressing empowerment issues, providing skill training in condom use, negotiation of safer sex, and role playing to teach negotiation skills; ICs for empowerment collapsed across salient categories (eg, gender or racial empowerment)
Cross et al <sup>23</sup>	Educational and needle exchange program for injecting drug users, 1995	26	0	None
Darbes et al <sup>24</sup>	Behavioral interventions for HIV risk behaviors and STIs in heterosexual African-Americans, 2005	38	6	On average interventions succeeded for trials with some ICs compared with those that lacked these; no moderator tests were presented
Denison et al <sup>25</sup>	HIV voluntary counseling and testing and behavioral risk reduction in developing countries, 2005	7	0	None
Durantini et al <sup>26</sup>	Condom promotion interventions with information about the interventionists, 2003	224	10	See results for Albarracín et al <sup>12</sup> ; this report focused on communicator dimensions
Earl and Albarracín <sup>27</sup>	Interventions promoting condom use, 2005	199	9	Fear-inducing arguments increased perceptions of risk at early FUPs but decreased knowledge and condom use; resolving fear via HIV counseling and testing decreased perceptions of risk and increased knowledge and condom use at both the immediate and delayed FUPs
Eaton et al <sup>8</sup>	Single-session behavioral interventions to prevent sexually transmitted infections, 2011	20	≤4	No moderator results for ICs were presented; methodological details for ICs do not appear in the report

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**TABLE 1.** (Continued) Meta-Analyses of HIV Prevention Trials and the Extent to Which They Have Coded and Examined IC, Including Relevant Results, if Any

Meta-Analysis	Topic and End Date for Search*	k†	No. ICs in Results‡	Significant Moderator Results for IC§
Fonner et al <sup>63</sup>	Voluntary counseling and testing for changing HIV-related risk behavior in developing countries, 2010	8	0	None
Healton and Messeri <sup>28</sup>	Video vs. other modes of communication to educate STI patients, 1991*	8	0	None
Henny et al <sup>29</sup>	HIV/STI behavioral interventions for heterosexual African-American men, 2008	44	12	ICs promoting protection of family and others and ICs matched to gender succeeded in lowering risk better than those that lacked these foci; final comprehensive model in report does not mention ICs
Herbst et al <sup>30</sup>	Behavioral interventions for reducing sexual risk behavior in MSM, 2003	33	3	NS (3 forms of skill training)
Herbst et al <sup>31</sup>	Behavioral interventions to reduce HIV risk behaviors of Hispanics in the United States and Puerto Rico, 2006	20	9	ICs promoting problem-solving skills, discussions of barriers to condom use, discussions of sexual abstinence, or use of peer norms to encourage behavior change, all reduced risk
Huedo-Medina et al <sup>32</sup>	Behavioral interventions for reducing sexual risk behavior in Latin American and Caribbean nations, 2008	28	12	ICs focused on behavior and sociocultural aspects succeeded better
BT Johnson et al <sup>33</sup>	Behavioral interventions for reducing sexual risk behavior in adolescents, 2000	44	8	ICs focused on condom skill training and HIV skill training reduced risk for intervention; generic sex education for controls was associated with increased risk relative to intervention groups; it is implied that other coded ICs did not predict risk reduction
BT Johnson et al <sup>34</sup>	Behavioral interventions for HIV risk behavior for PLWHA, 2004	15	3	Including all 3 ICs for information, motivation, and behavioral skills was associated with increased condom use
BT Johnson et al <sup>35</sup>	Behavioral interventions for reducing sexual risk behavior in adolescents, 2008	67	5	Abstinence focus decreased efficacy as gauged by sexual frequency outcomes; dosage of ICs dedicated both to condom skill training and motivational training increased efficacy as gauged by condom use; it is implied that other coded ICs did not predict risk reduction
BT Johnson et al <sup>36</sup>	Behavioral interventions to reduce sexual risk for African-Americans, 2006	78	8	Intrapersonal skill training improved short-term condom use, whereas tailoring and interpersonal skill training improved long-term condom use. Counseling and testing were associated with worse long-term outcomes; it is implied that other coded ICs did not predict risk reduction
WD Johnson et al <sup>37</sup>	Behavioral interventions to reduce risk for sexual transmission of HIV among MSM, 1998	9	5	None, homogeneity among results precluded moderator models
WD Johnson et al <sup>38</sup>	Behavioral interventions to reduce risk for sexual transmission of HIV among MSM, 1998	13	1	None, homogeneity among results precluded moderator models
WD Johnson et al <sup>39</sup>	Behavioral interventions to reduce risk for sexual transmission of HIV among MSM, 2004	40	3	NS (losses, perceived risk, personal skills)
WD Johnson et al <sup>40</sup>	Behavioral interventions to reduce risk for sexual transmission of HIV among MSM, 2007	44	12	NS; in one model, for small group and individual-level interventions, controlling for non-ICs left the ICs NS
Kalichman et al <sup>41</sup>	Theory-based behavioral interventions to reduce risk of HIV, 1994*	12	0	None but qualitatively mentioned “central components” of risk education, risk sensitization, self-efficacy building, and skill training
Kaufman et al <sup>42</sup>	Trials that evaluated sports-based HIV prevention, 2011	21	0	None
Kennedy et al <sup>43</sup>	Behavioral interventions for HIV-positive prevention in developing countries, 2006	18	0	None
LaCroix et al <sup>44</sup>	Behavioral interventions to reduce sexual risk for HIV in heterosexual couples, 2012	29	7	Including condom skill training with the partner was associated with larger condom use effect sizes; it is stated that other coded ICs did not predict risk reduction

**TABLE 1. (Continued) Meta-Analyses of HIV Prevention Trials and the Extent to Which They Have Coded and Examined IC, Including Relevant Results, if Any**

Meta-Analysis	Topic and End Date for Search*	k†	No. ICs in Results‡	Significant Moderator Results for IC§
Lennon et al <sup>45</sup>	Behavioral interventions focused on women in trials with depression outcomes, 2010	10	10	Trials with condom information, active treatment components, and counseling and testing succeeded better at decreasing sexual risk; not explicitly stated whether other coded ICs predicted risk reduction
Levin <sup>46</sup>	Behavioral interventions targeting adolescents, 1999	58	2	Including condom information increased HIV prevention knowledge; interpersonal skill training was associated with increased self-efficacy; these ICs were unrelated to risk behaviors
Logan et al <sup>47</sup>	Behavioral interventions for high-risk heterosexual adult populations, 2000*	30	5	Including either cultural race components or social and contextual factors increased condom use; cultural race components decreased number of partners
Lyles et al <sup>9</sup>	High-quality behavioral interventions for US populations at high risk, 2004	18	≥13	None
Meader et al <sup>48</sup>	Psychosocial interventions for reducing injection and sexual risk behavior for preventing HIV, 2006	35	0	None
Medley et al <sup>49</sup>	Peer education interventions for HIV prevention in developing countries, 2006	28	0	None
Michielsen et al <sup>50</sup>	Behavioral interventions to HIV transmission by reducing sexual risk taking for youth in sub-Saharan Africa, 2009	28	0	None
Mize et al <sup>51</sup>	HIV prevention interventions used to affect outcomes relevant to HIV/AIDS risk behavior in women, 2007	24	0	None
Mullen et al <sup>52</sup>	Behavioral interventions for sexually experienced adolescents in controlled studies in the United States, 1998	16	5	Only technical skills with practice were associated with greater risk reduction
Neumann et al <sup>53</sup>	Behavioral interventions for heterosexual adults in the United States, 1996	14	5	None; because of homogeneity, no models were conducted
Noar et al <sup>54</sup>	Communication about condom use and other risk-relevant dimensions, 2003	55	0	None
Ojo et al <sup>55</sup>	Interventions to reduce high-risk sexual behavior delivered in an occupational setting, 2010	7	0	None; no moderator models were applied to effect sizes because small k precluded such analyses
Ota et al <sup>56</sup>	Behavioral interventions in high-income countries to reduce the transmission of HIV infection among sex workers and their clients, 2010	4	0	None
Prendergast et al <sup>57</sup>	Behavioral interventions within drug abuse treatment programs, 1998	18	18	Didactic lectures, self-control skills, and peer group counseling were associated with sexual risk reduction
Scott-Sheldon et al <sup>58</sup>	HIV/STI risk reduction interventions for patients attending sexually transmitted disease clinics in the United States, 2009	32	10	Targeted interventions succeeded in increasing condom use; motivation and skill provision resulted in lowered efficacy on earlier FUPs; motivation improved efficacy on intermediate FUPs; it is implied that other ICs were not significantly related to effect size magnitude
Scott-Sheldon and Johnson <sup>59</sup>	Educational, psychological, social, and behavioral interventions advocating sexual risk reduction and including safer sex eroticization, 2005	21	8	None, no moderator analyses were conducted; this meta-analysis used IC in selection criteria
Semaan et al <sup>60</sup>	Behavioral risk reduction as a means of prevention for drug users, 1998	33	15	None, no moderator analyses were conducted
Smoak et al <sup>10</sup>	Behavioral interventions to reduce sexual risk for HIV, 2003	174	≥6	Including information, motivational, and skill components was associated with decreased frequencies of sexual behavior

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**TABLE 1.** (Continued) Meta-Analyses of HIV Prevention Trials and the Extent to Which They Have Coded and Examined IC, Including Relevant Results, if Any

Meta-Analysis	Topic and End Date for Search*	k†	No. ICs in Results‡	Significant Moderator Results for IC§
Tan et al <sup>11</sup>	HIV/AIDS prevention interventions in Asia, 2009	46	≥3	Providing trans-situational motivational strategies was associated with better condom use; condom skill training was associated with lower sexual frequencies; it is implied that other coded IC dimensions were not significantly related to effect size magnitude (these were not described)
Wariki et al <sup>61</sup>	Behavioral interventions to reduce the transmission of HIV infection among sex workers and their clients in low- and middle-income countries, 2010	13	0	None
Weinhardt et al <sup>62</sup>	HIV counseling and testing and sexual risk behavior, 1997	27	0	None; the authors stated that the “studies generally provided little or no detail about the counseling used” (p. 1399); this meta-analysis used IC in selection criteria

\*If the report left the date when the search ended unstated, it is estimated as 2 years before publication.

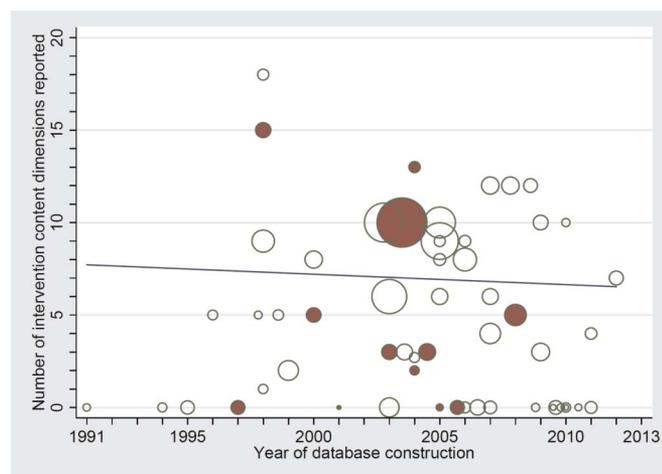
†Number of independent databases in the meta-analysis focused on HIV risk (some meta-analyses included trials focused on other health behaviors).

‡Including qualitative (eg, in descriptive summaries) and quantitative aspects of the Results, when these aspects were formally coded (rather than merely described qualitatively).

§Nonsignificant ( $P > 0.05$ ) moderation results are generally omitted from this column, as are results about other aspects of the meta-analyses; when a meta-analysis offered results for risk behaviors, these are provided rather than psychological dimensions.

FUP, follow-up assessment; IC, intervention content dimension; MSM, men who have sex with men; NS, not statistically significant; PLWHA, people living with HIV/AIDS; STI, sexually transmitted infection (or sexually transmitted disease).

risk of acquiring or transmitting HIV (Table 1), and they have been appearing with increasing frequency over time. Although logically all intervention trials that these meta-analyses reviewed used some form of communication content, numerous meta-analyses reported examining no information content dimensions whatsoever and temporal trends suggest no tendency for content dimensions to appear with greater regularity (Fig. 1). Most meta-analyses examined at least one content dimension; meta-analyses with larger samples of studies were both more likely to consider information content and to find individual content dimensions



**FIGURE 1.** Number of intervention content dimensions reported in meta-analyses plotted as a function of the year of database construction, with scatter points jittered and sized proportionally to the number of studies sampled. The line describes a nonsignificant temporal trend.

related significantly to the magnitude of risk reduction that the trials gauged. A qualitative inspection of the significant dimensions (Table 1) suggests that behavioral interventions that incorporated skill development or motivational enhancement in some fashion had greater success than did those that excluded skill-related dimensions.

Although many of the meta-analyses in this sample have had considerable scholarly impact, the fact that the impact was unrelated to the number of information content dimensions examined suggests that consumers of meta-analyses on HIV risk reduction commonly cite the metaanalyses' results for purposes other than comparing ICs. Of note, very recent meta-analyses have had less chance to accrue citations relative to older meta-analyses. As examples, total citations were inversely correlated with date of publication ( $r = -0.32$ ,  $P = 0.015$ ) and no meta-analysis with a database compiled after 2009 was among the top 20% most impactful meta-analyses in this sample (Fig. 1). Therefore, we also examined whether scholarly impact in meta-analyses published before 2010 was related to using more intervention content dimensions; it was not,  $r = -0.25$ ,  $P = 0.13$ . Instead, consumers of meta-analyses often have an explicit goal to assert that interventions have been shown to be efficacious in reducing risk for HIV in relation to some target population. Indeed, nearly all meta-analyses in this literature report statistically significant reductions in risk behavior and other relevant outcomes for those who participate in interventions as prior meta-reviews have shown.<sup>5,6</sup> Relatedly, some meta-analyses examined methodologically diverse HIV risk reduction interventions but limited their samples in other respects, such as to particular nations or particular risk groups (Table 1). Without reports about the nature of the messages and activities in the intervention curricula, it is unknown the degree to which the interventions grouped by sample are

similar in content. Finally, some meta-analyses limited their samples to trials that investigated a particular form of intervention content, such as motivational interviewing<sup>16</sup> or eroticization of condoms.<sup>59</sup> Doing so can be useful in documenting that a particular intervention content area has been linked to risk reduction, at least in terms of particular samples or locales, but the strategy assumes that no other type of content is responsible for the outcomes. A more powerful analytic design is to take into account all the intervention content dimensions simultaneously. Consumers of meta-analysis should be encouraged to take advantage of moderator trends in meta-analyses, which show how effect sizes vary based on coded features, such as intervention content.

### Limitations of the Meta-Review

Limitations of our investigation stem from the sample of meta-analyses we examined and, in turn, from the trials they sampled. First and most obviously, our methods and results examined the numbers of dimensions of information content that the meta-analyses reported to investigate. It is entirely possible that meta-analysts coded dimensions that then did not appear in the final report; note that we were forced to estimate the number of coded information content dimensions in some cases.

Second, the sample of studies relied on a prior meta-review focused on behavioral interventions to reduce risk of HIV. It is possible that this review missed meta-analyses. More consequentially, the trends we have identified in this meta-review may not well describe research in other HIV-relevant domains, such as strategies to increase adherence to ART. At least 4 meta-analyses have addressed such trials: Three meta-analyses identified no message content dimensions related to enhanced adherence.<sup>64–66</sup> These 3 meta-analyses thus seem quite similar to those reviewed in the HIV risk reduction sample. The fourth meta-analysis, which is discussed at length below, used a formal taxonomy to categorize content with some success, which is discussed at length below.

Third, meta-analyses in our sample used information on content dimensions reported in publications, rather than coded directly from treatment manuals, intervention curricula, and other records of the literal content as used in the intervention. No meta-analysis in our sample mentioned having contacted authors of trials to learn more exact information about the content delivered in their interventions, although they routinely reported obtaining needed statistical information. Authors of meta-analyses often comment about the lack of information available on critical issues. One ART adherence meta-analysis remarked that the details of the interventions in question were so commonly underreported that it was not possible to examine whether the content of the intervention related to its success.<sup>64</sup> The consequence may be that most past meta-analyses have not fully captured the extent to which elements of the communicated content are responsible for behavior change. Thus, our conclusions about which intervention content dimensions are associated with greater risk reduction should be considered preliminary.

A final limitation we will note relates to the methodological quality both of the meta-analyses in our sample and of the quality of the studies they sampled. In theory, the

clearest knowledge gains should emerge from the highest quality studies on a phenomenon<sup>7</sup>; yet, methodological quality varies widely, and meta-analyses inconsistently take quality-related factors into account in their results and in their conclusions about the trends in studies.<sup>7,67</sup> It is possible that our conclusions about the role of intervention content in the HIV risk reduction literature would change if methodological quality is better controlled.

### Formalizing BCTs in HIV Prevention Trials

We believe that both future trials and meta-analyses of trials can profit by focusing much more specifically on potential BCTs underlying risk behavior change. Fortunately, in the last decade, scholars have begun to develop a shared and standardized method of classifying intervention content in the form of taxonomies of BCTs. These taxonomies serve many purposes, including as an aid to systematically describe the communication content of interventions for both research and practice.<sup>1,68</sup> These taxonomies begin to hint at a virtual periodic table of the elements that go into making communication-based interventions successful: (1) They offer unique labels for each BCT, with clear unambiguous definitions. (2) They present a hierarchical structure based on the degree of connectedness between techniques. (3) They help to develop knowledge of boundary conditions for the impact of BCTs, which helps to inform theorizing on how best to improve future interventions and promote health and helps to make translation efforts more efficient in moving BCTs into relevant communities. (4) Because interventions are usually complex and composed of interacting components (eg, BCTs and modes of delivery), they allow one to investigate those interactions with greater precision,<sup>69</sup> as investigators have shown with behavioral interventions for physical activity and obesity.<sup>70,71</sup>

Formally speaking, a BCT is an observable and replicable intervention component designed to change behavior. It is the smallest component compatible with retaining the postulated active ingredients—ie, the proposed mechanisms of change. It can be used alone or in combination with other BCTs.<sup>68,72</sup> BCTs are well-specified, distinct nonoverlapping descriptors: They may or may not be successful at changing behavior in specific situations, and their theoretical mechanism may or may not be understood. BCTs may be a valuable tool for evidence synthesis because they may be key moderators in determining which type of communication content is more often successful and in uncovering the mechanisms of behavior change that have been fruitful in the past.

The first taxonomy of BCTs was developed to provide a method for reliably specifying intervention content in systematic reviewing of complex interventions.<sup>1</sup> Subsequent taxonomies have been developed to address specific behavioral domains: physical activity and healthy eating,<sup>73</sup> smoking cessation,<sup>74</sup> and alcohol consumption.<sup>75</sup> To develop shared language across behavioral domains with international consensus, Michie et al<sup>2</sup> built on this work to develop BCT Taxonomy, version 1, labeled BCTTv1. This extensive cross-domain taxonomy comprises 93 BCTs with clear labels, definitions, and examples, organized into 16 groupings to

facilitate its application. For clarity, in the remainder of this article, we refer to investigators' ad hoc efforts to operationalize active communication dimensions as "intervention content," and we reserve the term "BCT" for instantiations that adopt a formal taxonomy.

The principal strengths of adopting a BCT approach are its precision in stating the specific element(s) of a message in a fashion that enables greater precision in research, which in turn should translate into improved success when trials' outcomes are generalized to the community. As we saw, past meta-analyses that have examined the ability of interventions to reduce HIV risk or to improve drug adherence have lacked this precision, making their findings less consistent and less parallel. These observations strongly suggest that fully incorporating BCT taxonomies would, in the long run, improve both scholarship and application related to HIV prevention and care. To this point, a pioneering ART meta-analysis<sup>3,76</sup> explicitly operationalized BCTs by obtaining details of the intervention content used in the past ART adherence trials from the original researchers, who helped to systematically code the content of both treatment and control conditions. The numbers of BCTs explained appreciable amounts of variation in effects for both conditions (eg, tailored medication schedules, planning coping responses).

As noted above, past meta-analyses focused on behavioral interventions have not formally used BCT taxonomies. Therefore, caution is merited in generalizing our meta-review's conclusions about active intervention content dimensions to specific BCTs. One problem appears because research reports commonly use labels for intervention content that poorly match taxonomies. For example, in our meta-review, one theme was that skill provision helps reduce HIV risk. Yet, BCT taxonomy research<sup>2</sup> has mapped several more precise BCTs related to skills, such as behavioral rehearsal or practice, skills in self-assessment, goal setting, and self-monitoring, and social support and persuasive skills. An additional difficulty is that BCT scholars have shown that authors of trials frequently err when describing the content of the intervention and control conditions.<sup>1,77,78</sup> No meta-analysis reported more than 18 information content dimensions, but it is likely that many meta-analyses underreported content dimensions.

It is important to note that intervention content is also present in the control arm of most studies, which often employ a "standard of care" design as a control for the intervention. Only a few meta-analyses in the present review examined the intervention content of control arms (Table 1) and treated effects as repeated observations rather than focusing on between-condition comparisons.<sup>12,13,26,45</sup> Indeed, in the ART meta-analysis mentioned, the amount of change exhibited in some control conditions exceeded that for some intervention arms in the meta-analysis of BCTs used in ART trials.<sup>3,76</sup> Assessing content in both arms and examining change over time rather than between conditions, therefore, made possible much better explanation of intervention success. In the meta-review sample, meta-analyses examined effects using between-group comparisons (ie, treatment vs. control at a posttest), which implicitly assumes that the control condition is the same across studies. As Abraham et al<sup>79</sup> detailed, meta-analyses

could instead code the content in both arms and examine effects temporally (eg, posttest vs. pretest risk).

At least 5 factors present challenges to the adoption of BCT taxonomies. First, using BCTs requires thorough understanding of the taxonomy to assure reliable and valid coding. Coding BCTs present in interventions is a highly skilled task, requiring familiarity with labels and definitions and the ability to make a series of complex interpretative judgments. BCTTv1 contains 93 BCTs, making it a formidable challenge to learn and requiring an effective program of coder training. Two formats of training programs have been developed by the BCT taxonomy team, including 1-day workshops and distance group tutorials. Wood and colleagues' (unpublished) study of 161 trainees evaluated their skills at coding intervention descriptions into BCTs and found that the training significantly increased agreement of trainees with expert consensus about BCTs identified in the descriptions. Training is now available in an online open-access training course (see <http://www.ucl.ac.uk/health-psychology/bcttaxonomy> for details).

Second, because intervention efforts were conducted to find a useful intervention rather than to test theory with great precision, the result is that intervention components are often confounded and poorly reported.<sup>4</sup> Important variables may be omitted, poorly measured, or lack sufficient variation. As an example, a recent meta-analysis<sup>35</sup> focused on behavioral interventions for adolescents found that provision of motivational and behavioral skill components increased adolescents' condom use. Yet, because nearly every trial provided information to participants, there was insufficient variability to test whether not providing information undermines the success of the intervention, as at least one prevention model<sup>80</sup> predicts. If researchers more often systematically and cleanly manipulated the dimensions posited to improve the targeted outcomes, evidence synthesis could proceed more efficiently. Similarly, BCT research has revealed that treatment manuals often call for using more BCTs than publication reports<sup>1</sup>—more than twice as many in at least one case.<sup>81</sup> Given that behavioral interventions are often delivered with less than 50% fidelity to that explicitly defined by a treatment manual, one can see why there may be a tenuous linkage between the intervention content reported in publications and those delivered in implementation.<sup>77,78</sup>

Third, greater precision in the reports of the content of interventions delivered is clearly necessary for a science of behavior change to advance or for implementation efforts to succeed. A recent survey by McCleary et al<sup>82</sup> of randomized controlled trials published in prominent medical journals revealed that efficacious components are reported more frequently in pharmacologic than in nonpharmacologic interventions. In effect, current reporting practices restrict the range of information available in publications to code as BCTs, leaving open the possibility that intervention content actually matters more to the success of interventions than past meta-analyses have been able to determine (Table 1). Fortunately, reporting standards are improving, as shown in at least 2 efforts. (1) the Workgroup for Intervention Development and Evaluation Research (WIDER)<sup>83</sup> has developed a checklist to assess the quality of the reporting of

interventions in systematic reviews, as Abraham et al<sup>79</sup> describe in this issue. (2) The Template for Intervention Description and Replication (TIDieR)<sup>84</sup> provides a checklist of the minimum information required to report interventions, including surgical, pharmacologic, psychotherapeutic, and behavioral interventions. Developed using consensus development methods with international participants from several disciplines, it proposes a minimum set of information: brief name, why (rationale), what materials, what procedure, who provided, how, where, when and how much, tailoring, changes, how well monitored, and how well delivered. These aspects are mainly procedures for delivery (often referred to as “mode” of delivery) rather than the content of the active ingredients. As time passes and scholars report their trials with greater precision, understanding the factors behind successful behavior change should improve accordingly.

Fourth, the samples of participants targeted in particular trials and meta-analyses typically differ widely; yet, currently there is no way to standardize these differences other than by using demographic labels. Reports ought to describe their samples in terms of their representativeness—the extent to which they are similar or different from the populations in the communities from which they are drawn—but representativeness is often not reported, and indeed, standards for the criteria by which to judge representativeness are debatable. Demographics, because they can be tied to census data, are a convenient way to label samples and populations. Unfortunately, they often only loosely describe health status or risk, which is ultimately most of concern in health interventions. Intervention studies drawing on convenience and self-selected samples, in particular, lack a means of judging generalizability. Even in studies limited to 1 demographically defined population may have great variation in other demographic characteristics. For example, meta-analyses focused on adolescents typically include both genders ranging from preadolescents to emergent adults; they include numerous races and ethnicities; they include samples from numerous communities. Invisible in the reports is also a sense of the comparative health status and health resources of the samples; some adolescents may live in places with greater or lesser access to health and preventive care; some may be at greater or lesser risk of HIV infection and other illnesses. Health-related research would benefit from a standard method to gauge key features of their samples—including both community factors and health status at a moment in time. Systematic reporting of sample characteristics could then be linked to studies of the effectiveness of BCT, enabling science to state with greater precision the effectiveness of BCTs on HIV prevention within specific populations.

Finally, disentangling confounded effects in meta-analyses rests on having sufficiently large samples of studies that vary in the information content presented. In our meta-review, the typical meta-analysis reviewed fewer than 30 studies, and relatively recent meta-analyses have shown no tendency to increase samples of studies; thus, meta-analyses seem to use increasingly restrictive selection criteria. Unless future meta-analyses broaden their selection criteria, knowledge about the particular BCTs that underlie intervention success will remain impoverished.

## CONCLUSIONS

The avenues we have outlined in this meta-review for methodological improvements in specifying BCTs and analyzing and evaluating HIV-related interventions offer the potential for vastly greater returns on future investment in research into interventions to reduce risk for HIV and to improve HIV care. This strategy will aid not only meta-analyses of trials but also original research on these topics. BCT taxonomies offer considerable advantages for authors of reports on clinical trials because BCT nomenclature permits efficient compact labels for the BCTs employed in intervention and control arms. As more trials are described in such careful terms, the result should be ever-clearer conclusions about what content actively drives behavior change.

Logically, improved science results in improved translation of effective interventions into communities that need to reduce risk or improve HIV care outcomes. An awareness of which combination of BCTs are effective and which are ineffective for which populations and settings could have a profound impact on cost-effectiveness by focusing on effective intervention elements and eliminating ineffective content. Implementation science<sup>85</sup> can thus also be enhanced by thoroughly incorporating BCT taxonomies into its methods.

As BCT taxonomies are applied to a wider range of populations, settings, and behaviors, adaptations of language, and possibly also of concepts, will be needed, and new BCTs will be identified. To preserve a shared methodology and avoid the fragmentation of the field, it will be important to build on BCTTv1 in a coordinated fashion. Michie et al are developing an international consortium to monitor and collate experiences, adaptations, and findings so that the next version of the BCT taxonomy can be developed and released. The emergence of this taxonomy will depend on judgment, balancing the needs for stability, and for accumulation of evidence using a shared method against the need for refinement and extension. A further advance will be the development of a complete ontology linking BCTs, modes of delivery, context (target population and setting), and type of behavior. Such an ontology would help the development and selection of time- and cost-efficient intervention strategies that maximize effectiveness. An international collaboration of behavioral and computer scientists is engaged in this work, which is in its early stages.

To date, BCT research has focused more on the qualitative dimensions present in a communication rather than the amount of BCT offered. The latter theme has emerged in some of the extant meta-analyses; some have shown dose–responses in relation to risk reduction. For example, a meta-analysis on risk reduction for adolescents<sup>35</sup> isolated time per session of motivational training and condom use skills as having been particularly successful. The fact that it was dosage per session rather than total dosage strongly implies that risk reduction can be accomplished in relatively brief interventions and need not require multiple sessions, a finding consistent with at least 2 other reviews.<sup>5,8</sup> This direction would seem profitable for future meta-analyses to pursue.

In focusing on BCTs in HIV-related interventions, we might have given the unintended impression that BCTs are

the only ingredient in successful health promotion. To the contrary, relevant theories increasingly are specifying aspects of the milieu that are important for risk reduction,<sup>86–88</sup> as Kaufman et al's<sup>89</sup> review in this issue concluded. Consider a recent meta-analysis of behavioral interventions<sup>36</sup> to reduce African-Americans' sexual risk for HIV; its analytic models focused on sample differences (eg, age, HIV serostatus) and intervention content dimensions (eg, skill provision, motivational training). Like nearly all past meta-analyses, it did not examine whether any aspect of the social milieu surrounding risk reduction in the interventions had any bearing on results. Yet, in theory, the milieu may have a substantial role, given that intervention participants must live for extended periods in environments that may contradict or even be hostile to the message in the intervention itself—or indeed, hostile toward the people addressed by the intervention—before the success of the intervention is finally gauged. Of note, there was heterogeneity in risk-related outcomes in the meta-analysis that could not be explained using the features of the interventions, studies, and samples. Reid et al<sup>90</sup> reanalyzed this database, adding residential segregation and prejudice levels of Caucasians toward African-Americans, defined at the level of the US county. Both factors related to risk reduction success; trials were more efficacious in places with less segregation or higher liking, and this pattern was especially marked for more vulnerable samples, such as adolescents. A limitation of this reanalysis, noted by the team, was that it did not theorize about which BCTs might prove especially valuable in difficult environments for particular populations. Future meta-analyses should explore such possibilities in detail. Effective interventions targeted at populations living in challenging circumstances deserve special attention.

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