**­OpenAI’s GPT API Models Can Function as a Highly Reliable Second Screener of Titles and Abstracts in Systematic Reviews**

**ABSTRACT**

Independent human double screening of titles and abstracts is considered a critical step to ensure the quality of systematic reviews and meta-analyses herein. However, double screening is a costly as well as a time- and resource-intensive procedure that slows the review process, ultimately excluding many researchers from using it. To alleviate this issue and potentially increase the reliability of systematic reviews and meta-analyses, we evaluated the use of OpenAI’s GPT API models as an alternative second screener of titles and abstracts in large-scale systematic reviews. Overall, we found that GPT models perform similarly or even better than human screeners in terms of detecting relevant studies to be included. To support future reviewers, we develop a reproducible workflow and tentative guidelines for when reviewers can use GPT models for title and abstract screening. For this purpose, we present the R package AIscreenR.

**KEYWORDS:** *title and abstract screening, ChatGPT, systematic review, meta-analysis, screening benchmarks, AIscreenR*

[CHECK DETAILS HERE: <https://onlinelibrary.wiley.com/page/journal/17592887/homepage/forauthors.html>]

**HIGHLIGHTS**

**What is already known**

* OpenAI’s GPT API models have been shown to work as a second screener of titles and abstracts within clinical and software literature.
* Automating screening tools can ease the burden of title and abstract screening

**What is new**

* We show that OpenAI’s GPT API models can function as a highly reliable second screener in social science reviews with better recalls than presented in previous evaluations.
* We develop general benchmarks to compare the performance of AI screening tools with human screening.
* We provide general guidelines for how and when GPT models safely can used
* We present and validate the R package AIscreenR to ensure standardized conduct of title and abstract screening with OpenAI’s GPT models.

**Potential impact for Research Synthesis Methods readers**

* Changing the double screening workflow of title and abstract screening in systematic reviews
* Increasing the reliability of systematic reviews
* Substantial reduction of human labor in systematic reviews
* Standardizing screening with GPT API models

**INTRODUCTION**

Systematic reviews are essential tools for informing policy, research, and practice. Therefore, it is all-important that systematic reviews adhere to the highest scientific standards. Distinct from other types of reviews, systematic reviews are defined as the process of collecting, assessing, and synthesizing findings from relevant papers using explicit and replicable research methods (Gough et al., 2017; Hou & Tipton, 2024). A critical first step to ensure the quality of systematic reviews and meta-analyses herein involves detecting all eligible references related to the literature under review (Polanin et al., 2019). This entails searching all pertinent literature databases relevant to the given review, often resulting in thousands of titles and abstracts that need to be screened. Screening of a large number of titles and abstracts is a time-consuming and tedious task. However, overlooking relevant studies in this phase can be consequential, leading to substantially biased results. In fact, this can be seen as a special case of publication bias (Rothstein et al., 2005). Hence, independent human double-screening is considered to be the ’golden standard’ to hinder a biased selection of relevant studies (Guo et al., 2024; Higgins et al., 2019; Wang et al., 2020). Previous research suggests that screeners tend to miss between 3% to 24% of all eligible studies, which most often impacts the final results substantially (Buscemi et al., 2006; Waffenschmidt et al., 2019). Yet, duplicate screening of all identified titles and abstracts is a costly and resource-intensive procedure, potentially requiring several months of skilled, full-time human labor to complete (Campos et al., 2023; Hou & Tipton, 2024; Shemilt et al., 2016). Consequently, many reviewers refrain from using duplicate methods due to scarce budgets or narrow time limits, for instance. Over time, this issue will only grow in size since the complexity of identifying all relevant studies increases with the rapid growth in the number of scientific publications (Bornmann et al., 2021; O’Mara-Eves et al., 2015). Thus, it can be considered an economically inefficient and unsustainable use of human resources only to rely on human screening of titles and abstracts in future systematic reviews (Shemilt et al., 2016). An alternative to human double-screening is to use (semi-)automated tools based either on text-mining or machine-learning algorithms to act as the second screener, a course-grained classifier, or to sort citation records in prioritized order (Cohen et al., 2006; Gartlehner et al., 2019; O’Mara-Eves et al., 2015; Van De Schoot et al., 2021). The use of (semi-)automated screening tools is considered invaluable in supporting living reviews and has shown a promising ability to reduce the screening workload by 30% to 70% (O’Mara-Eves et al., 2015; Perlman‐Arrow et al., 2023). However, a clear disadvantage of substantial workload savings is that they will always result in missing at least 5%-10% of all eligible references since ”a 100% recall rate with a stochastic algorithm is generally considered unattainable” (Hou & Tipton, 2024, p. 3). This creates a screening paradox. While trying to reduce selection biases caused by single screening, automated screening potentially introduces a novel type of publication bias defined by König et al., (2023) as the ‘artificial screening bias’. A further challenge with machine-assisted tools is that most of them are based on supervised and active learning methods. This means that they need to be trained on a large enough set of in- and excluded references to perform adequately which in turn can be a time-consuming task. In addition, it is most often unknown when it is safe to stop screening in terms of finding all or close to all eligible references. Albeit, various stopping rules have been proposed, the adequacy of these is sensitive to a range of factors such as the length of the databases and prevalence of included studies (Campos et al., 2023; König et al., 2023).

To date, many automated screening tools have been thoroughly evaluated (Burgard & Bittermann, 2023). The overall picture is that they are generally not capable of replacing an independent human second screener without significant risk of omitting a substantial number of eligible studies (Gartlehner et al., 2019; O’Mara-Eves et al., 2015; Olorisade et al., 2016; Rathbone et al., 2015). By using the level of automation heuristic (Table 1) developed by O’Connor et al. (2019), it can be said that current automated tools generally fail to function at the highest levels of automation (i.e., Level 3 and Level 4) where they can make trust-worthy independent, deterministic screening decisions. Instead, the vast majority of tools are predominated used to conduct Level 2 tasks such as sorting citation records in prioritized order from highest to lowest probability of being relevant to the review (O’Connor et al., 2019; Olofsson et al., 2017). If considerable time savings should be realized, it is regarded as pivotal that machine-assisted tools rise to Level 3 or 4 automation.

Purpose of the paper, models in LLM vs. GPT.

If considerable

Instead

Predominant used to conduct level 2 tasks (c.f. Table 1) (O’Connor et al., 2019; Olofsson et al., 2017). Previous evaluations of existing tools find that most automated tools fail to reliably act as/imitating a human second screener or should be used cautiously

not GPT model, and not in the social sciences.

Building the brigde -

**Table 1.** Levels of automation for human-computer interactions\*

|  |  |
| --- | --- |
| **Level** | **Task** |
| Level 4 | Tools perform tasks to eliminate the need for human participation in the task altogether, e.g., fully automated article screening decision about relevance made by the automated system. |
| Level 3 | Tools perform a task automatically but unreliably and require human supervision or else provide the option to manually override the tools’ decisions, e.g., duplicate detection algorithms and software, linked publication detection with plagiarism algorithms and software. |
| Level 2 | Tools enable workflow prioritization, e.g., prioritization of relevant abstracts; however, this does not reduce the work time  for reviewers on the task but does allow for compression of the calendar time of the entire process. |
| Level 1 | Tools improve the file management process, e.g., citation databases, reference management software, and systematic  review management software. |

\*Adopted from O’Connor et al. (2019)

Read Campos ther paper and Syriani – then Guo

Most machine-learning tools are well evaluated (Burgard & Bittermann, 2023), do not work good as an indenpendent second screener. Mostly used to conduct level 2 tasks.

not GPT model, and not in the social sciences.

In this paper, we evalute the perform. As key obstracle for the commen use of What we do connect it with Campbell bullet points. We build user-friendly software to overcome the earilier issue that reviewers are unfamiliar with the software. Bla. Bla.

Most safe use of current machine learning tools is use them for priorization order and not deterministically make a include or exclud screening decision.

Present main results

What we do in the rest of the paper as in Hou & Tipton

needs to be trained on significant amount of references, stopping rules, reading all references.

Purpose of this paper, find working in Guo et al.

No need for unnecessary restriction on search string. Makes it possible to screening large amount of references.

This ultimately excludes many researchers from using it. Instead single screening often used partly due to general lack of trust and partly due to knowledge about given software opportunities (O’Connor et al., 2019; O’Mara-Eves et al., 2015).

An often suggested alternative to independent human double-screening is to use semi-automated machine-learning tools

Mention the advantage of using this approach. Require lots of training, uncertain when to stop and will always miss around 5 percent of all relevant studies.

The first step for all systematic reviews entails finding all relevant studies concerning the scientific question on review.

Systematic reviews, the process of collecting, assessing, and synthesizing findings from relevant papers using explicit, accountable research methods, are pivotal

“review[s] of existing research using explicit, accountable rigorous research methods”

An all-important first step to ensure the quality of systematic reviews and meta-analyses herein involves detecting all relevant references related to the literature under review (Polanin et al., 2019). Usually, this involves independent human double screening of all references detected in relevant databases and literature with two human screeners. This procedure has shown pivotally since less experienced single screeners tend to miss around 13% of relevant studies (with 3% for experienced screeners), mostly changing the main review findings (Waffenschmidt et al., 2019). Yet, double-screening is a costly and resource-intensive procedure which ultimately excludes many researchers from using it. An alternative to human double-screening is to use automated tools to act as the second screener (Gartlehner et al., 2019; Van De Schoot et al., 2021). Previous evaluations of existing tools find that most automated tools fail to reliably act as/imitating a human second screener or should be used cautiously (Gartlehner et al., 2019; O’Mara-Eves et al., 2015; Olorisade et al., 2016; Rathbone et al., 2015). Meanwhile, it is still less known how well or if the newly developed large-language models (LLMs), such as ChatGPT, can work as a reliable second screener, especially within social science reviews.

We still need to know if it can work for social science reviews, there is a lack of guidelines for how to use GPT plus we software has not yet been develop to scale up the use of these models for title and abstract screening.

“*Deployment and user acceptance: requires (a) functioning tech (b) proof that it is functioning appropriately (c) the tech embodied in usable products (d) agreed guidelines for appropriate use (e) training (f) ongoing support.*” ([Campbell Collaboration](https://www.campbellcollaboration.org/news-and-events/news/stepping-up-evidence-synthesis.html))

We focus on proving (b) and developing as well as providing software and user guidelines to fulfill (c) and (d).

*Previous research*

Syriani et al. (Syriani et al., 2023) test the performance relative to other machine-learning models.

*What we do differently*

* Use newest models with function calling. We are the first to present results for the GPT-4 model.

”*Function calling allows developers to more reliably get structured data back from the model.*” (<https://openai.com/blog/function-calling-and-other-api-updates>)

* Instead of comparing GPT to other machine learning models, we develop benchmark for comparing human and AI performance.
* Develop new software (AIscreenR) to standardize the title and abstract screening with GPT.
* Multi-core process to increase the time used on screening.
* Draw on function calling an incorporates uncertain decisions. “Function calling allows developers to more reliably get structured data back from the model” (<https://openai.com/blog/function-calling-and-other-api-updates>)

*Metrics we use to evaluate the performance of the gpt models*

All metrics presented below were chosen based on the recommendations made by Syriani et al. (2023). The two main metrics we used to evaluate the performance of the GPT API models were the recall and specificity metrics since these are intuitive to understand and interpret and are not sensitive to imbalanced data (i.e., data with a large discrepancy between inclusion and exclusion references). The recall “represents the proportion of relevant records being correctly classified” (Hou & Tipton, 2024), and can be written as

where (true positive) represents all the studies that are correctly included, and (false negative) is the number of studies falsely excluded. By contrast, specificity “measures the ability to exclude all references that should be excluded” (Syriani et al., 2023), given by

where (true negative) represents all the studies that are correctly excluded, and (false positive) is the number of studies falsely included. The recall metric can be considered the most important metric since it can seriously bias a review if the screener excludes references that should have been included. [FIND FURTER REASONS IN HOU & TIPTON] Whereas, a low specificity “just” means that reviewers must re-examine a larger share of the reference. This goes without saying that reviewers should accept low specificity rates. We will come back to that in the following sections.

We applied to overall assessment metric deduced from the above measure: mention imbalanced data

In our simulation, the , , , and conditions are determined by comparing the GPT decision with the final decision made by a minimum of two independent human screeners. For benchmark development, the conditions are determined by comparing the single screener decision with the final decision agreed upon between a minimum of two human screeners. This approach is suggested by O’Connor et al. (O’Connor et al., 2019)

Mention how to calculate variance and confidence intervals. Viectbauer and Research synthesis methods. (Röver & Friede, 2022; Schwarzer et al., 2019)

Mention the nMCC model and formula and why it is prefer above the receiver operating characteristic Curve (ROC AUC) (Chicco & Jurman, 2023)

Insert WSS (Campos et al., 2023)

*Human performance vs. AI performance*

To grasp a better understanding of the AI performance. (O’Connor et al., 2019) map how humans perform.

We think it is more fair to compare the performance of the GPT models

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source**  **Authors** | **Short title** | **Double-screen refs** | **n\_relevant;**  **N double-screened** | **Ass.** | **Aut.** |
| *Campbell review* |  |  |  |  |  |
| Bøg et al. (2018) | Deployment of personnel to military operations | 2899 | 106;2899 | 2 | - |
| Bondebjerg et al. (2023) | The effects of small class sizes on students’ academic achievement, socioemotional development and well‐being in special education | 11860 | 244;1160 | 4 | 2 |
| Dalgaard, Bondebjerg, Klokker et al. (2022) | Adult/child ratio and group size in early childhood education or care to promote the development of children aged 0–5 years | 3667 | 258;3667 | 4 | 2 |
| Dalgaard, Bondebjerg, Viinholt et al. (2022) | The effects of inclusion on academic achievement, socioemotional development and wellbeing of children with special educational needs | 14491 | 373;14491 | 5 | 2 |
| Dalgaard, Filges et al. (2022) | Parenting interventions to support parent/child attachment and psychosocial adjustment in foster and adoptive parents and children | 13106 | 424;13106 | 3 | 2 |
| Dalgaard, Jensen et al. (2022) | PROTOCOL: Group‐based community interventions to support the social reintegration of marginalised adults with mental illness | 17614 | 557;17614 | 4 | 3 |
| Dietrichson et al. (2020, 2021) | Targeted school-based interventions for improving reading and mathematics for students with or at risk of academic difficulties in Grades K-6 [plus 7-12] | 15273 | 2952;15273 | 6 | 1 |
| Filges, Dalgaard et al. (2022) | Outreach programs to improve life circumstances and prevent further adverse developmental trajectories of at-risk youth in OECD countries | 4890 | 387;4890 | 4 | - |
| Filges, Dietrichson et al. (2022) | Service learning for improving academic success in students in grade K to 12 | 6269 | 619;6269 | 4 | 1 |
| Filges, Montgomery, et al. (2015) | The Impact of Detention on the Health of Asylum Seekers | 10061 | 573;10061 | 2 | - |
| Filges, Siren et al. (2020) | Voluntary work for the physical and mental health of older volunteers | 14919 | 43;14919 | 2 | 0 |
| Filges, Smedslund et al. (2023) | PROTOCOL: The FRIENDS preventive programme for reducing anxiety symptoms in children and adolescents | 2745 | 96;2745 | 1 | 1 |
| Filges, Sonne-Schmidt et al. (2018) | Small class sizes for improving student achievement in primary and secondary schools | 7802 | 303;7802 | 5 | 1 |
| Filges, Torgerson, et al. (2019) | Effectiveness of continuing professional development training of welfare professionals on outcomes for children and young people | 5147 | 298;5147 | 1 | 4 |
| Filges, Verner et al. (2023) | PROTOCOL: Participation in organised sport to improve and prevent adverse developmental trajectories of at-risk youth | 7021 | 158;7021 | 2 | 1 |
| *NIPH review* |  |  |  |  |  |
| Ames et al. (2024) | Acceptability, values, and preferences of older people for chronic low back pain management | 6644 |  | - | 2 |
| Evensen et al. (2023) | Sutur av degenerative rotatorcuff-rupturer [Rotator cuff repair for degenerative rotator cuff tears] | 425 |  | - | 4 |
| Jardim et al. (2021) | Effekten av antipsykotika ved førstegangspsykose [The effect of antipsychotics on first episode psychosis] | 3924 |  | - | 3 |
| Johansen et al. (2022) | Samværs-og bostedsordninger etter samlivsbrudd [Custody and living arrangements after parents separate] | 1525 |  | - | 4 |
| Meneses Echavez et al. (2022) | Psykologisk debriefing for helsepersonell involvert i uønskede pasienthendelser [Psychological debriefing for healthcare professionals involved in adverse events] | 5452 |  | - | 3 |

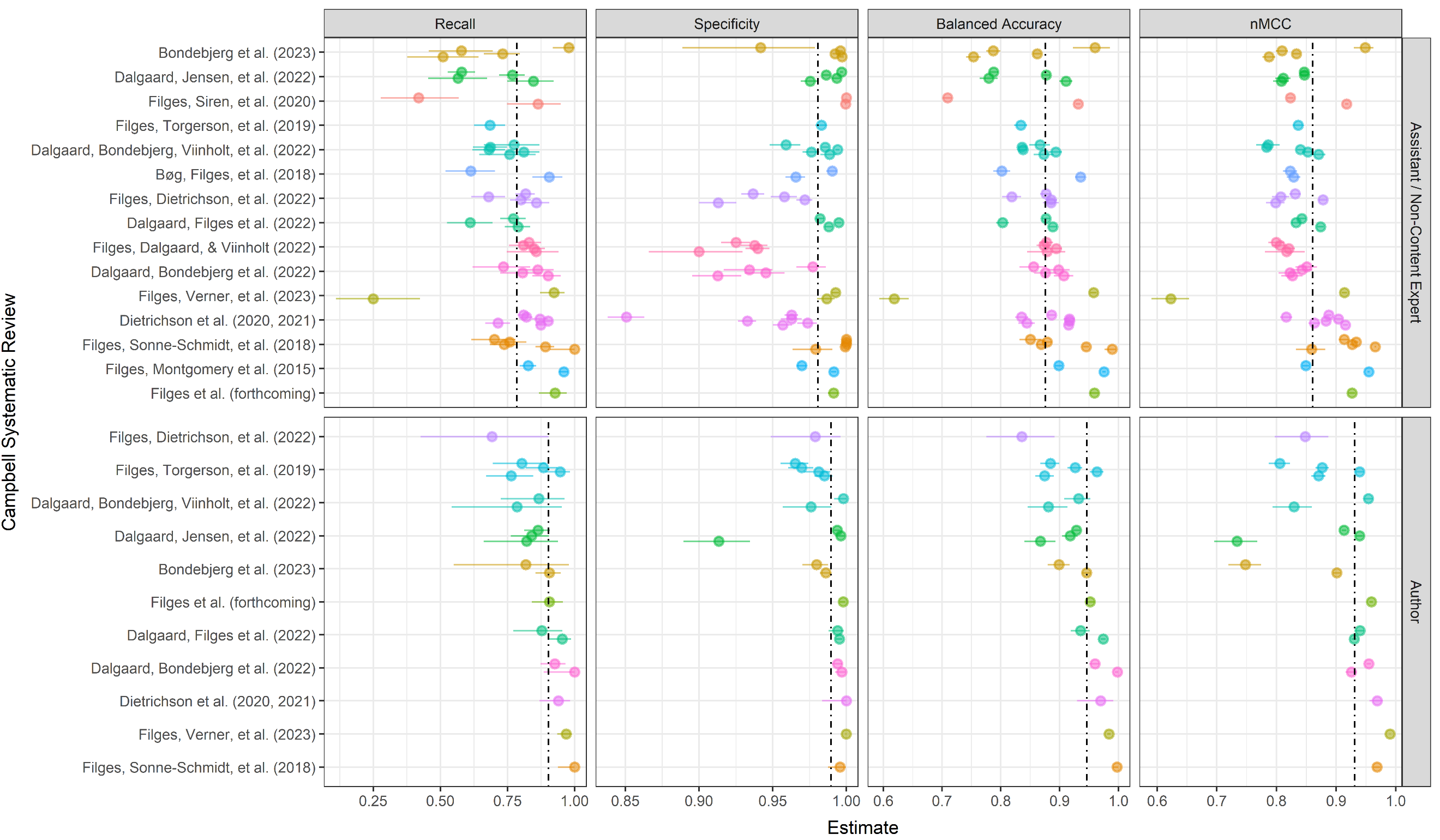


FIGURE 1. Performance measures within Campbell Systematic Reviews across assistants vs. authors. Dashed line indicate the average estimated via the SCE+ model.



FIGURE 2. Researcher-researcher screening performance measures within NIPH Systematic Reviews. Dashed line indicate the average estimated via the CHE model.

Mention the authority and deeper content knowledge of the main author which might cause the recall to increase when review author screen with student assistants. Therefore to compare screenings with more equal relations, we analyze data from sixe systematic reviews conducted by the Norwegian Institue of Public Health (NIPH).

Imbalance is not a problem with GPT models cf. FRIENDS

Does not need to be trained. Only initial testing is needed.

*Simulation data*

FRIENDS and FTT, only citation records with abstracts

*Prompt engineering*

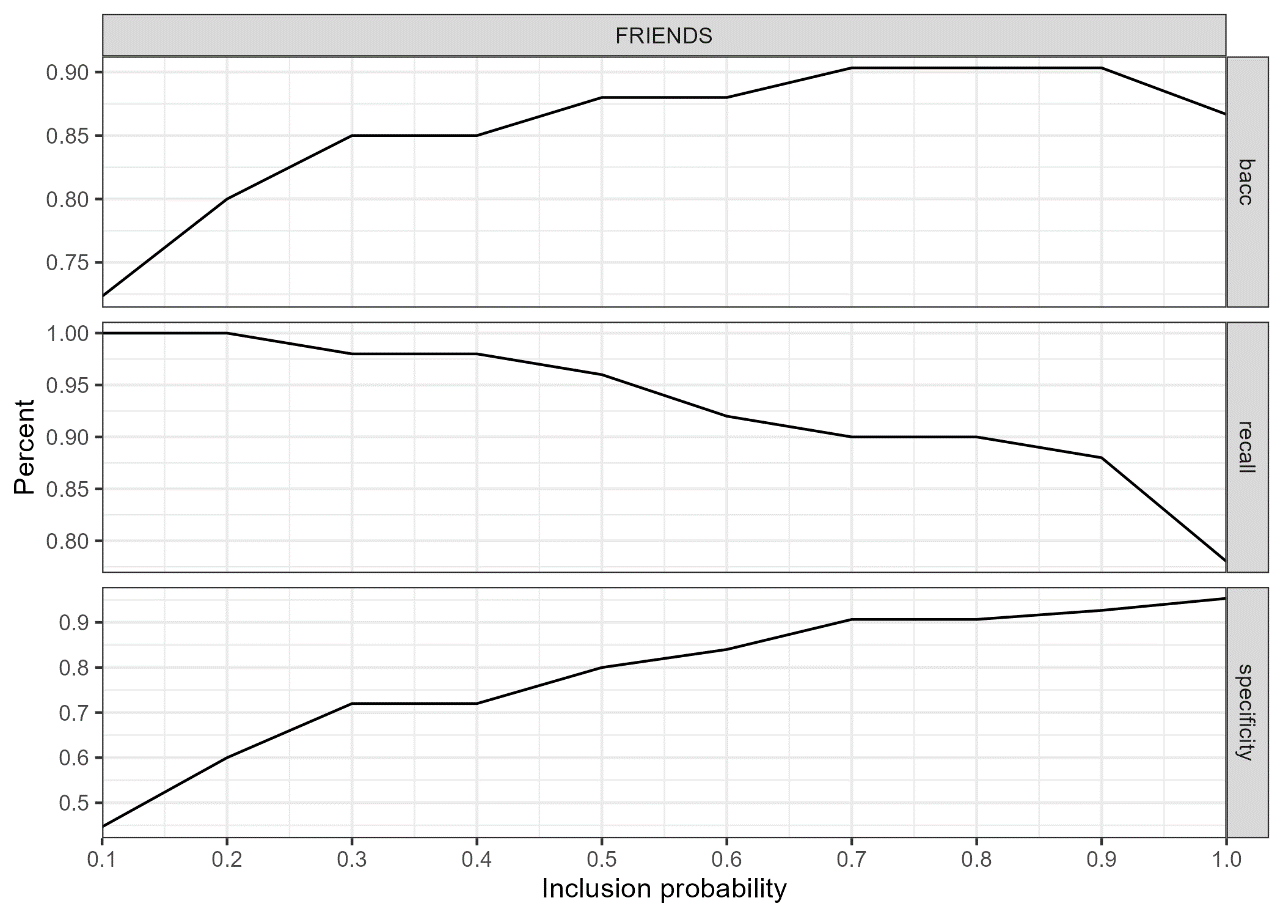
[insert prompt example]

*The simulation results*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Review**  **Model** | **Reps** | **Recall (%)**  **[TP/(TP + FN)]** | **Specificity (%)**  **[TN/(TN + FP)]** | **Raw aggrement (%)**  **[(TP + TN)/]a** | **bAcc**  **(%)** | **WSS** |
| *FFT* |  |  |  |  |  |  |
| GPT-3.5-turbo-0613  (incl. prop = .5) | 10 | 71  (49/69) | 95.6  (3888/4066) | 95.2  (3937/4135) | 83.3 | 94.5 |
| GPT-3.5-turbo-0613  (incl. prop = .3) | 10 | 81.2  (56/69) | 93.7  (3809/4066) | 93.5  (3865/4135) | 87.4 | 92.4 |
| GPT-4-0613 | 1 | 89.9  (62/69) | 93.7  (3810/4066) | 93.6  (3872/4135) | 91.8 | 92.3 |
| *FRIENDS* |  |  |  |  |  |  |
| GPT-3.5-turbo-0613  (incl. prop = .5) | 10 | 96.9  (62/64) | 76.5  (1930/2511) | 77.1  (1992/2575) | 86.7 | 75 |
| GPT-3.5-turbo-0613  (incl. prop = .7) | 10 | 95.3  (61/64) | 89.8  (2256/2511) | 90.0  (2317/2575) | 92.6 | 87.7 |
| GPT-4-0613 | 1 | 98.4  (63/64) | 97.4  (2455/2511) | 97.4  (2518/2585) | 97.9 | 95 |

*a*: is the total number of references





Concise text more important than information-dense prompt.

GPT-3.5-turbo is sensitive to the number of times a reference is included across the 10 iterations. If 3.5 models are used then this most efficient threshold must be determined in the test phase.

Due to costs, we have not investigated the performance of GPT-4 with 10 iterations. As soon as the cost get close to the current cost of GPT-.3.5 models, users could considered screening all titles and abstracts with 10 iterations. For now suggest just to re-screening all references where humans and GPT disagree.

In contrast with priority screening methods (Hou & Tipton, 2024), the gpt models do have the potential to find more than 95% of the relevant study cf. FRIENDS.

A side-goal of this simulation was also to validate the performance of the AIscreenR software. Especially the use of function calling.

Student screening evaluation (Ng et al., 2014)

*Tentative guidelines*

*80% recall and 95% specificity.*

*Workflow and short package presentation*

Testing, not training. Less is more.

*Deficits of using GPT API models*

* Black box (but this does not only count for GPT this is often true for human screening as well)
* Function tech? We have no control over the existence of OpenAI

*Future research*

* The use of hierarchical prompting in complex reviews
* Shiny app to ease user set-up challenges (O’Connor et al., 2019) to make the workflow more user-friendly.

*Discussion*

* Talk about the interface here – cannot replicate the results on the ChatGPT interface
* Reviewers should not consider screening prioritization methods and GPT screening as two incommensurable methods. Instead, the strength from both should ideally be combined.
* Forces review times to make very narrow searches due to lack of ressources to conduct the title and abstract screening rigorously (Guo find in ICloud)
* We believe that the GPT-4 models will perform even better when fed with abstracts following a rigorous structure as in medicine.
* When not to use. If you cannot make the prompt work properly or if you screen very few studies.
* We believe that no automated tool should ever be at level 4 – there shall always be a human-in-the-loop to ensure adequate behavior the the screening tools. Consequently, GPT models used in non-systematic to reduce the number of studies needed to be screened should always include safety checks. For example, reviewers should randomly sample 5-10% of the studies excluded by GPT to test for serious flaws in its decision-making. If serious flaws are detected the reviewers must re-test the used prompt(s) or refrain from using the given GPT model.
* More rapid transfer of knowledge from review to policy, research, and practice
* Makes it possible to help screening in extreme-sized reviews (Shemilt et al., 2014, 2016)

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**CONFLICT OF INTEREST STATEMENT**

The authors declare no conflict of interest.

**DATA AVAILABILITY STATEMENT**

To adhere to the reproducibility framework proposed by Olorisade et al. (2017), replicate codes can be found at OSF and GitHub page

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